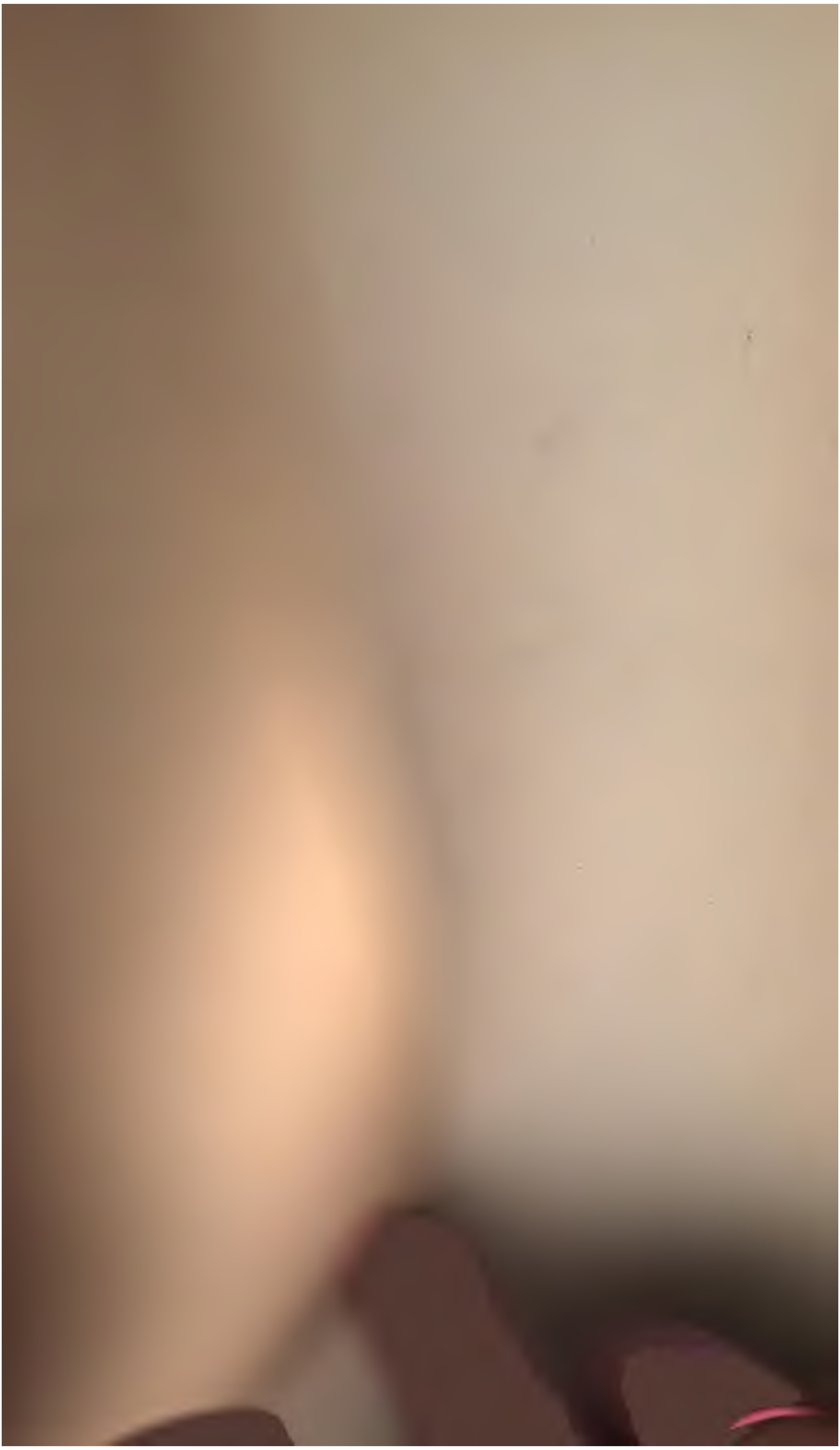

The Health Officer

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PREFACE

THIS book contains the information which the average health officer must have in order to discharge his duties. It tells the health officer what to do, how to do it, and why he should do it. It describes the various activities in which a health officer engages; his relation to boards of health, physicians, social agencies, and the public; his qualifications and methods of work; the various diseases and unsanitary conditions with which he deals; and the scientific principles on which the specialty of preventive medicine is founded. It is the result of the years of experience of the authors in public health work, both in rural communities and in New York City, and as supervisors of health officers under the New York State Department of Health. While the book is designed primarily for health officers, its simple language and untechnical form will commend it to college students, public health nurses, members of boards of health, social workers, teachers, and others who are interested in public health work.

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THE HEALTH OFFICER

CHAPTER I

ORGANIZATION AND POWERS OF A HEALTH DEPARTMENT

Departments of Health.—The prevention of diseases has long been recognized as one of the duties of a government. This duty in the United States of America lies primarily with the several states. Nearly every state in the Union has a department of health to which various powers are given for the purpose of suppressing epidemics, preventing diseases, and promoting the strength and vigor of the people.

United States Public Health Service.—The government of the United States maintains an efficient organization, called the Public Health Service, in order to deal with health problems which are beyond the jurisdiction or power of the states. The principal activities of the national organization are as follows:

1. The control of health work on vessels entering the seaports of the United States and its colonies.
2. Detailed public health work on United States Government reservations.
3. Advising and assisting state and local authorities, particularly in conditions which may effect the health of people in adjacent states, as in the poliomyelitis epidemic of 1916.
4. Investigation, research, and standardization. Examples of these activities are recording contagious diseases throughout the world, researches into the causes of typhus fever, and maintaining a supply of antitoxins of standard strength to be used for testing purposes.

State Departments of Health.—Experience has demonstrated that the essential staff which is necessary for conducting public health work in a state is as follows:

1. A central staff of technical experts, administrators, and clerks.
2. A field staff to supervise the local workers in the various municipalities.
3. Local health officers.

The manner of organization of the staff differs widely in the various states. The State Departments of Health of Pennsylvania and Florida conduct all phases of public health work, and the local municipalities have little or no legal duties or responsibilities. The State Departments of Health of Michigan, California, and Indiana are responsible for most phases of local work, but many duties and responsibilities are lodged with the local municipalities. The original public health laws of New York State placed the responsibility for public health wholly upon the individual cities, villages, and townships. The local municipalities are still supreme in carrying out the details of public health work. Broad general powers are also given to the State Department of Health, although they are not always clearly defined. New York State may be classed among those states in which the responsibility for local health work is placed jointly upon the state and the local municipalities.

The activities of the health departments of some states are merely statistical and advisory, and in these states the work of the local municipalities is inefficient and confused.

A standard form of organization is that adopted by New York, Massachusetts, Maine, and other states, and is as follows:

1. A commissioner of health and his staff.
2. A public health council to have legislative and advisory powers, particularly the power to enact a sanitary code.
3. Directors of divisions and their staffs. The divisions include vital statistics, communicable diseases, sanitary engineering, laboratory, child hygiene, and public health education.
4. Local health officers in the various municipalities.

The form of the organization for doing public health work is of less importance than the personnel of the staff, and the financial means at the disposal of the officials; but the appropriations themselves depend largely upon the personality and efficiency of the members of the staff. Capable officials will find ways of doing efficient work regardless of the form of the organization under which they work.

Source of Power of Health Departments.—The powers of a department of health, or health officer, are derived from acts of the legislature. No act of a department or board of health is legal unless authority for it is found in a law passed by the legislature. The legislatures of the various states have passed general laws regarding health matters, and have delegated to certain other political bodies and to certain officers the power to make additional rules and regulations which have the force of laws provided they are not inconsistent with higher laws. The body of laws enacted by the legislature of a state constitute the trunk of the legal tree whose branches are the rules and regulations and the modes of procedure of the state and local health departments.

Consolidated Laws.—The legislative enactments of a state are collected and arranged in what are called the consolidated laws, and comprise four different codes: 1, The penal code; 2, the code of criminal procedure; 3, the code of civil procedure; 4, the great mass of laws which correspond to the civil code, and whose subdivisions are known by the names of the public health law, the village law, the town law, and other descriptive titles. Health matters are frequently mentioned in other laws than in the particular ones relating especially to health.

A subject in a law is usually located by means of the title of the law, and the number of the article and section in which it is found. For example, the authority for the organization of local boards of health in New York State is found in the Public Health Law, Article 3, Sections 21 to 21c inclusive.

Court Decisions.—Legislative enactments are called statutory or written laws. In addition to these laws, the decisions of the courts are the source of much of the authority of boards of health. These decisions are founded on the written laws and make applications of them to specific cases and doubtful conditions. They form a part of what is called the unwritten law of a state. They indicate many of the details of what a health officer or department of health can legally do under a statute law.

The decisions which are most frequently quoted are those of the highest court of a state, and are referred to by means of the volume and page of the report. For example, the cold storage law of New York State was held to be constitutional, and the decision is recorded in volume 160, p. 591, of the reports of the New York Court Appeals. This is usually abbreviated as 160 N. Y. 591.

Public Health Council.—The legislatures of some of the states have established special bodies called public health councils, and have delegated to them the power to make rules and regulations which shall have the force of law in all matters relating to public health. The Public Health Council of New York State has drafted a sanitary code which applies to the whole state outside of New York City. The establishment of a public health council is an advanced step in public health. It enables a body of experts to keep a sanitary code up to date and to take advantage of new discoveries as soon as they are announced. It also makes possible a uniform method of procedure throughout the state.

Local Ordinances.—The legislatures of many states have also delegated to local departments of health the power to make health ordinances, provided they are not inconsistent with the laws or sanitary code of the state. The local codes usually deal with matters of minor detail, such as the suppression of nuisances, while the state codes and laws deal with matters of greater importance, such as the suppression and prevention of epidemics.

The Health Officer.—The local executive officer is the health officer. It is essential that he be a trained sanitarian, and in most states he must be a physician. His duties will depend largely on the population of his district and on the attitude of the public toward health matters. New York State has over 1000 health officers. The great majority of them are in rural districts, in each of which the health officer constitutes almost the entire executive force of the health department. The position is one of responsibility, and demands a considerable degree of skill and more than ordinary medical knowledge along all lines of public health work. The efficiency of the local health department depends almost entirely on the health officer.

Powers of the Health Officer.—The local health officer is charged with the duty of enforcing the health laws that apply to his district. His powers are strictly limited to those conferred on him by the statute law and by the sanitary codes of the state and of his district. His acts are subject to review by the courts, and he is personally liable for acts for whose authorization there is no specific law. But the laws and the code are sufficiently broad to enable him to cope with every condition that is actually unsanitary, and the health officer is clothed with abundant power to remedy practically all conditions that are a direct menace to life or health.

The health officer has no power over conditions which do not affect health. When he receives a complaint, his first concern is to determine whether or not the condition has an effect on the health, as distinguished from the feelings and wishes, of the complainant. A country health officer receives all sorts of complaints about conditions which do not affect the health of human beings. Examples of these complaints are those about sick chickens, barking dogs, and ash heaps. A health officer sometimes feels that he must act on these complaints, for he is often the only public officer whose scope of work is at all related to the subject of the complaint; but his powers are no more than those of any other public-spirited citizen, except that the prestige of his office and the righteousness of his cause may enable him to secure remedies when other persons fail.

A health officer derives part of his authority from the state laws and part from local ordinances. When he acts under a state law he has the prestige and power of the state to support him. But when he acts under a local ordinance he is not always sure of the support of the local board of health. If he has the active co-operation of his board of health he may be reasonably sure that he has sufficient power to carry out his work. If the board is lukewarm or hostile, he can do little under the local ordinances. Whatever he does, he must be able to refer to a definite section of a law or code which specifically covers his act. Failure to know the law accurately is responsible for most of the legal troubles of a health officer.

While some health officers are overzealous and are inclined to exceed their authority, others shirk their duty and refuse to act when there is no special law ordering them to act under a particular condition. A wise health officer will adopt a golden mean of action between zeal and timidity.

Public sentiment and the courts grant almost dictatorial powers to a health officer in the presence of an epidemic. The same powers are conceded in the suppression of a nuisance involving offensive odors, for many people still cling to the old idea that gaseous emanations breed diseases. The public is not always willing to allow him power over disease carriers who are apparently healthy. His success in handling this class of cases depends on having proof of the dangerous conditions. Mere suspicion is not sufficient. The burden of proof is on the health officer, and he must have sufficient evidence to convict if the case should come to court.

Police Power.—The duties of a health officer often require him to interfere with private property and personal liberty of action. For example, a village develops around the barnyard of a farmer who claims that his neighbors voluntarily settled around him, knowing that his business required him to keep pigs, cows, and chickens. He objects to the investigations of the health officer and claims that the health officer has no right to tell him how to run his barnyard. The principle of law that applies in such a case is that of the *police power* of a municipality. The police power means the power to control the acts and property of individual persons for the benefit of all the people of a community. This is one of the fundamental principles in law, and its application to health departments and health officers has been established by the highest courts in the land. Health laws and ordinances are founded upon the principle of the police power of the state.

Lines of Work.—A health officer is the duly authorized person in charge of the public health work in his municipality. This work consists in the control of those conditions which are likely to harm the health of others besides the persons who are responsible for the conditions. The health officer cannot interfere with the liberty of choice and action of a private person unless the acts are likely to have a harmful effect on the health of a number of other persons. Public health work originally was merely the suppression of epidemics of contagious diseases. It was then extended to the control of whatever might produce an epidemic, such as sewage and public water-supplies. Its newer development includes all unhealthful conditions and practices, whether the diseases which they produce are communicable or not. Examples of the newer lines of public health work are the control of child labor and the prevention of diseases which arise from unhealthful occupations.

A health officer is an all-round practitioner in public health. The health departments of the larger cities develop specialists in each line of work, but most health officers are like general practitioners in private practice, and must do all kinds of public health work. A country health officer in the course of a year or two will have to deal with as wide a range of problems as a city health officer, but he will have very few cases of each kind. The standard lines of work which a local health department is expected to conduct under the supervision of the health officer are as follows:

1. Communicable diseases—their suppression and prevention.
2. Laboratories—the collection and transmission of specimens for diagnosis and investigation, and the distribution and administration of antitoxins and serums.
3. Nuisances—their investigation and abatement.
4. Water-supplies—their purity and purification.
5. Sewage and sewer systems.
6. Milk-supplies and dairies—their inspection and control.
7. Food and meat inspections and the control of slaughter houses, butcher shops, and grocery stores.
8. Inspections of public buildings.
9. Vital statistics, including a record of prevailing diseases.
10. Medical inspection of school children and the correction of their defects.
11. Infant welfare work.
12. Insanity, commitments to hospitals, and preventive work in mental hygiene.
13. Occupational diseases, dangerous trades, and child labor.
14. Educating the public by exhibits, lectures, circulars, newspaper articles, etc.
15. Clerical work, correspondence, records, and reports.
16. Public health nursing.

The laws sometimes impose duties on a health officer arbitrarily, probably because there may be no other available official to do the work. For example, the New York State laws require the health officer to examine children for labor certificates, to inspect the means of comfort provided to women clerks in stores, and to investigate the cause of death of persons who die without medical attendance, and to supervise the commitment of the indigent insane. The position of health officer is one of constantly increasing responsibility and scope of duties.

The Staff of a Health Officer.—The staff that is needed to carry on the various lines of health work in a community will depend upon the population of the district and upon the amount of work which public sentiment demands of a health officer. Usually a health officer is the only authorized employee of the Health Department of a small municipality, and he gives only a part of his time to the work, although he is supposed to be ready to respond to public health calls at any time. Under normal conditions a health officer can do all the public health work for a community of 2000 or 3000 persons without undue interference with his private business. If a population is more than 3000, a health officer will be burdened with petty complaints and with sanitary inspections which could be done by a layman as well as by a trained sanitarian; but a part-time health officer can do all the medical and other expert work for a community of 10,000 or 15,000 people if he has competent laymen for assistants.

The assistants which a health officer needs may be divided into three classes: 1, office clerks; 2, inspectors; 3, public health nurses.

Clerks to the Health Officers.—Every act of the officials of the health department of a city is reported in detail, and the annual summary makes an impressive array of figures. Most health officers have no idea how many inspections they make or how many calls upon cases of contagious disease. They do their work quietly and unostentatiously, and they modestly consider an interview with a person on the street to be not worth mentioning. A reason for the failure of the public to appreciate public health work is that health officers do not report what they are doing. Records of work will not be kept satisfactorily until clerks are provided to keep them. A part-time clerk is needed for every health officer.

A health department usually has a registrar of vital statistics who does the clerical work of recording births and deaths and issuing burial permits, but this officer usually acts independently of the health officer.

Sanitary Inspectors.—Every health officer of a community of over 3000 population needs a sanitary inspector whom he may send to inspect nuisances and unsanitary conditions, and serve notices, thus relieving the health officer of the burden of the inexpert field work. He will be the agent of the health officer in making reinspections and seeing that the orders of the health officer are carried out. The work of a health officer is often a failure because no one is charged with the duty of following up his original visits and seeing that his directions are understood and obeyed.

Public Health Nurse.—Every community of over 3000 people needs a public health nurse. She may also do much work as sanitary inspector. She is an inspector and instructor of persons, while the sanitary inspector deals with their environment. The nurse is almost indispensable to a health officer who wishes to do constructive work. The only health officers who object to public health nurses are those who wish to do only routine work along traditional lines.

The ideal official staff for a country health officer will consist of a part-time clerk, a part-time inspector, and a full-time public health nurse. A health officer can also employ helpers in emergencies, such as watchers at quarantined houses, and scavengers to clean up unsanitary premises, provided their employment is authorized by the health board. If a health officer does not go to his board of health for the employment of his helpers, he may have to pay them out of his own pocket.

The members of a board of health are usually willing to go with a health officer to make inspections in difficult cases and to assist him in the discharge of his duties, but they are not required to do this work.

Unofficial Helpers.—Most communities now have societies for the improvement of civic conditions. These organizations are composed of public-spirited persons who are willing to assist the health officer and to educate the public in favor of his work. They also provide funds for carrying on advanced lines of public health work, such as public health nursing. Boards of health are usually willing to allow a health officer to do advanced work so long as it does not cost them money. The usual way in which advanced work is undertaken, even in large cities, is by an organization providing the funds to support the work until boards of health and the people recognize its value and necessity, and appropriate the funds to support it. A health officer will find civic organizations to be his best aids.

CHAPTER II

THE HEALTH OFFICER HIMSELF

Public Health Work a Specialty.—Public health work is a new specialty in medicine, and outside of cities its practice is confined almost entirely to part-time health officers. It calls for more skill and knowledge than the average doctor possesses. A health officer is a public health specialist whom the physicians in his jurisdiction are compelled to consult. His opinion has a legal as well as a medical value, for it will often determine the liberty of a whole household for days or weeks. The position of health officer is always one of responsibility. It will also be one of honor and respect if it is attained by careful study and conscientious practice and experience.

The health officer is the medical adviser of the community in matters of public health. The public is often as unreasonable and as exacting as a nervous patient, and the successful health officer must be as wise and diplomatic with the community as a nerve specialist with a neurasthenic. The health officer often finds it difficult to give satisfaction in his dual position as consultant to the family physician and as public medical adviser. For example, the parent of a diphtheria carrier often resents the restriction of the liberty of an apparently well child, even though the restriction is necessary for the protection of the public. Satisfying the conflicting interests of his two clients requires a combination of judgment, knowledge, and diplomacy that can come only from exact observation and thoughtful experience.

A family doctor frequently owes his success to his ability to please his families, regardless of his ability and knowledge. This ability to please is a most important asset for a health officer as well as for a family physician. A health officer must know the needs and the peculiarities of his community, and must have special skill in treating and satisfying the public, just as a specialist in any other line of medicine must have skill in handling the class of patients which come to him. A pleasing and yet convincing manner of dealing with the public is necessary for a health officer's success.

Preparation for Public Health Work.—A physician is not qualified to be a health officer merely because he is successful in private practice. The position requires special skill and experience in subjects of which private physicians have no time or occasion to make a special study. For example, each private physician in a rural district will see only 2 or 3 cases of diphtheria in a year, and will have no occasion to devote special time to a study of the disease. A health officer will see all the cases that occur in the district and will be expected to be able to advise family physicians in all phases of the subject of diphtheria.

The knowledge and skill of a health officer will depend largely on his love for the work. If a physician is public spirited, he will naturally do some public health work because he likes it. The best health officers, like the best surgeons, are general practitioners who gradually devote more and more time to the study of public health until they acquire a proficiency in it. The proportion of health officers who are successful is about the same as that of successful specialists in other lines of medicine.

A great difficulty in public health work has hitherto been a lack of exact knowledge of the nature of infectious diseases and of the manner in which they spread. A health officer's work formerly consisted mainly in enforcing strict quarantine and in cleaning up nuisances which were offensive to the sense of smell. This was chiefly clerical and could have been done by one doctor as well as by another; or even by a layman, for no special knowledge was required. But today we possess a vast amount of exact knowledge concerning infectious diseases, and in many diseases this knowledge is sufficiently complete to make sanitary and preventive medicine exact sciences. The detection of many diseases is now made by means of exact laboratory tests with which a health officer must be familiar, even though he cannot actually perform the tests. Trained workers in the laboratories of state and national governments and in endowed institutions for research are constantly making discoveries and applying them to the detection and treatment of diseases, and the results are published freely for the public benefit. A health officer who is a year or two in arrears in his knowledge cannot do his full duty, and his deficiency in knowledge is likely to cost lives. If a health officer is five years behind the advanced knowledge of the day, he is hopelessly behind the times.

The health departments of the states and of the larger cities provide free laboratory facilities for diagnosis, and make provision to supply the materials for the treatment of many diseases. The local agent for a department is the health officer. He must know how to obtain material for the laboratory tests, how to interpret the reports, and how to apply the treatments which are sent out by the experts in the laboratories. A community has a right to demand that its health officer shall be able to make use of the facilities which are provided for diagnosis and treatment and that he keep himself informed regarding recent advances in sanitary science.

One of the surprising things in public health work is the sudden development of new phases of old diseases. An example is the development of extensive epidemics of septic sore throat chiefly as the result of the concentration of milk production in large dairies. Another example is the sudden development of virulence in the germs in poliomyelitis in 1916. A health officer may be confronted with a unique problem on which he will fail unless he keeps himself well informed and up to date in medicine and epidemiology. This knowledge and expertness can be maintained only by constant reading and study. A physician who has not given special study to sanitary science is not qualified to be a health officer; and a health officer who ceases to study, or to keep abreast with the current publications on public health, or who fails to attend meetings and conferences of sanitary workers, is not qualified to retain his position. New York State requires every health officer to take a special course of instruction in public health.

The Health Officer a Leader.—Certain duties are imposed by law on a health officer. He is to perform some of those duties on his receipt of reports of the existence of contagious diseases or of complaints of nuisances. Some health officers take a passive attitude, and act only on receipt of reports or of complaints. But a health officer must be something more than a passive agent. He must be a leader. One who does his duty must seek for missed cases of contagious disease, make inspections to discover nuisances, and urge physicians and other public health workers to undertake new lines of work. Instead of waiting for the people to ask him to do his work, he will wake the people up to do their duty.

Some of the newer health laws impose certain duties of initiating work upon the health officers. For example, the New York State health laws require health officers "to make an annual sanitary survey and maintain a continuous sanitary supervision over the territory within their jurisdiction."

The most evident duty of a health officer is to suppress epidemics, and to this duty he is spurred on by the complaints of the public. But a modern health officer is expected to prevent epidemics from developing. He is expected to save the lives of babies, to prolong the lives of adults, and to promote the health and comfort of everybody in the community. He must rouse those who, through ignorance or self-satisfaction, do not wish to be disturbed. This work will be accomplished not by spasmodic effort, but by a continuous, well-balanced activity, founded on knowledge and backed by conviction. The successful health officer is a prophet in the old meaning of the word, signifying one who speaks forth. He is a leader in sanitary progress in his community. He seeks to improve social conditions which foster physical defects and sickness. He is also a physician to the strong and the well, and seeks to maintain a high standard of health and efficiency in a community. The next great development in medical practice will be the treatment of the well, and in this movement the leaders will be the health officers.

The Health Officer an Educator.—A health officer is dependent on the response of the people to his appeals and on the support of the public when he undertakes new lines of work. In the ordinary course of events it takes about twenty years for knowledge of a medical discovery to spread through society and to become a matter of common thought. But most Departments of Health carry on campaigns of education in order that a knowledge of sanitary discoveries may immediately be spread to the public as well as to physicians. They also make elaborate provision for educating the public along health lines, in order that the people will not only support the departments in instituting new work and improving the old, but also that they will improve their own sanitary habits. The ideal condition in a community is that the people are educated to such a degree that they habitually do those things which the departments of health now force them to do.

A health officer is a public educator, and his success will depend largely on his ability to make the public understand the reasons for his acts and advice. It is the duty of a health officer to make use of every case of contagious disease and of every complaint to explain the sanitary principles that are involved, and to prove the desirability as well as the necessity for his orders. If he is a ready speaker, he will deliver addresses on sanitation. If he is a facile writer, the local newspapers will use his copy. The laws of some of the states impose educational duties on health officers.

A health officer has a higher object than merely preventing physical diseases and suppressing epidemics. Physical sickness and bodily defects dull the mind and blight the soul, and the health officer who preaches public health serves the people in the same way as the teacher and the minister of the gospel. A health officer has missed his calling if he is not actuated by a missionary motive and a sincere desire to strengthen mankind not only in body but also in mind and spirit.

Relation to Physicians.—The health officer stands in a peculiar relation to other physicians in that they are compelled to consult him and to allow him to see their cases of contagious diseases. This relation offers great opportunities to the efficient health officer, but it is the source of endless disputes if he is dictatorial and critical to the family physician or is deficient in ability. The co-operation of physicians is absolutely necessary in doing efficient health work. One of the distinct duties of a health officer is to study to secure that co-operation. The health officer is himself in great need of training and mental discipline if he is unable to hold the good will of his medical colleagues. He must remember that physicians are not expected to have skill in sanitation to as great a degree as he, and he must freely place his knowledge at their disposal. He must help them out of difficulties and show them the newer methods of handling communicable diseases. He will be active in medical societies, and will take every occasion to promote good fellowship among physicians.

An efficient health officer can do much to assist and instruct the physicians of a community. He will be acquainted with the workers in public laboratories, and will know how to forward specimens to them promptly. He will know how to give antitoxins; how to intubate; how to do spinal punctures; how to give intravenous injections; and how to secure the admission of patients to hospitals. He will be familiar with the early signs of tuberculosis. He will know something of sanitary engineering and sewage disposal. He will understand the production of pure milk and the prevention of milk-borne diseases. He will be familiar with the relation of social conditions to malnutrition and defects among school children. There is a large and varied field in which a health officer is expected to offer special assistance to his medical colleagues.

Relation to Lay Societies.—Every progressive idea is born in the brain of an individual from whom it spreads like a contagion until it pervades a whole community. A new idea in the administration of sanitary affairs is usually introduced into a community by an earnest person who persuades his friends of the value of the new line of work, and they form an organization to finance it and give it a trial. Finally, when the community becomes convinced of its value, the legal body of officials assumes the work at public expense. The members of village improvement societies, charitable organizations, granges, boards of trade, and women's clubs are usually anxious to be leaders in progressive movements, especially those for the relief of suffering. The health officer can usually find an existing organization that will support him in his progressive policies, and will finance them during a period of experiment and trial. The societies may annoy a health officer who is unprogressive and inactive, but a health officer who fails to co-operate with them or to direct their public health activities neglects a great opportunity, for they may be invaluable aids in promoting his work.

Activities of a Health Officer.—The standard lines of work which are conducted by a local health department are enumerated on page 22. The health officer is the director of all these various activities, and he often constitutes the entire field force of the municipality. He is a combination of health commissioner, medical expert, clerk, plumbing inspector, legal adviser, and chief of the sanitary police. Whatever is done, he must either do it himself or personally oversee it. Whenever an emergency arises, he must create an organization which will cease to exist as soon as conditions are again normal. The small volume of work in any particular line does not justify its systematic organization, but he attends to his public health duties as a side issue to his regular practice.

The activities of a health officer may be divided into field work and office duties. Most of the actual work of preventing diseases and remedying unsanitary conditions is done in the field, and a health officer can perform these duties without doing office work. But he must consider more than the immediate duty of the hour. The people look to him for information and instruction. They pay the bills which he contracts, and they have a right to know about his activities. If the health officer fails to inform the people of their needs and of the measures which he has taken for their protection, he cannot blame them for their ignorance of his work and for their prejudice against modern innovations in sanitation. He has a duty to keep the people informed regarding health conditions in his district, and he can do this only by devoting a considerable time to office activities. These activities may be classified as: 1, Records and reports; 2, correspondence; 3, telephone calls; 4, vital statistics; 5, educational; 6, conferences; 7, study.

Records and Reports.—If a record of every little act done by a health officer were kept, the total would probably surprise the public, the board of health, and the health officer himself. The health officer often considers that the incidental inspections and warnings cost him little effort, and he prefers to forget them rather than to go to the trouble of recording them. This lack of records accounts in large measure for the failure of boards of health and of the public to appreciate his work. The act of keeping a record of his work lends dignity and importance to his position both in his own estimation and in that of the board of health and the public. A health officer will receive recognition for the work which the public knows that he has done. If the public does not know of his work, the health officer has no ground for the frequently expressed complaint that his work is not recognized. A health officer owes it both to himself and to the public to keep a record of every item of duty that he performs.

The pay of a health officer cannot be based on a fixed amount per call as in private practice, but it is best estimated by the time spent in the work. Health officers are usually underpaid, but very few of them can demonstrate the fact by actual records of the time spent in performing each kind of work. The New York State Department of Health is trying to secure a record of the time spent by each health officer in the performance of public health work, including office work, in order to form an estimate of what is a proper remuneration for him. It is desirable that a system of grading health officers be developed, based on the population of their districts, the character of the work that needs to be done, their personal initiative in developing the work, and their efficiency in getting results. This can be done only after accurate records are secured. These records need not be elaborate, but they must be complete and include items which health officers often overlook and forget.

Correspondence.—A large amount of mail relating to his work comes to every health officer. He has requests for assistance and instructions from people living in distant parts of his district, and for information from investigators, societies, teachers, and others who are interested in public health work. His state department of health often asks him to make reports on special work done, and on complaints which come to the central office. Letter writing is often dull work, and is usually reckoned as a gratuitous activity, but it is important. A health officer neglects his opportunities if he does not answer each inquiry and letter promptly, courteously, and fully.

It is an excellent plan for a health officer to preserve each letter he receives, to endorse it with a brief note of the date of answering it, and to place it on a letter file. Any health officer can easily do this even when he has to write the replies with his own hand. It is also desirable for him to retain carbon copies of his replies.

Telephone Calls.—Every health officer receives and makes numerous official calls over the telephone. These calls are often as important as correspondence. They come at all hours, and are often a source of great annoyance, and a health officer may justly consider that he is entitled to receive pay for the time that he spends at the telephone.

Vital Statistics.—The records of diseases, deaths, and births are the basis for judging efficiency in public health work. An annual estimation of death, birth, and communicable disease rates for his municipality is one of the duties of every health officer, for these rates are the means by which a comparison of the health work in various districts is made all over the world.

Educational.—Every health officer is compelled to do work which may be classed as educational. He receives newspaper reporters and writes news items for them. He arranges lectures and exhibits, and takes photographs and makes lantern slides illustrating public health conditions. He prepares lectures and papers for medical societies and writes articles for medical journals. He consults experts and contractors regarding public works. All these educational activities consume time and require expert thought.

Conferences.—A health officer spends considerable time in receiving calls from his superior officers, and in seeking advice from them. He attends official conferences of the health officers of his district or state, and he holds consultations with officials of related societies, such as churches, charitable organizations, and scientific societies. One of the greatest benefits from these conferences is the inspiration that comes from his personal contact with other health workers. A health officer is entitled to credit for the conferences and consultations in which he engages.

Reading and Study.—Books and journals on public health topics are among the tools with which a health officer works. He must constantly acquire new ideas in order to keep abreast of the times and be able to do up-to-date public health work. Studying is not to be taken as evidence of deficiency either in instinctive knowledge and natural ability or in previous education. It is the evidence of an active mind and of interest in public health matters. The time which a health officer devotes to study is spent in the discharge of a necessary public duty for which he may properly be recompensed. A health officer may be judged by the studying which he does, for it represents the amount of serious thought which he gives to his work and his degree of devotion to preventive medicine and public health.

Judging a Health Officer.—A health officer's success depends on the man himself. The office will not run itself, but public health work will be accomplished in direct proportion to the ability and qualifications of the man at its head. Since he often comprises the entire health force of a community, the health officer must be a man of many parts and possess varied qualifications and accomplishments. The following is a list of the principal points to be considered in judging a physician's fitness to be a health officer:

Knowledge

Comparison with that of neighboring physicians.
Medical journals taken or read.
Attendance at medical society meetings.
General education.
Success in private practice.
Ability as a public speaker.
Ability as a writer.

Initiative

Ability as a leader.
Reputation for doing only what he is forced to do, or only what he is invited to do, and for planning original work.
Practical or idealistic.

Adaptability

Reputation for working with other physicians.
Co-operation with social agencies (schools, churches, civic societies).
General sociability.
Willingness to do any kind of work.
Willingness to take advice.

Personality

Personal appearance.
Overbearing, or meek.
Courageous, or time serving.
Talkative, or a good listener.
Methodical, or careless.
Objectionable peculiarities or habits.

Character and Reputation

Uprightness.
Payment of personal bills.
Public spirited or selfish.
Optimist, or pessimist.

Outside Interests which Might Affect His Usefulness

Business projects.
Sporting proclivities.
Hobbies.
Philanthropic associations.

CHAPTER III

THE LOCAL BOARD OF HEALTH

Need for a Local Board of Health.—There are three essentials in carrying on local health work: first, expert health officials; second, money; third, favorable public sentiment. Expert health officers often fail because the people do not support them with their purses and their influence. The people can give official support to a health officer in two ways: first, by voting him funds to carry on his work; second, by standing by him when violators of the health ordinances are brought before the courts. The power of the people to hinder public health work is frequently exercised either by withholding public funds or by refusing to convict offenders against the laws.

The frequent failure of the people to support the local health officer has led some states to adopt the plan of conducting all health affairs either entirely by the state, or jointly by the state and the counties, in order to remove the work from the influence of local ignorance, jealousy, and prejudice. But whatever may be the details of the organization of a local district, the health officer must depend on the local courts of law and on chance juries of laymen to enforce the health ordinances. The people must take part in the administration of public health work whether they wish to do so or not. It is in keeping with the spirit of American institutions that the people in each municipality should be represented in public health work by a local board of health. If a health officer receives the support of his local board of health, he may confidently rely on the support of the people.

Composition of a Board of Health.—The membership and the methods of choosing the members of boards of health vary widely in different states. In New York the board in a town is composed of the town board, and in a village, of the village board of trustees. But in cities the duties are so many and various that public health work is entrusted to a special board of health whose members are usually appointed by the mayor.

The members of the health boards of villages and towns are usually business men who have no special knowledge of sanitation or of the administrative problems of public health. They represent the average attitude of the people of a community toward public health. They are likely to follow the American plan that office-holders shall reflect public opinion rather than mold it. They are, therefore, likely to get the reputation of retarding progress in local sanitation rather than of being leaders in public health work. Yet there is a great advantage that a local board of health shall be composed of average laymen of a community, for if the members of the board are not convinced of the value of a line of work, much less will the general public support the work. The success of constructive public health work in the United States depends on public sentiment and not on force impressed on the people from above. A local board composed of members with open minds will broaden the field of local public health activities as soon as the general public is prepared to support the work.

Relation of a Health Officer to the Board of Health.—The health officer stands in the same relation to a board of health that the manager of a factory does to its board of directors. He represents the medical and scientific side of public health work; the board of health represents the legal, political, and business sides. The health officer diagnoses public ills and prescribes treatment for the community as his patient. The health board represents the public in accepting or rejecting his diagnosis and treatment. The private physician frequently is unable to convince a patient of impending disease. Likewise a health officer often has difficulty in convincing the public of impending dangers to public health. Health boards are the guardians of public health in the same sense that parents are the guardians of the health of their children. They are very willing to consult experts when a serious epidemic breaks out, but they are not always so willing to undertake preventive work when no immediate and evident danger is in sight.

A board of health usually adopts one of three attitudes toward a health officer. The first attitude is to consider the health officer and his work as a joke. The trained health officer sees danger afar off, and, because it is not nigh at hand, the board of health is likely to ignore the warning and to consider preventive measures to be infringments on private privilege and personal liberty. The average American community expects to offer up a sacrificial toll of human lives and suffering to its god of personal independence before the deity is appeased, and the public wakes up to its duty of preventing disease while the task is still small. It is difficult for a health officer to maintain a respectful dignity of manner and a convincing balance of speech in the face of sarcasm and jokes about his policies and suggestions. But this attitude of indifference is rapidly disappearing under the influence of educational work and of demonstrations of efficient work by health officers. The most convincing of all arguments is the record of actual results of public health work.

A second attitude of a board of health is one of panic in the presence of an actual epidemic, and of indifference between epidemics. When the hand of affliction and death is laid on a few prominent people, a board of health and a community will take extreme and unnecessary measures to stop the spread of sickness. For example, when a mild case of smallpox was discovered in a certain rural town of 3000 inhabitants, the patient was removed to an isolated house and then the wagon in which he rode was burned and the horse was shot by order of the board of health. But the attitude of fear and panic, like that of indifference, is rapidly changing to confidence in the wisdom and ability of the health officers.

A third attitude of a board of health is that of co-operation with the health officer. The New York State public health law reads that a board of health shall direct a health officer in the performance of his duties, but conditions are usually reversed, and the health officer directs the board of health. The ideal relation is that the health officer shall feel free to discuss health affairs with his board of health, and that the board shall give a respectful consideration to his proposals. An active health officer will plan for the future, and will suggest more lines of work than can be attempted at once. He can readily annoy a board of health by too great a show of zeal and versatility, and by insisting on starting reforms before the public is prepared to accept them. The health officer is fortunate if his board of health will give sympathetic consideration to his plans for constructive health work, or if members of the board will accompany him on investigations of difficult conditions.

Relations of a Local Board to a State Department of Health.—The laws under which health boards are established often charge both the State Department of Health and the local health boards jointly with the enforcement of the laws. For example, Section 4 of the New York State Public Health Law reads that the State Commissioner of Health "shall be charged with the enforcement of the public health law and the sanitary code"; and Section 21b reads that the health officers "shall within their jurisdiction enforce the provisions of the public health law and sanitary code." The universal intent is that the State Department of Health shall assume command when actual danger is at hand, and at other times shall act as a kindly teacher and counselor to the local health authorities. For example, a state department of health will examine a public water-supply, and if the water is not pure, it will point out the sources of pollution and will advise the local authorities regarding remedial measures; but if the pollution produces sickness, the State Department of Health may take charge of the situation and compel the local authorities to remedy the conditions.

Local health boards sometimes resent the participation of a state department of health in local affairs, and they support their attitude with variations of three stock arguments: first, that the public will be alarmed; second, that the town is the healthiest spot in the country; third, that the methods of investigation are mysterious and impractical.

A town is always in danger from fire, but the people take pride in their elaborate pieces of fire-fighting apparatus. The fire companies usually secure the equipment by means of an active campaign in which they point out the danger to the village if the best means of fighting fire are not obtained. Calling attention to danger is the first step in guarding against it. Public sentiment is often indifferent to sanitary conditions in the absence of an epidemic, but on the appearance of a pestilence it goes to the opposite extreme of a panicky fear and of a wild exaggeration of the sickness and danger. The best cure for fear and alarm is publicity and education. When rural departments of health give as much publicity to their activities as the city and state departments do, the people will learn to place a calm reliance on the protectors of their health, and will welcome the presence of the experts from the State Department.

The argument that a locality is the healthiest in the land is based on the old belief that the germs of sickness exist naturally in the soil, air, and water. The fact is that with very few exceptions of unusual diseases the soil, air, and water are free from the germs of human diseases unless they are polluted by human beings. The source of sickness is not a locality, but the people in it. The more rapid the growth of a town and the more prosperous and progressive its people, the greater is the probability that the citizens will come in contact with persons who harbor disease germs. Popular health resorts are especially likely to contain persons who are mildly sick with unrecognized infectious diseases. The detection and control of unsuspected carriers of disease often require greater expert facilities than a town or village can command. The aim of a state department of health is to perfect and unify the work by assuming the direction and supervision of it, but leaving its execution as much as possible to the local authorities.

The first advances in public health were made through personal and public cleanliness. The lesson was so well learned a generation ago that the people now consider uncleanliness to be indecency. They approve of stringent measures to abate nuisances which offend the senses, and consider that the chief qualification of a health officer is that he shall have a sensitive nose. But all have not yet learned that the essential thing which makes dirt dangerous is disease germs whose source is human beings, and which are often found in the mouths of clean persons, in clear, tasteless water, and in appetizing food. The delicacy and refinements of the methods of detecting disease germs are incomprehensible to those who have never seen a microscope, and the accuracy of their results may seem uncanny and unworthy of belief. The tendency of the public is to condemn what it does not understand. The truth is that the detection of small numbers of disease germs, and also of intestinal bacteria, is a simple and easy problem, and is the most practical and useful procedure at the service of a modern sanitarian. Every health department is dependent on refined bacteriologic and chemical examinations which few practising physicians know how to perform. A rural board of health is dependent on outside assistance in tracing the origin of most cases of communicable diseases.

A rural board of health is usually willing to have the state remedy unhealthful conditions so long as the local board itself is not required to act. It is a universal principle in American government that each community shall manage its own affairs and that each citizen shall bear his share of the burden. The responsibility for public health conditions lies jointly with the local authorities and with the State Department of Health. The local health authorities are properly required to suppress local nuisances that affect life or health, to detect and control ordinary cases of contagious diseases, and to maintain sanitary inspections of dairies, water-supplies, and sewers. The State Department will supplement this work along at least four lines:

1. Laboratories are maintained for the detection of disease germs in specimens sent to them by the local health officers. This service is of the greatest importance, and its field of usefulness is constantly being extended.

2. Antitoxins and serums are manufactured and distributed without cost through health officers to all physicians who need them in the treatment or prevention of diseases.

3. Medical experts and trained sanitary engineers are sent to advise the local authorities, when the services of experts are needed.

4. Educational literature, lantern slides, moving-picture

films, charts, exhibits, and lecturers are sent out to educate the people in public health matters.

Local boards of health are likely to concern themselves principally with curative measures, while state departments of health are placing more and more emphasis on prevention. Efficient health officers and the officials of state departments of health are doctors of the body politic, and are trained to recognize unhealthful conditions while they are yet in the preventable stage. But the public, like a spoiled child, does not like to be examined by a doctor, or to submit to minor operations, or to take unpleasant medicine. When the officials delve into sanitary matters, a community often complains that it is hurt, or that it does not want to be bothered, or that it prefers the disease to the medicine. Local boards of health are often incapable of treating themselves. A diagnosis must usually be made and treatment suggested by the experts in the State Department of Health, and then frequently nothing is done unless the State Department gently but firmly insists that the public shall begin treatment.

Basis of Action.—The source of the power of a board of health is the written or statute law of a state. Under it a local board of health performs three classes of duties. The first class of duties consists of those which are imposed on it specifically. These relate largely to organization and finance. They also include the suppression of contagious diseases and the abatement of nuisances, but these duties are usually performed by the health officer as the agent of the board, and come to the attention of the board itself only when some one clearly violates the law. The duties that are specifically required of the board are few, and the board that does no more than it has to do is narrow in its interpretation of the scope of its work.

The second class of duties consists of those which a board of health is specifically permitted to perform. An example of this class of work is that the New York State law permits a local board to employ a public health nurse. A board that undertakes permissive work will nearly always be supported by the people. Public health work is becoming increasingly popular, and the people are beginning to demand that the officials responsible for sanitation shall give evidence that they are doing something more than the specific routine duties that are required.

A third class of duties consists of those which are not mentioned in the statute law, but which are legalized by a broad interpretation of a general section of the law. For example, the New York State law authorizes a health officer to employ as many assistants as may be necessary to enforce the laws, and to fix their compensation within the limits of an appropriation for that purpose. This section enables a board to employ lecturers, milk inspectors, and public vaccinators, and to publish educational literature. Progressive boards of health are constantly enlarging the scope of their work by instituting new activities, and by assuming charge of lines of work which have been started and carried on by lay societies (see p. 29).

Appointment of a Health Officer.—A board of health is usually charged with the duty of appointing a health officer. This is the most important duty that the board has to perform, for the health officer is the manager of the local public health system, and is responsible for public health conditions in his jurisdiction. A doctor is not qualified to be a health officer simply because he is successful in private practice. Yet some boards advocate the appointment of a young physician just starting into practice, thinking that he will be impartial and that his knowledge is of an up-to-date brand; others would choose a doctor who is gruff and outspoken in manner, expecting that he will be fearless in the performance of his duties; and some hand out the office as a political reward. The position of health officer is too important to be given to any one except to a specialist in public health who has qualified himself by study and experience. New York State very properly requires that each health officer shall have made special preparation for the office by taking a course of study in public health.

Finances.—A board of health is charged by law with the expenditure of public funds with which public health work is carried on. Finances are the basis of all governmental activities, and a board of health can promote or cripple sanitary work by its attitude toward expenses. Public health work is usually conducted more economically than any other branch of the government's activity, and refusals to appropriate money on the grounds of past extravagance are seldom justified.

There are three methods of making appropriations for public health work. One plan is to give no money to the board, but to audit the itemized bills after the work has been done. This plan has been unsatisfactory, for financial boards often have difficulty in seeing the justification of expenditures for guarding against epidemics which merely threaten a community afar off, but which never appear. A danger which seems urgent to a board of health often becomes a vague memory when the bills are audited months afterward by a financial board that knows nothing of the real conditions.

Another and better plan is to give the board of health a definite sum to carry on ordinary routine work during the fiscal year.

If the board knows how much money it will have to spend, it can plan its work with confidence and intelligence, and with a view to efficiency and economy.

The New York State law provides a third and still better plan by making the board of health of a village or town to consist of the financial board. Thus the same body that expends money has the power to raise it.

The budget of the board of health of a village or town must contain several items which are required by the statute law of most states. Among them are the following:

1. The pay of the health officer. The New York State law requires that the pay shall be at least 10 cents for each inhabitant in his jurisdiction up to a population of 8000. One good effect of this law has been to do away with the practice of shopping for a health officer and of giving the position to the doctor who bids the lowest. It is a principle of law that an officer is entitled to his expenses which are necessarily incurred in the discharge of his duties, including postage, stationery, and traveling expenses.

2. The pay of the registrar of vital statistics and the fees to physicians for reporting births, deaths, and communicable diseases.

3. The maintenance of guards at quarantined houses and of disinfecting after communicable diseases. The newer methods of quarantine and of disinfection have greatly reduced the expenditures for these purposes.

4. Vaccines, antitoxins, culture-tubes, and other supplies for diagnosis and treatment. State departments of health are preparing more and more of the supplies, and are furnishing them free or at cost.

5. The suppression of nuisances. Most of the expenditures under this head are for legal services and advice.

6. Extraordinary expenditures such as those incurred in suppressing epidemics.

A board of health may also spend money for purposes which are not specifically stated in the statute law. The following are some of the activities for which rural boards of health often contract bills:

1. Regular sanitary inspections for the discovery and suppression of nuisances.

2. Milk and dairy inspections.

3. Public health nursing.

4. Educational work, including the expenses of lectures and exhibits, and of the printing and distribution of educational literature.

There is no standard of the amount of the expenses of a rural board of health. The principal item will be the health officer's pay, which in New York State must be at least 10 cents per capita annually. The amount of the other expenses will be at least half that of the health officer. But effective public health work cannot be done for 15 cents per capita. At least twice that amount is needed. New York City spends 70 cents per capita on its local public health work.

Communicable Diseases.—A local board of health is charged with the duty of preventing and suppressing communicable diseases. The health officer will attend to the routine cases without referring them to the board of health. Yet the board of health will decide, either intentionally or unconsciously, many matters of great and immediate effect in the suppression of diseases. One matter of great importance is the attitude of the board toward bills for the health officer's supplies, such as sputum cups, antiseptics, and surgical dressings. The board will decide whether disinfections after contagious diseases shall be done at public expense or be charged to the head of the afflicted family. The board will also determine whether or not the health officer will feel free to secure the services of skilled assistants to do expert emergency work, such as intraspinal injections in lockjaw and intubations in croup. Every board of health must necessarily acquire a reputation among public health workers for its attitude either of liberality or of parsimony in its expenditures for suppressing contagious diseases. If it is liberal, a health officer will feel free to take immediate and effective steps for suppressing diseases before they get beyond control.

Local Ordinances.—Local health work is done under the authority of three sets of laws or regulations: first, the statute law which is enacted by the legislature; second, the state sanitary code, if the state department of health has enacted one, as has been done in New York State; third, local ordinances which are enacted by the local boards of health. Local ordinances are intended to specify the details of matters which are mentioned generally in the statute law. For example, a statute law may require that every business shall be conducted with due regard to the health and comfort of the people of a community. A local board of health may enact an ordinance applying this law to the livery men in a village by requiring every person who keeps a horse to provide a water-tight and fly-proof box in which all the manure shall be kept.

Local ordinances reflect the sentiment of a community toward conditions which affect the health and comfort of its inhabitants. They express the standards of sanitation in that community. They put the people on their guard, and render easy the detection and conviction of offenders. They substitute definiteness for uncertainty in the interpretation of laws, and support the health officer with the authoritative backing of the representative body of men who made the code. The enactment of a sanitary code is a duty as well as a privilege of every local board of health.

Among the subjects which may properly be included in a sanitary code are the following:

Communicable diseases.
General relations of the health officer to the board of health.
Unnecessary noises.
Smoke.
Dogs in public places.
Food inspections.
Dairy regulations.
Garbage disposal.
Slaughter houses.
Disposal of household wastes.
Cesspool construction and cleaning.
Privy construction and management.
Pig-pens and chicken yards.
Disposal of stable manure.
Prevention of the breeding of flies and mosquitoes.
Housing rules.
Street cleaning.

Legal Matters.—The handling of all legal matters is one of the duties of a local board of health. The abatement of nuisances and the suppression of unhealthful conditions rests with the health officer; but if he is unable to secure a remedy by personal appeals to the offenders, the next step is to ask the aid of the police or of the law courts. The judgment whether or not legal action is required rests with the board of health after hearing the medical and scientific evidence given by the health officer. The board of health can act in an emergency through a standing committee, or through one of its members. Legal action is too serious a procedure to be started by a health officer without the advice or orders of his official superiors. It is the duty of every member of a board of health to give immediate attention to the requests of a health officer for legal advice and assistance. The fact that the health officer is acting under orders of a member of the board of health will often bring an offender to terms. If it is necessary for a health officer to have the aid of the police or the law courts, his board of health owes him the protection of authorizing him to employ that assistance. Health officers are frequently sued personally for assuming to do necessary acts in which boards of health have not been consulted. The responsibility for action or inaction in any given case that is brought to their attention rests equally with the health officer and the board of health. The New York State sanitary code charges boards of health with the responsibility of taking the necessary steps to abate nuisances which health officers are unable to abate by ordinary means.

Reports.—It is the duty of a board of health to demand reports from its health officer, and to consider them seriously, in order to know what is taking place in its jurisdiction. It is often the attitude of a board of health to consider the health officer's reports to be either a bore or a joke. A health officer whose reports are treated lightly has no incentive to do good work. If his board of health shows no interest in public health work, much less can the general public be expected to appreciate it. If a health officer is failing to earn his salary, the board of health is equally responsible with him, for the board is supposed to be familiar with his work.

A monthly report on all the varied activities of a health officer will enable the board of health to compare them with the past and to form plans and estimates for future work. It will encourage the health officer to have something worthy to report and will educate the public regarding the scope and importance of the sanitary work in a community. The New York State Department of Health requires a monthly report from every health officer.

Relation of a Board of Health to the Public.—The public expects a local board of health to protect the citizens from preventable diseases and deaths, to understand the problems of sanitation and public health in its jurisdiction, and to take the lead in promoting the health of all persons in the community. The work of a department of health is based on education and expert knowledge which is often unappreciated by the general public. If the appropriations for public health work depended on the votes of a majority of the taxpayers, very little work would be done except to fight fully developed epidemics. The very success of public health work in preventing diseases blinds people to the need that the work be continued, and even pushed with increased vigor. A board of health is expected to lead the public in the movement for a still broader field of health work and for more effective steps in the prevention of disease and in the prolongation of lives.

CHAPTER IV

THE PUBLIC AND THE HEALTH OFFICER

"Public Health is Purchasable" is the motto of the Department of Health of New York State. Every health officer is an agent who offers public health for sale. The people generally think that public health is a good thing to have, but sometimes they expect to get it free, like their air and rain, and are unwilling to pay money for it or to get it by work. They usually judge the value of public health by a few samples of work which they see done by amateur health officers; but they are usually willing to pay taxes in support of public health work whenever they see its value demonstrated by actual trial in their midst. A health officer has the power to correct many of the popular misapprehensions regarding the aims and scope of his work.

Public health work was formerly spectacular. It dealt with wide-spread epidemics while the people were in panics of fear and were ready to adopt any measure that offered a hope of relief. It consisted in cleaning great collections of filth from the streets, in bringing supplies of pure water into cities, and in constructing extensive sewer systems. Such work as this almost eradicated cholera from the United States, and has reduced typhoid fever to a tenth of its former prevalence. Its striking results gave people the idea that the complete eradication of visible dirt would cut down all infectious diseases, but it had little or no effect on diphtheria, scarlet fever, and pneumonia. It is probable that this line of work has nearly reached its full development, for we have already controlled the diseases that are spread by gross filth. Civilized people now generally observe private and municipal cleanliness to a degree that was advocated by only a few of the leading sanitarians a couple of generations ago. Their advanced ideas are now habitually practised by most people, and we are surprised when we find a community that has not reached that standard of cleanliness and of what we call decency. For example, we expect every dwelling to be provided with some kind of a toilet arrangement, and we are shocked to learn that hookworm disease is prevalent in some sections of the United States because of the lack of such facilities. A health officer now has to clean up only an occasional house or yard, for public sentiment demands that every house and yard shall be kept clean, and that all sewage and garbage shall be removed from sight. There is a great outcry if a health officer fails to compel the observance of this standard of cleanliness by the few who do not observe it. Most persons have an unreasonable fear of what is offensive to their sight and smell, and when an infectious disease breaks out, they can readily find an infraction of the standards of cleanliness to which they can ascribe it. But filth is not often the cause of the common epidemics that now prevail among intelligent people. The trained health officer no longer expects to find the cause of a sickness in things. He looks for it in persons. He knows that unclean things do not produce diseases unless the dirt comes from persons who are producing disease germs in their bodies. But the germs of which he talks are invisible and sometimes they do not produce evident sickness in the persons in whom they grow. Most people do not yet understand why a health officer should pay little attention to back yards, and yet should restrain the liberty of an apparently well boy whom he accuses of carrying diphtheria germs in his throat. It seems to them that the health officer talks about danger when there is none, and that he is a false prophet who magnifies dangers and arouses fears unnecessarily. A common argument for instituting and enlarging public health work is that there will be a sickness if existing conditions are allowed to go on. It usually happens that few persons get sick, and that epidemics are rare, and so the health officer is discredited, together with his allies and supporters. A community is usually slow to take warning from the experiences of a village ten miles away, and its people are usually convinced only by a disastrous epidemic in their own midst. Public health work is so new and modern that a knowledge of its basis and scope has not yet become common. It takes about a generation for a knowledge of medical progress to filter from the leaders down through the practising physicians and to the great mass of people.

Health officers are often impatient with what seem to them to be the stubbornness and hostility of the people, but which is really only ignorance. A health officer must always deal with ignorant people, for he is hopelessly behind the times if the people whom he serves know as much as he. Whether or not a health officer meets with stubbornness and hostility will depend largely on his own attitude toward his people. Most stubbornness is merely indifference due to ignorance; and hostility is usually due to a health officer's disregard of the people's feelings. A health officer can usually control the attitude of the people toward him. The methods which he can employ effectively are those of education and example.

A health officer can educate his people by taking pains to explain what he wants done in each case, and the reasons for doing it. Each visit and inspection affords him an opportunity to instruct a number of persons, and they will pass the advice to others until the whole community will know what to expect from a health officer. The object of his talk is to make people really understand what he is talking about. If he uses technical language, the people will not understand him, but they will think that the work which he is trying to do is a technical matter which they cannot understand, and with which, therefore, a common person has nothing to do. But if a health officer uses the every-day language and expressions of the home, his ideas will fit into the usual lines of thought of his hearers, and will become a real part of their common thought. The most effective of all means of educating the public in health work is by brief explanations by the health officer during his ordinary calls.

The feelings of the people toward a health officer and his work will depend largely on the feelings which the people think the health officer has toward them. If the health officer is gruff and overbearing and issues threats and curt orders, the people will naturally have little use for him or his work. When ignorant, inefficient persons wish to make themselves impressive, they talk loudly, make threats they are powerless to carry out, and use exaggerated language which no one believes. If a health officer does these things, he is like an engine that is out of order and is producing more noise than work. He seems to be neglecting the health conditions which he is investiagting, and to be seeking personal quarrels with those to whom he is talking. An efficient health officer will confine himself with a singleness of purpose to the matter which he is investigating and will not be sidetracked by personalities. He will try to leave a person in such a state of mind that he is thinking only of remedying an unsanitary condition while forgetting the health officer. The best personal assets for a health officer in dealing with people are a listening ear, an unhurried manner, a quiet tone of voice, and the use of temperate language which means exactly what it says.

Some persons consider a health officer to be a trouble maker and an enemy. The public will be likely to hold this opinion if the health officer does only police duty and confines his work to repressive measures, such as giving spasmodic and erratic orders on the receipt of complaints, and enforcing harsh quarantines when contagious diseases are reported. The public will look upon a health officer as a friend when he does constructive work, such as assisting in the treatment of contagious diseases and promoting child welfare work.

The people sometimes consider a health officer to be an impractical theorist and his work a joke. They get this notion when they see health officers advocating impossible reforms and impracticable measures, such as the ventilation of every public building, or the use of a nasal douche by every child as a preventive against contagious diseases. Every active health officer has advanced ideas which seem impossible to carry out. Progress depends on giving publicity to these ideas and in securing their adoption. A health officer will retain the respect and support of the public if he consults the physicians of his town and brings his ideas before the people for discussion before he tries to force them upon the community.

While people are slow to take warning when danger is invisible, they often go into a panic in the presence of an epidemic, and demand that the health officer shall go the limit in the use of discredited methods of suppression, such as closing schools and restricting travel. A panic is the result of ignorance and uncertainty. If a health department is secretive and undecided, the people will become alarmed and will demand unreasonable actions. A policy of publicity and education regarding the cause and progress of the epidemic and the means of its suppression will reassure the people and secure their support.

The people of a community sometimes think that a health officer has an easy job, and so they are willing that the office should be given as a reward for political work. If the health activities in a community are confined to police work which a constable can do, the people are justified in their low opinion of the office. But every health officer is subject to inconveniences and dangers which are peculiar to the office. When he comes from a case of contagious disease, many persons refuse to employ him as their physician for fear that he will carry disease germs. A health officer usually loses more money from his well-to-do patients than he gets from his salary.

A health officer is also in danger of catching contagious diseases from the cases which he visits. For example, he must examine the throats of children who have diphtheria and scarlet fever, and run the risk that they will cough disease germs into his face. Most people have a horror of contagious diseases, and yet they do not give the health officer credit for his disregard of the danger to which he is subjected.

People in rural districts hardly know what kind or quantity of health work to demand from their health officer, or how much to pay him for it. The health officer can enlighten them if he keeps a record of his work and the time spent in doing it. The laws of New York State require that a health officer shall be paid at least 10 cents for each inhabitant of his district. Hundreds of health officers receive less than $200 annually. The people know that this sum will not purchase much public health work. A good health officer is public spirited, and will do excellent work regardless of what his salary is. The people will usually grant him adequate pay when his reports show that it is justified. A health officer can profit by a study of the advertising methods of merchants and manufacturers. The first step is to do good work, and the second is to make his work known by reports, lectures, and articles in the local newspapers. This is legitimate advertising, for it promotes public health work and makes it known to the public.

Whenever an epidemic breaks out, the streets are full of exaggerated rumors regarding the number and severity of the cases and the laxity of the suppressive measures. These rumors interfere seriously with health administration, and cause the health officer much inconvenience and annoyance. Those who hear the gossip can do a great service in the cause of public health by investigating the rumors and ascertaining how much truth is in them before they criticize the health officer.

The people have much to do with making the work of a health officer a success. The greatest source of his power is favorable public sentiment. A state department of health is able to enforce the public health laws in larger matters, but public health measures secured by force are not nearly so effective as those which are carried out voluntarily. The principle of home rule prevails in public health administration as in other matters. One of the best assets of a community is a reputation for healthfulness; and this will depend largely on the attitude of the people toward the health officer and the department of health.

CHAPTER V

THE PHYSICIAN AND THE HEALTH OFFICER

Public Opinion and the Physician.—Every physician is a guardian of public health, and the people expect him to be interested in medical matters of a public nature, just as they expect the lawyer to speak out regarding the legal aspects of public affairs, or any other citizen to contribute his best thoughts upon public questions. The opportunities and influence of the physician as an educator are greater than those of almost any other person. Nearly every person has a blind and implicit confidence in the word of some physician, and the attitude of the people toward public health matters is the composite attitude of the physicians of a community. The knowledge and practice of many physicians in matters of public health is that of five, ten, or twenty years ago, and their ideas are adopted by the people on their visiting lists. Few medical schools have given instruction in preventive medicine, and almost the only physicians who can qualify as public health specialists are those who have been intensely public spirited and unselfish, and have kept themselves up to date in all lines of medical progress. But medical schools are now beginning to require courses in public health, state departments of health are insisting that physicians shall know and practice the most modern methods of public health procedure, and the people are becoming educated by lectures and magazine articles to demand that family physicians shall practice modern preventive medicine. It will be necessary that physicians in the future shall take more and more interest in public health affairs.

The Attitude of the Physician.—Physicians are often inclined to shirk public health work. They say that the people do not appreciate the work of a health officer; that many persons resent interference with their personal liberties; that public health workers make enemies; and that the physician who practices preventive medicine soon loses his private patients. Most physicians are compelled to give their attention to the work that pays a financial return. But a few pioneers have done public health work because it needs to be done, and by their sacrifices of private gain they have established preventive medicine as a specialty which future physicians will probably exploit and make profitable. The people are unwilling to pay for public health work, for they do not see the need of it. Here is an undeveloped field in medicine. Let the physician take more interest in preventive medicine as a specialty and educate the public to desire it, and soon the people will respond by offering their dollars in order to obtain its benefits.

Some physicians consider that they are under no obligation to practice preventive medicine. They say that they are paid to treat sickness and not to do a health officer's work of placing restrictions upon a family. Those who employ a physician have a right to expect that he will advise them not only how they may recover from sickness but also how they may prevent the sickness from developing again in the future, and from spreading the disease to other persons. The laws and sanitary code of New York State recognize these obligations, and require physicians to perform specific duties which make them an official part of the public health organization of the state. A number of mandatory duties are imposed upon every physician by the public health law and the state sanitary code, other duties are implied, and an intimacy and co-operation with the health organization are presupposed. The duties which are imposed upon physicians by law in New York State are those which the public has a right to expect all physicians everywhere to perform. One of the duties of a health officer is to instruct physicians in their duties to the state, and to assist them in performing those duties.

Reporting Communicable Diseases.—The Public Health Law of New York State (Sec. 25) imposes a mandatory duty upon every physician that he shall immediately give notice of every case of infectious and contagious or communicable disease, required by the State Department of Health to be reported to it, to the health officer of the city, town, or village where such disease occurs. The New York State Sanitary Code (Chap. 2, Sec. 2) requires a physician to make the report within twenty-four hours after he sees the case for the first time, and immediately when the case is on a dairy farm. Reporting communicable diseases is universally conceded to be necessary in preventing their spread, and a physician can comply with the requirement without embarrassment when the disease is evident and the diagnosis is plain. But a physician is often censured by indignant citizens for making reports when the classic signs of the disease are undeveloped or the diagnosis is uncertain. It is the implied duty of every physician to make a correct diagnosis within a few hours after he first sees a case. He is a diagnostician for the department of health as well as for the private patient, and it is his duty to make prompt use of all available means of diagnosis. It is the privilege, as well as the duty, of every physician to avail himself of the diagnostic services of the health officer in every suspicious case. If the physician reports a suspicious case, the health officer must assume the further responsibility for determing the diagnosis, for making a final report on the case, and for preventing the spread of the disease.

The attitude of physicians toward reporting cases depends largely upon the health officer. If the health officer is a political appointee with no special qualifications for his work, physicians will naturally have no confidence in him, and will report cases only on compulsion. But if the health officer is known to be an expert in diagnosing communicable diseases, and is trustworthy, popular, and diplomatic, the physicians will have confidence in him and will gladly consult him.

Physicians are entitled to the protection and support of the health officer in performing the unpleasant duty of giving the public the benefit of the doubt in suspicious cases, and in making a decision which involves the curtailment of the liberties of patients and their families when the signs of disease are faint and obscure. A physician is naturally unwilling to acknowledge ignorance in diagnosing common diseases, or to appear to concede superior diagnostic ability to another practitioner in his own locality. The local physicians form the first line of defense against communicable diseases, and the efficiency of that defense depends on their alertness and willingness to co-operate with the health authorities. When the health officer is not obviously an expert diagnostician, and does not enjoy the full confidence of his medical brethren, the physicians have a large measure of excuse for their hesitation to report cases on suspicion. The responsibility for the attitude does not rest upon physicians alone, but it rests equally upon boards of health that appoint health officers of inferior ability. On the other hand, physicians and their organizations have an obvious duty to perform in advising boards of health regarding the qualifications of prospective health officers. They know better than any one else what are the abilities of candidates, and their advice would be invaluable in securing high-grade men for the office.

Health officers and other members of departments of health have the unique distinction of forming almost the only official body that requires physicians to be up to date in their knowledge and practice, and accurate in their diagnoses. After a physician obtains a license to practice medicine, there is no law that compels him to continue his studies or to make a further advance of his knowledge. He is allowed to practice the kind of medicine which he learned fifty years ago in nearly every line except communicable diseases; but he cannot handle that class of diseases unless he keeps himself fairly up to date in knowledge. Each health officer is an inspector who reviews the work of family physicians in their management of communicable diseases, and compels them to study whether they wish to do so or not. Health officers have a great influence in promoting knowledge and efficiency on the part of physicians. An expert health officer will lead and inspire physicians to study, while one with inferior ability and a combative nature will drive them to study for the protection of themselves and their patients against the unwise acts of the health officer.

Isolation and Disinfection.—It is a recognized duty of a physician when he treats a case of communicable disease that he advise the family regarding the procedures to take in order to prevent the spread of the disease. The New York State Sanitary Code (Chap. 2, Secs. 11, 16, and 17) requires physicians to secure the isolation of cases of communicable disease and the proper disinfection and disposal of the excreta and discharges from the sick. These measures are to be taken immediately on the discovery of the case. Physicians take contradictory views of their duties and privileges regarding isolation and disinfection. Some would avoid the responsibility and embarrassment of imposing restrictions upon their own private patients, and would place that disagreeable duty entirely upon the health officer. Others object to visits of the health officer, and wish to attend to the duties of isolation and disinfection themselves. These duties may be made easy for both the health officer and the physician by the adoption of uniform methods of procedure by health departments and boards of health. The New York State Department of Health issues circulars of information for each disease, stating what the parents, the physician, and the health officer are to do. Such a circular of information is an official notification of the standard measures which have been devised by experts. It relieves the physician of the embarrassment of seeming to originate the restrictions, and the health officer from the charge that his measures are arbitrary and are imposed with partiality.

While a physician is expected to advise a family regarding the proper measures of preventing the spread of diseases, the enforcement of the measures upon unwilling persons is the duty of the health officer. It is the duty of the physician to inform the health officer regarding violations of the preventive measures, and to give him the entire control of isolation and disinfection when the violations are repeated and serious.

Instituting quarantines, directing isolations and disinfections, and discharging cases of communicable diseases and pronouncing them free from infectiousness are all official duties which devolve primarily upon the health officer, and it would seem proper to require the health officer to visit every case of communicable disease in order to advise regarding isolation and disinfection, to determine the time of discharge from observation, and to give a certificate of freedom from disease. The ideal condition is that in which the health officer and the physician work in close co-operation in all these matters.

Laboratory Supplies.—Departments of health of many states furnish laboratory supplies for both diagnosis and treatment. It is the implied duty of physicians that they make use of the supplies. The Sanitary Code of New York State (Chap. 2, Sec. 10) requires physicians to take a culture from every person whom they suspect to have diphtheria. Physicians have the right to expect the cordial assistance and co-operation of the health officer in the use of the laboratory material. The health officer is supposed to know how to take cultures and specimens for examination, and to be able to administer antitoxins and vaccines.

Vaccination.—It would seem that vaccination for the prevention of smallpox is a subject in which the truth should be known and universally accepted by physicians. The causes of the dangers and accidents that follow vaccination are well known, and may be readily prevented. If the instructions that are sent out by the departments of health of the leading states and cities were followed, there would be no complications following vaccination. It is the duty of every physician to become familiar with these instructions.

Tuberculosis.—The laws of the several states are imposing an increasing number of duties upon physicians, registrars, and health officers for the control of tuberculosis. It is the intent of the laws to compel physicians to seek for cases of the disease instead of trying to avoid them. The tuberculosis law of New York State covers several pages, and its effect is to make a physician act as an inspector for the department of health for each case of tuberculosis that he treats, unless he shall make a written declination to perform that duty. The intent of the law is to aid the physician if he wishes to treat the case, and to relieve him of responsibility if he is unable or unwilling to carry out all the troublesome measures which are necessary for preventing the spread of the disease.

Vital Statistics.—Physicians in most states are required to report births and to certify the causes of deaths. These reports form a part of the records of state departments of health, and are often of great legal and financial importance. The family physician often fails to realize that he is an essential part of the governmental machinery for registration when he signs a simple certificate of birth or death; and he is often correspondingly angry when he is subjected to a penalty for improperly performing that duty. Physicians are required to perform these duties for little or no pay, but the theory of the law is that the duties are simple in their nature, and are to be rendered as a slight return for the exclusive privilege to engage in the remunerative profession of practising medicine.

Clinics.—The departments of health of some states, counties, and cities conduct clinics for the diagnosis and treatment of cases of tuberculosis, venereal diseases, and paralysis following poliomyelitis, and for the correction of the defects of school children. Many physicians seek to avoid cases of these diseases, particularly those whose victims are unable or unwilling to follow instructions. The treatment of these conditions is largely a public health problem which the majority of physicians are unable or unwilling to carry out, and it must be done by the department of health or other organized agency if it is done at all.

Physical Examinations.—The laws of some municipalities require the examination of cooks and waiters in restaurants. These examinations are usually done by officials of the department of health upon the same principle that life insurance companies require applicants for insurance to be examined by physicians chosen by the company.

Private Physicians and Health Departments.—Physicians often complain that departments of health are encroaching on their rights and privileges by conducting clinics and administering treatments. The clinics and treatments are for the benefit of those who cannot obtain relief in any other way, and are similar to those conducted by hospitals and medical schools. They educate the public in scientific preventive medicine, and popularize modern methods of diagnosis and treatment. If physicians wish to assume any of the duties and responsibilities now devolving upon departments of health, they will be cordially welcomed. But experience shows that the great majority of cases treated in the department clinics would remain untreated if public health officials did not follow them up. Few physicians will accept the responsibility for quarantining their own cases of contagious disease, but they usually accept the varied forms of assistance that are offered to them by departments of health. The benefits which physicians receive from departments of health far outweigh the small losses and inconveniences which are caused by the departments' activities.

CHAPTER VI

RURAL PUBLIC HEALTH WORK

Death-rates in City and Country.—The influences which affect health may be divided into those which are external to man's body and those which are internal. The external influences are those of man's environment, and include such things as fresh air, pure water, sunshine, cleanliness of houses and yards, and proper sewage disposal. The internal influences are those which exist within the human body itself. They include communicable diseases, disease germ carriers, immunity and susceptibility, education, and personal habits, such as those of cleanliness of the body, coughing, sneezing, and the disposal of excretions.

Man's environment in the city is naturally unhealthful, and the unhealthful internal influences are increased by the frequent contact of persons with one another in crowded sections. The environment in rural districts is naturally healthful, and the internal influences which lead to sickness are far less than in cities, owing to the separation of the people from one another. The effects are shown by the death-rates which formerly ranged between 30 and 40 per 1000 in the city, and were below 20 in the country.

The first boards of health were organized in cities, and their efforts were directed principally against external influences in order to imitate the natural conditions of the country. Pure water was introduced, back yards and streets were cleaned, sanitary conveniences were installed in the tenements, sewers were constructed, garbage collection was instituted, and a beginning was made in the supervision of milk and other foods. The result was the elimination of the grosser avenues of infection, a great reduction in the so-called filth diseases, such as typhoid and cholera, and a very considerable lessening of the death-rates. The death-rate in New York City in 1900 was 20.6, while it was 15.5 in rural districts of the state, which included villages having a population of 8000 and less. This was justly considered to be a great achievement, and it is probable that the practical limits were reached in health work directed against man's environment. But this work scarcely touched the rural districts, for their conditions were already ideal according to the standpoint of the city sanitarians of a generation ago.

The next step in public health work was the application of modern discoveries in preventive medicine to the internal influences which affect the health of human beings. The sick individual was inspected, the carrier of disease germs was controlled, the private routes by which disease germs passed from one individual to another were blockéd; child hygiene work was begun, infant welfare stations were established, and a wide-spread campaign of personal education of the people was inaugurated. The result was a progressive fall in the death-rates of cities where the work was done efficiently, while the death-rate showed a tend-

DEATH RATE IN NEW YORK CITY COMPARED WITH DEATH RATE IN RURAL NEW YORK

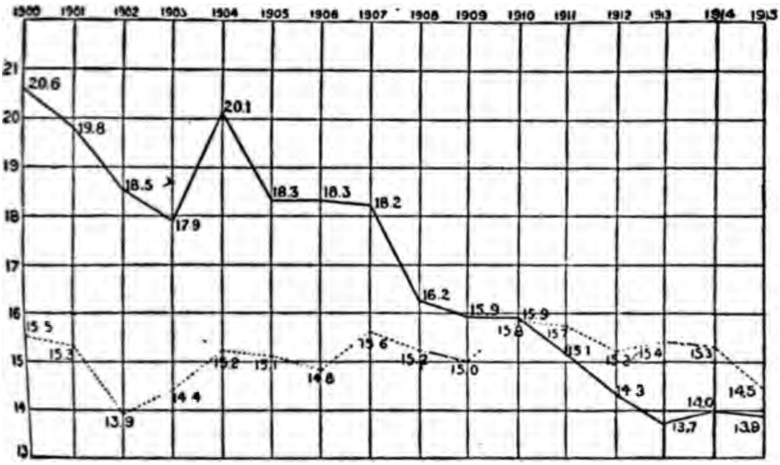

Fig. 1.—Heavy black line shows decline in death-rate of New York City, Dotted line shows recent increase in death-rate of rural New York (villages below 8000 population classed as rural). Note that New York City loses fewer lives in proportion to population than does the rural portion of the state.

ency to rise in rural sections where the work was unorganized. The death-rate of New York City was almost exactly that of the rural districts in 1910 (15.9 city and 15.8 rural), and has been below that in rural districts ever since. The rates in 1915 were 13.9 for New York City and 14.5 for the rural districts of the state. The change is due almost wholly to the efficient health work in cities. The country no longer needs health protection against the city, but the city must be protected against the unhealthful influences of the rural districts. The public health problem of the future is to bring the work of the country up to the standard of that in the city.

Rural health districts may be divided into three groups: 1, the rural proper; 2, the unincorporated villages; 3, the incorporated villages. The problems in these groups differ from one another almost as much as they differ from those in the cities. The rural districts afford concrete illustrations of the evolution of public health work from its crude undifferentiated beginnings up to its specialized activities in the larger progressive villages.

Sparsely Settled Townships.—Each household in a sparsely settled township is an independent entity, and its isolation renders an elaborate system of public health administration as unnecessary as a complex system in its other governmental activities. The two problems with which the health officer deals principally are the control of contagious diseases and the disposal of human wastes. If the natural environment were the principal factor in causing disease, those who dwell in country districts would be almost entirely free from communicable diseases. But colds, consumption, and diarrheas are as common in rural townships as in villages and cities. A hot, close kitchen is usually the sitting-room and dining-room for the whole family, and when a child contracts a cold, the disease spreads through the whole household. Overcrowding of rooms, which is the most dangerous form of overcrowding, is as common in the country as in the large cities. This overcrowding, and the frequent lack of a sufficient water-supply, facilitate the spread of colds and other respiratory diseases.

The spread of diarrheas in rural districts is promoted by the primitive system of disposing of human wastes. The receptacles of outdoor water-closets are often overflowing and swarming with flies, and whatever infectious material is deposited is soon carried back to food and to persons. Diarrhea frequently attacks one person after another in a family, and is often ascribed to green fruit, when, in reality, it is caused by infection from the outdoor toilet.

Most infectious diseases affect either the organs of respiration or those of digestion, and people in rural districts usually diagnose them as simple colds or diarrheas, at least in their early stages and in mild cases. They delay calling a physician owing to the expense, and in the meantime no precautions are taken during the most infectious periods of the diseases. Mild cases and carriers are often missed, and it is probable that in strictly rural communities only about half of the cases of communicable diseases are reported to the health officer. The menance of the city by the country in health matters is now greater than that of the country by the city, and the affliction of the cities with milk-borne epidemics is developing a demand for efficient preventive work in rural districts. The greatest immediate need in rural health work is the organized means for detecting and controlling communicable diseases in their early and mild stages.

The health officer of a rural township seldom has a public health nurse to assist him or a civic club to encourage him in his preventive work. Even complaints of neighbors against one another are seldom made, for unclean conditions arouse no interest when people live an eighth of a mile or more apart. Each person considers himself to be free from danger of contamination from a distant neighbor, and he resents the suggestion that he himself may damage his neighbor's health. The health officer must deal with each household as a unit. He can make only a beginning in co-operative health measures, which are the essence of health work in cities. The basis of his work is personal hygiene; but a great incentive to personal hygiene is social contact with other persons. The customs of polite society require certain standards of cleanliness and personal appearance, and of freedom from apparent signs of disease. Families living in isolated places relapse into unsanitary personal habits of which they are ashamed when others see them. The lack of civic pride and of the incentive of fashion makes the work of the rural health officer especially difficult.

The great need in public health work in sparsely settled communities is the education of individuals regarding the relation of their own personal habits to disease, and particularly regarding the infectious nature of colds and diarrheas. Personal education rather than compulsion will solve the problem of health in purely rural communities. The rural health officer has the power to control evident cases of contagious diseases, but that is about all the direct authority he can use. He must depend on education for accomplishing results in other lines of public health work.

Unincorporated Villages.—An unincorporated village has all the problems of a purely rural district, but other problems develop in proportion to the closeness with which the people are associated together. Milk routes may need the health officer's attention, and water-supplies may require protection. The cesspool nuisance is added to that of privies, and a co-operative sewage district may be demanded. The necessity for co-operation in health protection becomes evident, a few specific lines of definite work begin to be apparent, and the effects of civic pride begin to be felt. The health officer receives complaints of unsanitary conditions, and he can secure the co-operation of at least a small group of citizens in remedying unhealthful conditions. The people see him when he inspects a nuisance or visits a case of sickness, and his actions receive immediate publicity. His health work is of a real public nature in distinction from its individual character in sparsely settled communities.

An unincorporated village and its surrounding rural township usually form a single political unit which is served by one health officer and one board of health. The village is simply a thickly settled portion of the township, and its health officer must reconcile the demands of the two conflicting groups. The people of the strictly rural section assert their individual independence, while those of the village demand some degree of co-operation in health matters. The health officer will naturally devote most of his activities to the village with the expectation that the work will spread into the surrounding rural sections.

Incorporated Villages.—All the principal activities of a city department of health are needed in an incorporated village, and they are at least brought to the serious attention of the health officer and the board of health by civic clubs and other organizations which now exist in nearly every village. Communicable diseases, milk, water, sewage, and garbage all require attention. A health officer cannot do his duty unless he has a knowledge of the elements of all phases of public health work, and is willing to give his time to developing the various activities which he is expected to conduct. Two very great advantages of an incorporated village over a township are that responsibility in a village is centralized in a small governing body to whom a health officer can go for authority and help, and that there is usually a considerable degree of civic pride to arouse the people to do their duty. There is probably as much public health work to do among a strictly rural population of 5000 as in a village of 5000; but there will be ten times as much work done in the village as in the rural section.

A conscientious village health officer will often be overburdened with a mass of detailed work, and it may be necessary to supply him with helpers. The assistants whom he will need at first are a public health nurse to look after persons themselves, and an inspector to look after their environment. The nurse will follow up school children who have physical defects. She will instruct parents in the care of babies, and will investigate carriers and mild cases of communicable disease. She will do child hygiene and infant welfare work, and will discover and supervise tuberculosis cases. Her work will be largely house-to-house visitations and private demonstrations of methods of home sanitation.

The inspector will look after outdoor conditions, and will also make inspections of markets and school buildings. He will investigate water, sewage, milk, food, garbage, and nuisances. A nurse will also do some of this work as she goes her rounds, and if only one assistant is provided, the health officer will choose the nurse. He will add other assistants as the work grows and new activities develop. The public health work of many progressive villages could well be taken as a model for the work in cities.

Organization of a Rural Health Department.—A rural health department has almost no organization, and little differentiation of health activities. The rural class includes nearly all the health departments of townships and unincorporated villages. Over half of the local health departments of New York State may be classed as strictly rural.

The rural health officer districts in most states are independent entities, and are not under the control of supervising experts. The states usually grant home rule in health matters to the larger cities, and the rural districts demand the same independence of control. The result is that efficiency of a rural health department usually depends almost entirely upon the local health officer himself.

The New York State plan of organization is that the local health department and the State Department of Health are jointly charged with the administration of local health affairs. The responsibility lies first with the local department, and, second, with the State Department. This plan enables the State Department to set uniform standards for rural departments; and the local departments to obtain expert assistance when unusual conditions arise.

Massachusetts and New York have tried the plan of consolidating local health districts into larger units in which effective health work can be done. The plan works well when a village or small city is a dominating center for a surrounding rural district. It extends the organization of the village or city into the surrounding rural districts.

Indiana and other states have adopted the plan of administering health affairs by means of county health officers who have deputies in the local districts.

All the plans of organization have the common element of a local health officer or deputy in each rural district. The principal responsibility for field work lies with the local officer, whether he is independent of outside control or is subordinate to a higher department of health in a district, county, or state. One of the greatest needs in public health work is that for efficient rural health officers. The efficiency depends on (1) securing the proper type of men, and (2) instructing them and giving them assistance in emergencies and difficult conditions.

Type of Health Officer.—Three types of men are not adapted to be rural health officers. The first type is the medical politician; the second type is the self-willed, independent local physician who gets his medical science from the daily newspapers, and is afraid to call a brother physician into consultation. The third type is the city official who is trained to follow inflexible city methods, and who always acts by rule. The physician that makes the best rural health officer is the public-spirited practitioner of medicine who understands rural conditions, who knows the psychology of the rural mind, and who himself has a successful medical practice in a rural district. This type of man will handle the various emergency conditions in public health just as efficiently as he does the graver and more severe diseases in his medical and surgical practice. He will recognize serious conditions in their early stages, and will seek the advice and assistance of expert specialists, or of his superior officers, before conditions get beyond his control. He will succeed in whatever he undertakes, and if a way to success is not apparent, he will not be content until he makes one. The number of available men of this type is sufficient to fill every position of health officer, and if boards of health would choose men of this class, rural health work would be done as efficiently as health work in the cities.

Training for Health Officership.—A rural health officer requires training in his specialty. New York requires its health officers to fit themselves for their duties, supervises them in their work, and gives them assistance in emergencies. The ideal condition is that in which the local health officers bear the same relation to their supervisors in their state department of health that the family physician bears to a consultant or to an operating surgeon. Rural health work will become efficient when a system of training, supervising, and assisting the health officers is universally adopted.

CHAPTER VII

RECORDS AND REPORTS

Reasons for Keeping Records.—The average health officer is a modest official, and his training as a private practitioner of medicine has taught him to refrain from talking about his work and accomplishments. His duties at any one time are usually so few that he can carry his acts in memory to his own satisfaction. But there are three great reasons why he should keep records and make public reports of the items of work which he does.

The first reason why a health officer should give publicity to his work is that he is a public official, and the people whom he serves have a right to know what he is doing. They may reasonably demand that he take them into his confidence regarding public health conditions, just as private persons may expect him to advise them frankly and fully regarding their personal diseases. If a health officer does not consider his advice and treatment of the public to be of sufficient importance to require a record of the items, the people will naturally place a small value on his services and on the cause which he represents. But a truthful statement and enumeration of the details of the varied duties which he performs will lead the people to appreciate the value of his diagnosis and treatment of public ills, and to give him their co-operation in the promotion of public health.

The second reason for keeping records and making reports is that they may be used as a basis on which the board of health may authorize work for the coming year and make the proper appropriations for carrying it on. When a health officer asks for an appropriation, the members of the board of health may properly ask two questions: first, What has the health officer done during the past year? and second, Exactly what does he propose to do during the coming year? They will also ask, Do the people want this work done? The answers to these three questions will necessarily be based on the records and reports which are on file in the department of health. The health officer may have the records stored away in his own memory, but they are of no value until they are in written form and available to the public. The people act on the information which they possess. A universal rule in American government is that appropriations of money shall be made only in response to a clear public statement of the exact conditions which require the expenditures. A health officer owes a duty to the people to advise them regarding conditions affecting public health, what he has done to remedy them, and what he considers necessary in the future. Health officers who have presented these facts clearly in detail have usually found their boards of health and the people to be responsive to their requests.

The third reason for making records and reports is their effect on the health officer himself. When he makes a report, he must ask, what definite thing have I done, and what definite results will come from it? A health officer must have a conscious knowledge of himself. Records and reports compel him to see himself as others see him. They reveal his own failures and successes, and the sources of his weakness and his strength.

The first step in solving a problem is to state it clearly. A report requires a health officer to state his problems in concrete form. Records in memory are crude, unorganized masses of impressions. A written report is an organized array of proved facts, and an interpretation of their meaning. It clarifies the health officer's ideas of health conditions and suggests the proper remedies. Records and reports constitute an index of the amount of thought which a health officer puts into his work.

What to Record.—Every act to which a health officer devotes time and thought in the discharge of his duty is worthy of record. His field activities are enumerated on page 22, and his office duties on page 30. The performance of each activity in a city department of health is assigned to one or more persons, and a separate record is kept of each individual. Each activity that a country health officer conducts is as important as a similar activity in a city. A health officer, for example, is his own telephone operator, and the time which he spends in making calls is even more important than that of the telephone girl in the city department. While a health officer is not expected to keep a record of every small item of work, yet he ought to have some idea of the amount of time which he devotes to each activity. He can estimate this by keeping a record of one item at a time for a short time. He may, for example, estimate the number of letters which he receives and sends by counting them for a week or a month.

Classification of Records and Reports.—The records and reports which every health officer may reasonably be expected to make may be classified under seven heads: 1, a diary; 2, a note-book; 3, a permanent record book; 4, individual reports on special work; 5, monthly reports; 6, annual reports; 7, plans for future action.

Diary.—The simplest record which a health officer can make is a brief daily account of the various items of his work. He can make the record in his personal diary or in a special book which he carries for the purpose. A daily record is necessary in conducting isolations and quarantines, making inspections and investigations, and in making up final reports. It is also necessary in noting future engagements.

A Note-book.—A necessary part of the outfit of every health officer is a note-book in which he may make field records of data concerning inspections, investigations, and conferences, and the examinations of cases of communicable diseases. A convenient form is a book with loose leaves measuring about 4 x 7 inches. A book of this size may be conveniently carried in the coat pocket, and is always ready for immediate use. The leaves may be removed and tied together for future reference. No one can trust to memory for recalling names, addresses, dates, distances, and other items whose value depends upon their accuracy. Notes made at the time of observation will be accepted as valid evidence in most law courts. It is an excellent plan for every health officer to form the habit of taking notes of every important condition which he observes, particularly if there is likelihood of future dissatisfaction or dispute. Making the notes requires no extra time, and the action impresses the bystanders with the accuracy and carefulness of the health officer. A field note-book is like the day book of a merchant.

Permanent Record Book.—It is the duty of every health officer to keep a permanent and consecutive record of his principal activities. This book is like the ledger of a merchant. The health officer will frequently refer to it in making up his reports and in answering inquiries regarding health conditions in his district. If it is kept up to date, it will constitute a summary of the main lines of work of the health officer.

The Department of Health of New York State has prepared a health officer's record book in which there are ruled pages for recording the following items:

Communicable diseases.
Complaints and nuisances.
Registration of deaths without medical attendance.
Commitments for insanity.
Inspections of public buildings.
Milk permits.
Expenses.
Supplies received and distributed.
Miscellaneous.

Reports of Special Work.—A health officer is often requested to investigate epidemics and unsanitary conditions, and to write reports on his findings and actions. A frequent defect in the reports is that they are incomplete and confused, are illogically arranged, and lack unity of construction. The style of a newspaper reporter is a good one for a health officer to follow in making his report. The questions who? what? when? and where? are to be answered in the first few lines of the report, and the details are then to be set forth. A model form of report is that adopted by the New York State Department of Health. It is in the form of a letter in which the subjects of the paragraphs are arranged in the natural order of the development of the investigation. After the usual superscription the standard form of the letter and the order of the paragraphs may run about as follows:

1. The following report is submitted on the investigation of (*state the condition*), at (*place*), on (*date*), in response to the (*order, complaint, or information*) given by (*name of party*), and received on (*date*), that——————————(*give a brief summary of the order, complaint, or information*).
2. Give other reasons, if any, for making the investigation.
3. Describe the conditions that you found, being sure to include names, addresses, dates, and accurate figures as nearly as possible.
4. Describe the action which you took.
5. State the advice which you gave, and the recommendations which you made.
6. State the attitude of the persons to whom you gave the advice, and give your opinion whether or not they will follow your advice.
7. Sign your name and give your official title.

Monthly Report.—It is a good plan for the health officer to submit a monthly report to his board of health, and to discuss and explain it personally to the board. The reports will usually be published in the local newspapers, and will help to educate the public as well as members of the board. A model form of report is that which the New York State Department of Health requires from every health officer. It is made on a blank which is supplied by the department, and consists chiefly of a statistical summary of the work performed. It has spaces for the following items:

1. Number of cases of the various communicable diseases reported.
2. Number of special conferences on health matters attended.

3. Number of hours devoted to health matters during the month.

4. Amount of money audited by the board of health during the month.

5. Number of public buildings or schoolhouses examined.

6. Number of premises cleaned, ——; renovated, ——; disinfected, ——.

7. Number of dairies scored, ——.

8. Number of permits issued to milk dealers, ——.

9. Number of other permits given, ——.

10. Number of lectures given, or managed, ——.

11. Number of board of health meetings attended, ——.

12. Number of complaints received, ——; investigated, ——; satisfied, ——.

13. Number of sanitary inspections made, ——.

14. Number of other items of health officer work performed, ——.

15. Amount of supplies given out, ——.

16. Remarks and explanations.

Annual Report.—The annual report is, in effect, a sanitary survey of the health officer's district. It consists of a summary of the statistics contained in the monthly reports, together with explanations and interpretations of the statistics. It also contains a summary of the vital statistics of the year, an estimation of the birth-, death-, and infant mortality rates, a comparison of them with the rates for the preceding years, and a discussion of the various causes of death. It further contains a summary and discussion of the following topics:

1. Milk-supply; the amount of milk and cream sold, the number of dealers, number of producers, and score of the dairies, the amount pasteurized, and a discussion of the methods of handling the milk.

2. Water-supply, municipal and private water companies, individual supplies; sources of the water, character and analysis; when surveyed or analyzed.

3. Sewage disposal; sewers and disposal plants, and their operation; cesspools and methods of disposing of their contents; privies, their construction and maintenance.

4. Garbage disposal, methods and results attained.

5. Refuse disposal, location of dumps; methods of their control.

6. Stables and barnyards, methods of their control and sanitation.

7. Antifly and antimosquito work.

8. Midwives, number practising; methods of their oversight and control.

9. Child welfare stations, little mothers' leagues, nurses, and a discussion of the results attained.

10. Public health nursing, number of nurses; their activities; a summary of their work.

11. Antituberculosis work, nurses, home oversight, sanatorium care, educational work.

12. Complaints, their classification, means employed in abating nuisances, results obtained.

13. Laboratory, nearest one available, number of diphtheria cultures taken; number of sputum examinations; number of Widal tests; number of Wassermann tests; number of typhoid vaccinations; amount of supplies received; dispensed.

14. Expenses for the health officer's pay; for supplies; for disinfections; for vital statistics; for other purposes.

15. Vaccination for prevention of smallpox; number, results, methods employed.

16. Educational. Lectures given; lectures managed; exhibits; copy for newspapers prepared; interviews given to reporters; posters and circulars prepared.

The statute law of New York State requires every health officer to make a survey of his district annually. This is equivalent to an annual report. Its preparation will not be difficult if the health officer keeps his monthly reports up to date, and is active in the discharge of his routine duties.

Program for Future Work.—One of the greatest objects of a health officer's annual report is to arouse interest in public health work in his municipality in the future. The health officer himself is the first person who may be expected to profit by the report and in whom an increased zeal may be anticipated. If he makes a comprehensive study of the health situation while compiling his annual report, he naturally will form an estimate of the peculiar difficulties which he has had to meet, and will consider plans to meet them and to increase the scope and efficiency of his work during the coming year. It is his duty to include in his annual report a definite program for the work of the coming year, and a request for the financial assistance of his board of health and the active co-operation of its members. It is a good plan to adopt a specific aim, such as the care or supervision of every tuberculosis case, or a sanitary toilet for every home, or the establishment of a dental clinic, or the formation of a sewer district, or the suppression of malaria, or the vaccination of every school child, or the introduction of a pure water-supply, or the improvement of the milk-supply, or the adoption of a system of food inspection, or the employment of a public health nurse. Experience shows that if one object is specially emphasized, public health work along all other lines will be promoted. Each municipality has its own peculiar problems and needs, and the health officer can suggest the line of work which will give the largest results for the money and effort invested.

Daily Record Sheet.—There is great need that a health officer shall systematize his work, and shall record what he does each day in his varied activities. If a health officer were working for an industrial corporation, he would be required to keep a daily record sheet of his work. Such a daily statistical record will be most valuable to health officers who are willing to keep it, and to boards of health who may require it. The form on pages 70 and 71 is suggested as a model.

Sanitary Survey.—A sanitary survey consists of a record of the principal sanitary features of a district. It is desirable that a copy of the survey of each health officer's district be on file in the local office, and another in the office of the State Department of Health. The form used in New York State contains the following items:

1. Population; age grouping; races.
2. Topography; soil; bodies of water.
3. Financial expenditures for health work.
4. Water-supplies; sources; purity; records of analyses; recommendations made by the State Department of Health.
5. Sewage disposal; sewer districts; sewer outfalls; cesspools; privies; relation to wells.
6. Disposal of other household wastes; garbage; manure; local ordinances regarding them.
7. Nuisances, the common ones; factory wastes.
8. Streets; paved, macadam, or dirt; accidents at railroad crossings.
9. Public buildings; tenement houses; bath-rooms; building regulations.
10. Schools, number; special provision for tubercular pupils; medical inspection.
11. Hospital provision for general cases; for contagious diseases; for tuberculosis.
12. Labor camps, number; character; sanitary conditions; permits issued.
13. Summer resorts; inspections made; milk-supplies, water-supply, sewage disposal.
14. Barber shops; sanitary condition.

HEALTH OFFICER'S DAILY RECORD

For the month of..........................191

....Health Officer of the

City / Village / Town } of.. ....State

Work Done.	Day of Month. 1	2	3	4	5	6	—	—	—	30	31	Total.
I. *Communicable Diseases:*												
1. No. of reports of new cases received.........												
2. No. of cases examined......................												
3. No. of diphtheria cultures sent away........												
4. No. of other specimens sent................												
5. No. of visits to infected homes.............												
II. *Medical Work:*												
6. No. of consultations with physicians.........												
7. No. of doses of antitoxin given by H. O......												
8. No. of specimens taken by H. O............												
9. No. of operations done by H. O............												
III. *Inspections:*												
10. No. of complaints received...............												
11. No. of sanitary inspections made..........												
12. No. of water-supplies inspected............												
13. No. of sewage nuisances observed..........												
14. No. of other nuisances observed...........												
15. No. of cases referred for legal action........												
16. No. of dairies visited.....................												
IV. *Welfare Work:*												
17. No. of persons examined..................												

18. No. of visits to homes												
19. No. of conferences with public health nurses, social workers, etc.												
V. *Clerical and General:*												
20. No. of letters												
21. No. of telephone calls												
22. No. of telegrams												
23. No. of special reports												
24. No. of regular reports												
25. No. of hours spent in statistical work												
26. No. of hours spent in study and reading												
27. No. of hours spent on calls from inquirers												
28. No. of inquiries answered												
VI. *Miscellaneous:*												
29. No. of meetings of health board attended												
30. No. of meetings for laymen												
31. No. of calls from superior officers												
32. No. of calls on experts, laboratories, etc.												
33. No. of insanity cases												
34. No. of cases under the labor law												
35. No. of cases of poverty, degeneracy, crime, etc., investigated												

15. Dairies; number, average score; licensing; general character of the milk-supply.

16. Special sanitary code regulations; common towels; drinking-cups; spitting; midwives.

17. Educational work done; lectures; number of persons reached; conferences attended by the health officer; other educational work.

18. Miscellaneous; board meetings; hours devoted to public health work by the health officer; assistants; lay societies co-operating; record book; tuberculosis register.

19. Conclusions regarding the special needs of the district; public health nurse; other assistants; more money; laboratory; co-operation of the board of health; pure water-supply; sewer system; educational work; better milk-supply, etc.

CHAPTER VIII

STANDARD PROCEDURES

Information to the Health Officer.—The health officer is the executive officer and field agent of the department of health. He represents both the state and the local departments, and is the first official to whom nearly every health condition is referred. The information on which he acts comes from four principal sources: 1, The reports of physicians, overseers, nurses, teachers, and other persons who are required by law to report certain conditions to him; 2, complaints from private parties; 3, his own inspections either regular or special; 4, requests and orders from a superior officer, board, or head of department. An active health officer will not depend entirely on someone else to report to him before he takes action, but he will make inspections and investigations at every opportunity on his own initiative. He is presumed to be familiar with health conditions in his district. The public health law of New York State is mandatory that health officers shall maintain a continuous sanitary supervision over the territory within their jurisdiction (Sec. 21b, Subdivision 1). A health officer of a rural municipality is usually familiar with all sections of his district, and knows where unsanitary conditions may be expected.

Investigation.—When the knowledge of a probable unsanitary condition comes to him, a health officer's first duty is to visit the place himself, or send a competent assistant, and make a thorough first-hand investigation. He will consult all the parties who are concerned in the unsanitary condition, and will take whatever measures are necessary to determine the nature of the condition and the identity of the persons who are responsible for it. He will take cultures and photographs if necessary, and will be accurate and complete in his observations. If the condition is that of a communicable disease, he will consult the physician in attendance, and will assist him in making a diagnosis and in carrying out protective measures.

The health officer has the power to enter upon any place or premises where conditions dangerous to health are known or believed to exist, and may make inspections and examinations of those places and premises. He may also make a medical examination of persons who are affected with or have been exposed to communicable diseases (New York Public Health Law, Secs. 25 and 26).

There is a question how much force a health officer may legally use in conducting an investigation. If he is denied entrance to a place where an investigation is needed immediately, the best course for him to pursue is to call a police officer to accompany him and assist in making an entrance. If a medical examination of a sick person is refused, it would be his duty to institute a quarantine or a lesser degree of restriction as may be indicated by the probable nature of the disease. But a health officer who is respected in a community will rarely be denied admission or refused a medical examination, especially when he makes a second visit.

A health officer must have a sound and sufficient reason to justify him in forcing an entrance upon private property, invading the privacy of an individual, or restraining the liberty of any person. He may be called to court to answer charges that his acts were unnecessary and unreasonable. The final decision regarding the unsanitary nature of any person or thing does not rest with the health officer, but with a judge or jury in a court of law. The health officer must be sure that the evidence on which he acts is sufficient to convince the court of the legality and necessity for his action.

When a health officer makes an investigation of importance, it is necessary that he make written notes on the conditions in order to be sure of his evidence. The date, time of day, place, and persons seen are all of great importance. If a conversation was carried on, it would be well to record the exact words which were spoken. If a health officer has to go to court, he may take his original notes with him to the witness stand, and may refer to them to refresh his memory. If he cannot make notes at the time of the investigation, he may make them soon afterward while the condition is fresh in his memory. Written records made in the field constitute the strongest possible evidence of the true nature of the conditions.

Health officers in some of the states are protected by law against personal suits for their official acts (New York Public Health Law, Sec. 21b). But if a judgment is obtained against a municipality on account of the acts or negligence of the health officer, the municipality may bring suit against the health officer.

Decision.—After a health officer has investigated a condition, he must make a decision covering two points: 1, whether or not it may affect health; 2, whether or not it may involve a considerable number of persons. It is a general rule, to which there may be exceptions, that a health officer deals only with conditions that may affect the health of a considerable number of persons. The health officer must also decide whether or not the condition is a direct violation of a law or a sanitary code.

Notice.—The third step which a health officer must take in dealing with an unsanitary condition is to inform the responsible party of its exact nature, and to suggest a remedy. If there is a section of statute law or a regulation in a sanitary code bearing upon the condition, the health officer will include it in the information. The notice and information may be oral or written, or it may be contained in printed leaflets such as those issued by the New York State Department of Health on the various communicable diseases. If a person on whom a notice is served readily agrees to remedy a condition, an oral notice may be sufficient, but if the condition is complicated, or if there is doubt about its being remedied, a written notice is essential. It is well for a health officer to retain a copy of the notice for his own protection and for possible evidence in court.

While ignorance of law is no excuse for its violation, yet courts and juries are justly lenient with those who presumably have had no opportunity to learn the law. But a broader reason for giving the notice is that it educates those to whom it is given. If a health officer gives a notice in a friendly way, and explains the condition in a simple manner, he will make friends with the person responsible for the condition, and will secure his cooperation in remedying it. Most persons with whom a health officer has to deal are not offenders to be punished, but they are innocent parties who sincerely desire to follow common sense instructions which they understand.

A notice given by a health officer is not an order, and a person who fails to comply with its suggestions may not be punished for disobedience. Whatever punishment is inflicted will be simply for maintaining an unhealthful condition. The notice conveys the information that, in the health officer's opinion, an unsanitary condition exists, and that certain procedures will remedy it. The force of the notice is contained in a statement that is usually added that, if the condition is not remedied within a certain time, legal action will be taken against the persons responsible for it.

The health officer himself has no power to enforce his orders except in conditions in which a contagious disease is involved and immediate action is required. But even in an emergency his power arises from the force of public opinion that would bring overwhelming evidence in his favor if the case should come to court. The ultimate power lies not with the health officer, but with the law courts. Forgetfulness of this fact often involves health officers and their municipalities in difficulties and needless law suits for unnecessary and illegal acts.

If the health officer cannot secure the correction of an unsanitary condition by a notice and explanation, or by persuasion, he may do one of three things—1, take summary action; 2, begin a suit at law; or, 3, refer the matter to his board of health or the state department of health.

Summary Action.—If a condition threatens public health with a great and immediate danger, the health officer is justified in taking summary action to correct the condition and ward off the danger. His action under those circumstances is like that of a policeman or fireman. The principal conditions in which a health officer must take summary action are those which involve a contagious disease or threaten the spread of disease germs. A health officer is justified in posting a guard at the house of a person who threatens to break a quarantine. If a person afflicted with a contagious disease leaves his home, the health officer will not wait to obtain a warrant, but he will bring the person back at once, and by force if necessary. If a garbage heap contains the discharges from a typhoid fever patient, the health officer may properly employ a laborer to bury it at once.

A health officer who acts summarily does so at his own risk. The danger must be real and immediate to justify his action. If no danger is likely to result from a few hours' or days' delay, a health officer is not justified in taking the law in his own hands. For example, he would not be justified in using force in order to vaccinate a person. But a health officer who is active and discrete may count on the support of his board of health and the public when he decides that summary action is necessary. It is always wise for a health officer, before he takes summary action, to consult some member of his board of health, if possible, or some prominent citizen in order to have a witness as to the necessity of his action. It is his duty also to obtain a ratification of his action by the board as soon as possible.

Bringing a law suit is not the duty of a health officer, but of a board of health. However, the matter is often referred to a health officer, and he may bring an action, and courts and public opinion usually uphold him in doing it.

Action by a Board of Health.—If the health officer is unable to secure the correction of an unsanitary condition by a notice, explanation, and persuasion, his next procedure will usually be to refer the matter to his board of health. If the nature of the condition is evident and the remedy is obvious, the board may not need to meet, but the president or some member of the board may advise the health officer or other representative of the board to bring a suit against the offender at once. If there is doubt regarding the nature of the condition and the proper remedy, it is the duty of the board to meet and consider the matter formally. The procedure by the board is similar to that by the health officer, and includes three steps; 1, making an investigation; 2, forming a decision; 3, issuing an order.

A board of health may make an investigation in one of three ways. Individual members or a committee may inspect the condition and obtain information from those who know about it. They would repeat the work of the health officer and check up his observations.

The second method of investigation by a board of health is to summon the offender before it and discuss the matter with him. The legal status of such an examination is that it affords the offender an opportunity to explain his side of the case and show cause why an order to correct the condition should not be issued. Such an examination and discussion is similar to the action of a health officer in calling upon an offender, but it has the weight and dignity of a formal action by an official body. It usually results in the correction of the condition of the offender.

The third method of conducting an investigation by a board of health is a formal hearing. A board of health in New York State has the power to subpena witnesses, and to examine them under oath according to the rules of court procedure (Public Health Law, Sec. 21).

After a board of health has completed its investigation, it must make a decision whether or not the condition affects the health of a considerable number of persons, or is a violation of a law or sanitary code. This act of decision by a board of health is similar in nature to that which is made by the health officer.

If the board decides that the condition requires a remedy, its next step is to issue an order that the correction be carried out. An order is analogous to the information and notice that is given by a health officer to an offender. It differs from a notice in two important respects: first, it is official, and is authorized by law; and second, disobedience of it is punishable (New York Public Health Law, Sec. 21; and Penal Law, Sec. 1740). An order has the force of law, and is practically a special law made to fit an individual condition that already exists.

Making an investigation, forming a decision, and issuing an order are official actions of a board of health, but they do not have legal force unless they are recorded in the minutes of the board of health. A mistake or omission in the minutes may render all the proceedings of no effect.

If an order of a board of health is disregarded, the offender is liable to punishment for disobedience; but the usual custom is not to exact punishment for the disobedience, but to bring suit for damages or punishment on account of the continued maintenance of the condition.

An order of a board of health is in one of three forms. The first form is that for the summary correction of a condition. It is usually issued to the health officer directing him to employ the necessary persons and means to carry out the remedy. The statutes of New York State (Public Health Law, Sec. 21) authorize the board of health to issue warrants to any police officer of the municipality to apprehend and remove such persons as cannot otherwise be subjected to its orders or regulations; and to the sheriff of the county to lend the aid of the county if necessary. This clause is the source of the authority which a health officer exercises in maintaining a forcible quarantine in a contagious disease and in doing other summary acts.

The second form of order is that which is issued directly to the offender. It sets forth the unsanitary condition, orders him to correct it within a specified time, and informs him that legal action will be taken against him if he fails to obey the order. An offender must be served personally with a copy of the order so that he may know what is required of him. The person serving the order must make an affidavit that he served it, in order that the board of health may be able to prove that it complied with all the necessary steps.

The third form of order by the board of health is that directing the health officer, or the counsel for the board, or some other officer to begin a suit at law in order to secure the correction of an unhealthful condition. It is the custom to have the health officer do it, but legally the counsel for the board should do it.

Court Action.—A suit at law is the last resort of an efficient health officer, and he will seldom start one or threaten to do so. A law suit takes a public health matter out of the hands of health experts and places it in the control of judges and jurymen who are laymen, and are usually imbued with the medical ideas of a generation ago. The result of a law suit is uncertain, and depends largely on the state of public sentiment toward the matter in dispute. If a person is disobedient, it is often because a group of people encourage him in his attitude, and make him feel that he has public sentiment on his side.

The basis of any suit is the violation of a law or local ordinance. It is necessary that a health officer be able to point to the exact section of a statute law or to a regulation of a local code that has been violated. If he cannot find one which applies to the condition, there will be no use in starting a suit, for the court will be compelled to dismiss the action.

The ordinary court actions brought by health officers are either criminal or civil. Some laws and codes specifiy that a violation of them will constitute a misdemeanor, and others make it a civil offense. A misdemeanor is a criminal offense. It implies moral misconduct, and is punishable by a fine or imprisonment. A civil offense does not imply moral misconduct, and a judgment against a defendant is rendered as a restitution of money for damages. Whether a violation constitutes a misdemeanor or a civil offense depends on the words of the law or code.

A health officer begins a criminal action by making a sworn statement, called a deposition, before a judge, naming the offender and the exact nature of the offense, the municipality and county in which the offense was committed, and the date, and the section of law or code that is violated. The judge then issues a warrant to a policeman ordering him to arrest the offender and bring him to court at once.

A health officer begins a civil action by going before a judge and making a sworn statement of the facts, as in a criminal action. The judge then issues a summons ordering the offender to appear in the court at a specified time, which in New York State must be at least six days after the summons is issued.

A civil action is a much slower procedure than a criminal one. When a condition requires immediate action, a health officer can usually find some ground for bringing a criminal action, and thereby hasten the settlement of the matter.

A court action is a legal matter, and a health officer may justly insist that the board of health employ a lawyer to take charge of the case from its beginning.

A health officer is responsible for the evidence in a public health case. If his inspections and investigations have been complete and he has written records of them, he can go to court with confidence. But if he has omitted any important part of his investigation, or is uncertain in his knowledge, the opposing lawyer will probably be able to show that the evidence is insufficient to convict. A court action will be futile unless a health officer is sure of every step which he has taken previous to bringing the action.

The judgment in a law suit over a public health matter does not order an offender to remedy a condition. It merely imposes a penalty for the past existence of the condition. But if the offense is continued, the health officer may bring a new action for each day on which the unsanitary condition exists until the offender corrects it.

Injunction.—If an unhealthful condition is continued, a health officer may obtain an injunction. This is a court order that a person shall cease from performing a designated act. Obtaining an injunction is a complicated legal process, and is used only for the relief of important conditions to which no specific law applies.

CHAPTER IX

LOCAL SANITARY CODE

Relation to State Law.—A large measure of home rule is essential in public health work. A community must develop its own strength for resistance to disease and physical decay. An ideal condition in public health is that local departments shall do their work so well that the only function of the state department is to act as a clearing house for collecting and distributing information. A near approach to that ideal is that each local department of health shall develop the details of its own work along the lines which the state department indicates in a general way.

The powers of governing bodies of local municipalities are those which have been delegated to them by state legislatures. Every state allows its legislature to delegate some of its powers to the local municipalities—the towns, villages, cities, and counties. Local governing boards may adopt rules and regulations dealing with any phase of public health.

Method of Adoption.—It is the duty as well as the privilege of every local board of health to take enough interest in public health matters to enact a set of local ordinances for the control of local health conditions, and to keep the regulations abreast of the constant progress in hygiene and sanitation. The legal method by which a board of health adopts a sanitary code is usually that by which other local boards adopt rules and laws. The steps vary in the several states, and whatever they are they must be followed in order to make the ordinances legal. The steps in New York State are simply that the board shall pass the ordinances and publish them. No method of publication is prescribed, and posting the ordinance on a bulletin board in a public place would meet the requirements of the law. It is a good plan to have printed copies of the ordinances made for free distribution to the public and to offenders.

Local officials sometimes confuse orders and ordinances. An order deals with a single specific past offense, and is not binding unless it has been served upon the offender personally. An ordinance does not apply to offences committed before it was passed, but deals only with future offenses. It applies to any number of offenders, and publication of it is sufficient to make it binding upon all persons.

Relation of a Sanitary Code to Statute Law.—A department of health, either state or local, may enact a sanitary code dealing with almost any matter provided it complies with two conditions: first, that the matter affects public health; second, that the ordinance does not conflict with a statute law or a regulation made by a higher authority. The statute laws are usually general. They outline the form of organization of the departments of health and indicate the general scope of the subjects with which the departments may deal. A sanitary code specifies the manner of carrying out the laws. For example, the Public Health Law of New York State, Sec. 25, provides that a local board of health shall exercise "Proper and vigilant medical inspection and control of all persons and things infected with or exposed to communicable diseases." The State Sanitary Code outlines standard methods of carrying on the inspection and control. The statute law is sufficient authority by which a local board makes rules and regulations concerning the quarantine of cases of contagious diseases, the control of sewage, water-supplies, and milk, and almost any other detail of controlling communicable diseases.

A statute law is enacted by laymen, and is designed to be permanent. A sanitary code is enacted by experts, and may be easily changed and adapted to progress in the sciences of medicine and sanitation. A code which is up to date today may be antiquated within five years unless it is frequently revised and standardized. A sanitary code or other authoritative statement of standard methods of procedure is necessary in carrying on any line of public health work.

Relation of Local Code to State Code.—A state sanitary code deals with conditions which are of universal application throughout the state, leaving matters of local interest to be included in the local code. For example, Chapter II of the Sanitary Code of New York State enumerates the communicable diseases which health officers are to control. It specifies the manner in which the diseases are to be reported, and how cases are to be quarantined and their rooms disinfected. The state code fixes minimum standards which the local boards may make more stringent if they choose. For example, the State Code requires an isolation of seven days in measles, but the local board may make the isolation period two weeks or more.

New York State has a sanitary code whose provisions apply equally well to a rural district and to a city. It is, in effect, a part of the local sanitary code of each municipality. It and the health ordinances enacted by his local board of health constitute the code under which a health officer must act.

Essentials of a Code.—A sanitary code must fulfil two essential conditions: First, its provisions must be reasonable. They must be in accordance with standard medical practice, and their requirements must not be unduly burdensome or arbitrary. It would be unreasonable, for example, to require a strict quarantine for a case of typhoid fever, or to specify the use of a particular brand of chlorid of lime as a disinfectant.

A second essential condition of a sanitary ordinance is that its application must be uniform throughout the district over which the enacting board has jurisdiction. For example, there is doubt that a board of health has a legal right to establish a restricted area within which pigs shall not be kept. But some method can usually be devised to accomplish a desired end legally. If a board, for example, should pass an ordinance that no pigs should be kept within 500 feet of a dwelling, the effect would be to establish a restricted area in the built-up portions of a village or city, and yet the ordinance would be of uniform application.

Wording.—A local sanitary code is designed for the ignorant and stupid as well as for the educated. It informs the people what they are expected to do in public health work. It is important that it be cast in simple, untechnical language which the people can understand readily. The primary object of a code is not to be a guide for judging lawbreakers in court, but to educate people of all classes in standard methods of sanitary and hygienic procedure. The code is a text-book in these matters, and the simpler and clearer its form, the more useful it will be. An ordinance that is lengthy and is complicated in grammatical structure is an excellent mark for attack by a shrewd lawyer; while the meaning of one that is short and concise is evident even to ignorant persons.

The educational value of an ordinance depends largely upon the expression which receives the emphasis. The most emphatic position in a sentence or paragraph is at its beginnning. It is well to begin an ordinance with the leading thought or with an expression of the first importance. For example, if a board wishes to prevent the exposure of food on sidewalks and in open stalls, it might draft an ordinance as follows: "All food sold or offered for sale on a sidewalk, or in an open stall, shall be kept protected from dust and flies." Here the emphatic statement is at the end and is likely to excite only a mild interest in the mind of an ignorant person. A more forcible wording is as follows: "No person shall sell or offer for sale any food that has been exposed to dust and flies on a sidewalk or open stall." This form emphasizes the fact that food cannot be sold, and the reader is at once curious to know why not.

Subjects of Ordinances.—An ideal sanitary code will deal with every condition that a health officer is likely to meet in his jurisdiction. It will be a guide for both the health officer and the people, and will indicate the scope of the work which the health officer is expected to perform. It will enable a health officer to point to a definite source of authority for each act. It will relieve him of the charge of partiality in dealing with unreasonable people, for he can show that the board of health has anticipated his decisions for him.

An ideal code will also exclude regulations dealing with trivial matters. A useless regulation will belittle a whole code, for the people may not discriminate between the useful and the useless.

An ideal code will deal only with subjects which have a direct relation to health. The older codes dealt with many matters which were formerly supposed to affect health, but which are now known to be matters of decency, and to affect property values rather than man himself. The control of street dust, rubbish heaps, and ash piles does not properly belong to the health department. Such conditions as these may be dealt with under a brief regulation dealing with decaying substances. Still, regulations on such matters are often useful in an unprogressive community, for it enables the progressive element in the municipality to carry on a clean-up campaign which may indirectly bear fruit in securing sanitation along more useful lines.

The consideration and adoption of a modern sanitary code will help to educate a board of health in sanitary matters. A code puts health matters before a board in a concrete form. It is a catalog of the varied activities of a health officer, and indicates the comparative values of different phases of his work. It is a guide to the board in estimating the amount of work which a health officer is expected to do, and a standard by which it may judge him in the performance of his work.

Rules of Procedure.—Boards of health of the larger cities issue handbooks of procedure for the various bureaus containing the uniform rules of procedure which the employees of the department of health are to follow in the discharge of their duties. The rules of procedure which the health officers of towns, villages, and the smaller cities follow in the discharge of their technical duties are often contained in instructions and circulars of information sent out by the state departments of health. A sanitary code is designed for the instruction of persons outside of the department of health, but it may properly include the general rules of procedure which legalize the acts of a health officer in his dealings with physicians and the people generally.

A MODEL CODE

Every municipality needs a sanitary code for the guidance of the health officer, the board of health, and the public. It makes little difference whether it is adopted entirely by the state department of health, or entirely by the local board of health, or partly by each. If there is a state code, its regulations will be binding if they are not in the local code. The remainder of this chapter will be devoted to examples of regulations for a local code.

Title.—The sanitary code of the——————————— of———————————, adopted by the board of health on———————————, pursuant to Section —— of the public health law.

Regulation —.—Any violation of any section of this sanitary code shall subject the offender to a penalty of $—— to be sued for and recovered by and for the benefit of the ——— of ———.

(A code is not binding unless a penalty for its violation is specified. A violation may be either a misdemeanor or a civil offense, according to the wording of the statute law under whose authority the code is enacted. The New York State law allows the State Department of Health to declare a violation of the State Code a misdemeanor, but the local department can impose only a civil penalty. It is well to fix the penalty at a sum so small that the offender may be tried in the lowest court. This sum in New York State is $50.)

Regulation —.—Regular meetings of the board of health shall be held on the ——————— in ———————. The president or any two members shall call special meetings whenever an emergency arises in which the health officer requires the assistance of the board. Each member may act as a committee of the board of health to make inspections and investigations, and to consult with the health officer and assist him in handling matters of a legal or financial nature whenever the health officer shall require his assistance.

Regulation —.—In addition to the duties imposed upon him by the public health law and the state sanitary code, the health officer shall perform the following duties:

1. Execute and enforce the regulations and orders which may be enacted or issued by the board of health.
2. Keep himself informed regarding the progress in the sciences of sanitation and public health work.

3. Preserve and file all official information and instructions which he receives from the State Department of Health and other superior official bodies, and carry out the instructions to the best of his ability.

4. Keep a record of his official acts, and make a monthly report to the board of health.

5. Keep supplies of antitoxins, serums, culture-tubes, and other laboratory products sent from the Laboratory of the State Department of Health, and assist and instruct physicians in their use.

6. He may give full information to the public regarding the existence of communicable diseases within his jurisdiction, except that which is held by law to be of a confidential nature.

7. When an emergency arises requiring immediate action, he shall consult some member of the board of health, if possible, before taking action, and shall report his action to the board of health has soon as possible thereafter.

Method of Procedure

Regulation —.—When a health officer receives a complaint regarding a condition, person, or thing which is likely to affect health, or when the probable existence of such a condition, person, or thing comes to his attention, he shall at once take action as follows:

1. Make an immediate and thorough investigation.

2. Decide (*a*) whether or not the condition, person, or thing may be a danger to health or life; and (*b*) whether or not it affects a considerable number of persons.

3. If it affects the health or lives of a considerable number of persons, the health officer shall serve or cause to be served upon the offending party a written notice which shall

(*a*) Describe the unhealthful conditions.
(*b*) Suggest the remedy.
(*c*) State the period of time within which the remedy shall be carried out.

4. Keep himself informed regarding the condition, person, or thing.

5. If he is unable to secure a remedy, he shall report his action to the board of health and request its assistance.

Regulation —.—When a health officer or his representative makes an investigation or inspection, he shall proceed as follows:

1. Visit the locality, and, if possible, talk over the conditions with the persons who have knowledge of or are responsible for them.

2. Take samples and cultures, if necessary, and transmit them to an authorized laboratory for examination.

3. Make notes at once describing the conditions accurately and stating the place, date, and time of making the investigation or inspection.

4. Inform the responsible parties of his findings, and explain the nature of the conditions, and the remedy if one is needed.

5. On returning to the office make a record of his action.

Nuisances

Regulation —.—When a health officer shall receive a complaint of a condition which is commonly called a nuisance and which is not specifically covered by any section of this code or of the State Sanitary Code, or by any statute law, or whenever the probable existence of such a condition comes to his attention, he shall at once take action according to the method prescribed by this code.

Regulation —.—The board of health shall take formal action regarding a condition, person, or thing that may endanger health when

(*a*) The health officer reports that he is unable to secure an adequate remedy; or

(*b*) The health officer fails or refuses to act; or

(*c*) Either the complainants or the party against whom complaint is made appeals to the board; or

(*d*) The state commissioner of health or other higher authority requests it to act.

The action which the board of health shall take shall be as follows:

(*a*) Make a formal investigation either
  (1) By a personal inspection made by the individual members or a committee of the board; or
  (2) By an examination of the person against whom the complaint is made after he shall have been summoned before the board; or
  (3) By a formal hearing conducted after due notice and according to law.

(*b*) Make a formal decision whether or not the condition, person, or thing may endanger the health of a considerable number of persons; and

(*c*) If the condition, person, or thing endangers the health of a considerable number of persons, the board shall either
  (1) Order the health officers to take summary action to remedy it; or

(2) Cause a written order to be served on the offender, stating the remedy and the period of time within which it shall be applied, and authorizing the health officer or the counsel for the board to institute legal proceedings against the offender in case the orders are not carried out; or

(3) Order the health officer or the counsel for the board to institute legal proceedings against the offender at once.

Regulation —.—The health officer is hereby authorized to take summary action when a condition, person, or thing is one in which the germs of a communicable disease are known to be directly involved and in which there is immediate danger that the germs may be transmitted to human beings.

Communicable Diseases

The regulations regarding communicable diseases are among the most important in a code. They embrace the following subjects:

1. A list of diseases to be reported.
2. Who shall report them, and how.
3. Taking cultures in suspicious cases.
4. Enforcing isolation, quarantine, and disinfection.
5. Placarding infected premises.
6. Exclusion from school and return of pupils.
7. Removal to a contagious disease hospital.
8. Relation to milk and other foods.

All these points are covered in a model manner, and at considerable length, in the Sanitary Code of New York State. It is a good plan for a board of health to enact these regulations, and also to adopt additional ones authorizing the health officer to act in mild or suspicious cases, and specifying the exact manner of conducting an isolation or quarantine. The following additional regulations are suggested:

Regulation —.—The health officer shall exercise diligence in the discovery and control of cases of communicable diseases. Whenever the rumor or report of the probable existence of a case of communicable disease comes to him from a source that is presumably reliable, he shall investigate the report, and if no physician is in attendance, he shall visit and examine the suspected person. If he finds the disease to be one which is reportable under the code, he shall take the necessary measures for its control.

Regulation —.—If an epidemic is prevalent, every person who has well-marked signs that are usually associated with the disease that is prevailing shall be excluded from school, Sunday school, stores, and other places of public gathering until the nature of the disease is determined.

Regulation —.—When there is doubt regarding the nature of a disease that is presumably communicable, the health officer shall examine the suspected person and shall consult with the family physician if possible, and the diagnosis of the health officer shall be the official diagnosis.

Regulation —.—Every person who is a carrier of disease germs shall be subject to the following rules and regulations:

1. They or those persons who are responsible for their care and welfare shall truthfully inform the health officer concerning their present condition, and the history of any recent sickness.
2. Except with the consent of the health officer, they shall not attend any school, Sunday school, church, theater, lecture hall, or other public meeting place, or be present at any gathering where they may come in contact with children.
3. Neither they nor their attendants shall engage in any occupation in which they handle food.
4. They shall follow the instructions of the health officer regarding coming in contact with other persons.

Regulation —.—When a physician reports a case of communicable disease, he shall inform the health officer regarding the measures of control which he has instituted, and whether or not the patient and those associated with him will submit to the control. If the measures are insufficient or ineffective for preventing the spread of the disease, the health officer shall visit the house of the diseased person and shall institute the necessary measures for control. He may employ guards and watchers if necessary in order to enforce the control.

Regulation —.—All persons afflicted with smallpox, cholera, typhus fever, or plague shall be subject to the folowing rules for their quarantine and control:

1. The patient shall be isolated in a house, and no one shall enter or leave the house except with the health officer's permission, which shall be given only to the necessary attendants.
2. Other occupants of the house and members of the household may leave the premises as soon as the disease is discovered, provided they comply with the regulations and instructions of the State Department of Health and the requirements of the health officer.

Regulation —.—All persons afflicted with diphtheria, cerebrospinal meningitis, measles, scarlet fever, and poliomyelitis shall be subject to the following rules for their isolation:

1. The patient shall be isolated in a room that is shut off from the rest of the house, and no person except the necessary attendants shall enter the room.

2. All excretions of the patient shall be disinfected in a manner approved by the health officer, and in accordance with the instructions of the State Department of Health.

3. The attendants shall sleep and eat apart from the other members of the household, and shall not mingle with them. They shall at all times keep their clothing and persons clean and disinfected. They shall not leave the premises except with the permission of the health officer and after following his directions for cleansing and disinfecting their clothing and persons.

4. Healthy adult members of the household may go about their usual vocations, provided they do not handle food or come in close contact with children.

5. If any member of the household violates these rules, the health officer may impose a complete quarantine of the house as in Regulation No. — (relating to smallpox).

6. If a house is arranged for two or more families, and the sets of apartments are completely shut off from one another, the health officer may omit to impose restrictions on the members of the households in which there is no sickness.

Regulation —.—All persons afflicted with chicken-pox, German measles, mumps, or whooping-cough shall remain at home, and shall not leave their premises except by permission of the health officer, and no visitor who has not had the disease shall be allowed to enter the house.

Regulation —.—The periods of quarantine, isolation, control, and observation of a person who has or is suspected of having a communicable disease shall be those prescribed from time to time by the State Department of Health.

Diseased Animals

Regulation —.—The health officer shall carry out the provisions of the Agricultural Law relating to diseased animals, except those which impose duties upon some other officer or a veterinarian.

Regulation —.—Every owner or custodian of any animal afflicted with glanders, anthrax, rabies, trichinosis, foot-and-mouth disease, tuberculosis, or other disease which may be transmitted to human beings, and every veterinarian treating such animal, shall report the existence of the disease to the health officer. The health officer shall cause the animal to be isolated, and to be given such care as may be necessary to prevent the transmission of the disease to other animals or to human beings. No animal afflicted with any of these diseases shall be allowed upon any highway or in any public place. If an animal having such a disease dies, its body shall be buried under the direction of the health officer in such a manner that the disease shall be prevented from spreading.

Regulation —.—No meat, milk, or other product from an animal that has a disease which may be transmitted to a human being shall be offered for sale, or used as food for animals or human beings, except with the permission of the health officer.

Regulation —.—The health officer may authorize the destruction and burial of any diseased animal that is found astray in any highway or in any public place.

MILK

A board of health may require permits for the sale of milk, specify the conditions under which milk may be produced and dispensed, fix the grades of milk, and institute a system of milk inspection. These points are clearly covered in the Sanitary Code of New York State. Additional regulations may be desirable, as follows:

Regulation —.—The health officer shall carry out the provisions of the public health law, the State Sanitary Code, and the official instructions and decisions of the State Department of Health, relating to the production and sale of milk and milk products. He shall also carry out the provisions of the Agricultural Law relating to milk, milk products, and cattle, except those which impose duties upon some other officer or a veterinarian.

Regulation —.—No person who has a sore throat or a fever, or who has any other usual sign of a communicable disease, or who is a carrier of the germs of diphtheria or typhoid fever, shall engage in the production or handling of milk. No milk produced in a dairy in which such a person comes in contact with the milk shall be sold or offered for sale until it has been pasteurized under the direction of the health officer.

Regulation —.—The health officer shall file a copy of the permit of each milk dealer, and of the score card of each dairy in which the milk is produced, with the clerk of the board of health, and the records shall be open to public inspection.

Regulation —.—No ice-cream containing milk or cream which is below the standard of purity and freshness of that which is sold to be consumed raw, shall be sold or offered for sale.

Regulation —.—No skimmed milk shall be sold or offered for sale unless the containers are plainly labeled "Skimmed Milk," and bear the date on which it was drawn from the cow.

Regulation —.—Each bottle or other container in which milk is dispensed shall be labeled with the date on which the milk was drawn from the cow.

Regulation —.—No milk shall be sold or offered for sale unless it shall have been cooled immediately after milking to a temperature below 60° F., and kept below that temperature continuously until its delivery, or unless it shall be delivered to the consumers within two hours after it has been drawn from the cow.

Regulation —.—Except with the permission of the health officer, no stable, water closet, garbage heap, or manure pile shall be maintained within 100 feet of any dairy in which milk is bottled, pasteurized, or handled for sale.

Regulation —.—No milk shall be delivered on the street from open cans from which the customer's supply is dipped.

Regulation —.—No milk shall be sold or offered for sale which falls below Grade B.

Food Stores

Regulation —.—No waiter, cook, clerk, or other employee who has a communicable disease or is a carrier of disease germs shall be allowed to work in a restaurant, hotel, kitchen, public dining-room, grocery store, ice-cream parlor, soda-water vending place, bakery, bakeshop, candy store, candy factory, butcher shop, dairy, or other place in which food or drink is prepared or dispensed, except with the permission of the health officer, and under the conditions which he may prescribe.

Regulation —.—No food or drink, including ice-cream and soda-water, shall be prepared or dispensed or served in or with dishes, eating utensils, or napkins which have been previously used until after they shall have been cleansed with boiling hot water.

Regulation —.—No food shall be prepared, dispensed, or served in any public eating place unless the kitchen or place in which the food is kept, prepared, or cooked is clean in every part, including the cellar and ice-box, and unless the hands and clothes of the attendants and employees are clean.

Regulation —.—No food shall be sold or offered for sale in any grocery, butcher shop, or fish market, or other food shop in which any marked condition of uncleanness or filthiness exists.

Regulation —.—No food or drink shall be sold or offered for sale that has been left uncovered on the street or in open stalls, or has been exposed to dust, or to flies or other vermin.

Regulation —.—No food or drink shall be sold or offered for sale which is decayed, or is contaminated with offensive or poisonous substances, or is moldy to an abnormal degree, or is in an abnormal state of fermentation. The health officer is hereby authorized to condemn any article which is unfit for food according to the provisions of this regulation.

Regulation —.—No person shall slaughter animals in the ———— of ———— except in places and under the conditions which shall be prescribed or allowed by the health officer or board of health. No meat from an animal that has been slaughtered or cut up in a slaughter house or other place that is in an unclean or filthy state, and no meat that has been transported under unclean or filthy conditions, shall be sold or offered for sale.

Vermin

Regulation —.—No person shall maintain a manure pile, garbage heap, compost heap, or any other collection of substances in which house-flies, bluebottle-flies, stable-flies, or other flies which are detrimental to human beings or domestic animals are breeding.

Regulation —.—No person shall maintain a cesspool, rain-water barrel, pail, or other receptacle for water, or any pool, marsh, swamp, or other collection of water, in such a condition that mosquitoes may breed in it.

Regulation —.—No person afflicted with lice in any form shall be allowed to be present at any school, church, or other public meeting place, or to visit a store or other place where people commonly assemble, or to mingle with other people. No clothes, hats, or other wearing apparel containing lice or their eggs shall be taken from the premises of the owner or other person responsible for them until the lice and their eggs shall have been killed by heat or other destructive agent, or adequate precautions have been taken to prevent their escape.

Regulation —.—No collection of rubbish shall be maintained in such a state that it is a breeding-place for rats and mice.

Sewage

Regulation —.—No waste water, household slops, or other putrescible liquids shall be allowed to accumulate upon the surface of the ground, but they shall be emptied upon such places, and under such conditions, that they quickly seep into the ground.

Regulation —.—No sewage or other liquid containing human excrement shall be emptied upon the surface of the ground within 100 feet of a dwelling.

Regulation —.—No plumbing fixtures or waste-pipes for the removal of waste water and sewage from a building shall be constructed in such a manner and maintained in such a condition that odors, gases, or liquids can flow backward through them, or escape through their walls or joints.

Regulation —.—Every cesspool shall be covered in such a manner that flies and mosquitoes cannot enter it. No cesspool or other device for the disposal of sewage shall be allowed to overflow upon the surface of the ground or be constructed or maintained within 50 feet of a dwelling or private source of water-supply, or in a location from which its drainage will render the surrounding soil or water a menace to health.

Regulation —.—Every privy, water-closet, and urinal shall be maintained in a dry, clean, and sanitary state, and its contents shall be protected from flies. No privy, water-closet, or urinal shall be constructed or maintained within 50 feet of a dwelling or source of water-supply.

Regulation —.—No cesspool, privy, water-closet, or urinal shall be constructed or maintained within 1000 feet of a public water-supply, unless it or its receptacle is water-tight.

Regulation —.—No person shall transport sewage or the cleanings from cesspools or privies along a public highway, except in closed, water-tight tanks, and unless he shall have a written permit from the health officer, and shall deposit the substances in the places and manner which the health officer shall require as the conditions for giving the permit.

Regulation —.—No person shall deposit sewage or cleanings from cesspools or privies upon the ground within 1000 feet of a dwelling or source of water-supply. (This regulation may be desirable under exceptional circumstances; as, for example, in order to force the installation of a sewer system that is needed.)

Regulation —.—No garbage shall be allowed to lie on the surface of the ground more than twelve hours. The receptacles for garbage shall be maintained in a clean and odorless state at all times, and their contents shall be protected from flies.

Water

Regulation —.—No person or corporation shall maintain a well, spring, or faucet whose water contains sewage, or the harmful products of sewage, or colon bacilli, as a source of water-supply for drinking, cooking, or culinary purposes. No such water shall be used for laundry purposes without the consent of the health officer, and under the conditions which he shall impose.

Regulation —.—Water containing an excessive amount of iron, magnesium, lime, or other mineral matter, or is turbid or discolored, or deposits a sediment on standing, or has an offensive odor or taste, shall be considered to be impure, and the board of health, after an investigation, may issue an order forbidding its use for drinking, cooking, culinary, or laundry purposes except with the consent of the health officer, and under the conditions which he shall impose.

Stream Pollution

Regulation —.—No person shall deposit any sewage, water-closet cleanings, or drainage containing human excrement, or any dead animals, garbage, kitchen waste, barnyard drainage, animal refuse, or other substance which may putrefy, in any stream, lake, estuary, bay, or other body of water, or allow the same to enter the water without a permit from the board of health, and unless the substance shall have been purified to such a degree that it does not contain the germs of human diseases, and will not undergo further putrefaction. No permit shall be granted for the deposit of any such material in any body of water until a written application shall have been made to the board of health, stating the character and amount of the material and the manner of its conveyance to the water, and until the board shall have held a public hearing on the application.

Manure

Regulation —.—No person shall maintain a manure pile, compost heap, or other collection of decaying barnyard material in such a condition that it is a breeding-place for flies, or gives off offensive odors or drainage. Between the first day of June and the first day of October of each year every collection of stable manure shall either be carted away at least once a week and spread upon the land, or be securely screened from flies, or be treated with substances which will prevent the breeding of flies in it. (Some villages may wish to enact an ordinance requiring that manure shall be kept in covered bins constructed of concrete. Some will want to exclude the importation of manure during the summer months.)

Keeping Animals

Regulation —.—No pigs shall be kept within 100 feet of a dwelling or public meeting place, or within the area bounded by ———————————— (This regulation is in accordance with the Village Law of New York State, Sec. 90, Subdivision 29.)

Regulation —.—No pigpen, stable, barnyard, or house or enclosure for fowl shall be maintained within 100 feet of a dwelling or public meeting place, or in a wet, uncleanly state, or in such a condition that flies may breed in it. (This regulation will enable the board of health to eliminate stables, etc., from a residential district.)

Offensive Odors

Regulation —.—No person shall deposit or maintain any garbage, refuse, manure, sewage, or other substance which gives off offensive odors upon any highway or public place, or in any place from which the odors may escape and become offensive to human beings.

Regulation —.—No person shall establish, maintain, or conduct a business, trade, or occupation in which offensive odors, or excessive dust or smoke are produced, to the disturbance of the comfort and repose of a considerable number of persons.

Housing

Regulation —.—No house that is in such a dilapidated condition or state of filthiness or uncleanness as to endanger the health or life of any person that occupies it, or that is not furnished with a safe water-supply or with toilet facilities, shall be used as a dwelling, or rented for that purpose. The board of health may investigate such dwelling, and if conditions are found to be dangerous to health or life, it may order the health officer to post a notice upon the house declaring the building unfit for human habitation, and may institute a suit to dispossess the occupants. (There may be a question regarding the legality of this regulation. If the state adopts a housing law, this regulation may be unnecessary.)

It is also desirable that a local board of health shall enact ordinances controlling barber-shops, and the use of common towels, common drinking-cups and eating utensils, and forbidding spitting in public places. The Sanitary Code of New York State contains model regulations on these subjects.

CHAPTER X

VITAL STATISTICS

Value.—The term *vital statistics* means numbers relating to population, marriages, births, diseases, and deaths, together with a discussion of the conditions which affect those numbers. A record of vital statistics is one of the severest tests of a health department. It is the means by which progress in public health may be traced from year to year and from one administration to another. It enables a health department to set a definite goal of attainment; and the degree of approach to that goal may be taken as a measure of the success of the work of the department. The goal set by the New York State Department of Health in 1914 was the saving of 25,000 lives within five years. The Connecticut Department of Health in 1917 guaranteed to save one life for every $500 of its appropriation. These ideals can be accomplished only by a careful study of all phases of the vital statistics of the past, and by the application of lessons drawn from them to future methods of public health work.

A group of figures taken alone may be used to prove the most contradictory statements. Many elements enter into an interpretation of vital statistics, and erroneous conclusions will be drawn unless all the elements are considered. The death-rate among college students, for example, is extremely low in comparison with the death-rate among the whole population. The comparison, in order to be of value, must be made not with the death-rate among old men and babies, but with that among young men of the same age as the college boys. A community that boasts of the universally great age at which its inhabitants die may be one from which the young and active boys have moved away, leaving only the older folk. The system of vital statistics used by the states and larger cities is not complicated or difficult to learn, and it is the duty of every health officer to understand the principles on which the system is founded.

Population is the basis of all vital statistics. It is determined by a national census taken every ten years at the beginning of each decade. New York and other states also take a census in the years ending with 5, and thus a census is available every five years. The census includes the age, sex, nationality, occupation, and other personal data of each inhabitant. A tabulation of the facts is made for each municipality, and a report of all the facts relating to its population may be obtained from the United States Census Bureau, Washington, D. C.

Population is not an absolutely accurate number, but is an estimate. People are constantly moving. Some die and others are born every day. The Federal Census is taken as the population was on April 15th of the census year.

The population of a locality is affected by the season of the year during which the census is taken. A large city contains fewer inhabitants in summer than in winter. The New York State census of 1915 was taken in the summer while thousands of people were away at summer resorts. Its figures are not accepted, but the Department of Health uses an estimated population based on the Federal Census of 1910.

The population of a locality is affected by the presence of large institutions. A state hospital located in a rural district increases the population and the death-rate to such a degree that the vital statistics of that municipality have no value unless the figures for both population and deaths for the institution are excluded.

Estimated Population.—The population of nearly every country and municipality is growing, and considerable errors will be made in the vital statistics unless corrections are made for the growth during the intercensal periods. The corrections are made by either the arithmetic or the geometric method. The basis of both methods is the growth during the preceding intercensal years.

The arithmetic method is performed according to the methods of arithmetic progression, and is as follows:

1. Find the average yearly increase in population during the last intercensal period.
2. Multiply it by the years elapsing since the last census.
3. Add the product to the population according to the last census.

Example.—The population of a city on January 1, 1900, was 15,000, and January 1, 1910, 20,000. What was its estimated population on January 1, 1912?

The growth from 1900 to 1910 was 5000, or an average annual increase of 500. The increase in the two years from 1910 to 1912 will be 1000, which, added to 20,000, gives 21,000 as the estimated population for 1912.

The estimation of the population for any intercensal year would be made in the same manner as that for a post-censal year. For example, the population in 1917 would be $500 \times 7 + 15{,}000 = 18{,}500$.

When exactness is required, the increase is estimated for fractions of a year. The estimated midyear population, or that on July 1st, is used as the population for the entire year. The Federal Census is taken as of April 1st. The midyear population would, therefore, be the population on April 1st, increased by $\frac{3}{12}$ of the average annual increase. Thus, the population on July 1, 1900, would be $\frac{3}{12} \times 500 + 15{,}000 = 15{,}125$.

The geometric method of estimating population is based on a fixed yearly rate of increase, and is similar to the method of computing the amount in compound interest. If A represents the amount, P, the principal, R, the rate per cent., and N, the number of years, the formula for calculating the amount at the end of

1 year is $A = P(1 + R)$
2 years is $A = P(1 + R)^2$
3 years is $A = P(1 + R)^3$
N years is $A = P(1 + R)^N$

When these formulas are applied to vital statistics, A corresponds to the required population; P, to the population given by the census; R, to the annual rate per cent. of increase; and N, to the years elapsed since the census. The formula for the population at the end of

(1) 1 year is $A = P(1 + R)$
(2) 2 years is $A = P(1 + R)^2$
(3) 3 years is $A = P(1 + R)^3$
(4) N years is $A = P(1 + R)^N$
(5) 10 years is $A = P(1 + R)^{10}$

When the rate of increase is known, the calculation for the population may easily be made by the simple methods of arithmetic; but when the rate is not known, it must be found by the use of logarithms. Taking the last formula, we have

(6) $A = P(1 + R)^{10}$
(7) $\log. A = \log. P + 10 \log. (1 + R)$
(8) $10 \log. (1 + R) = \log. A - \log. P$
(9) $\log. (1 + R) = \frac{\log. A - \log. P}{10}$

Let us apply the formula to the following problem: The population of a city on January 1, 1900, was 15,000, and on January 1, 1910, 20,000. What was the rate per cent. of its annual increase? What would be the population on January 1, 1912, calculated by the geometric method?

$A = 20{,}000$
$P = 15{,}000$
R is unknown

By substituting, formula (9) becomes:

$$(10)\ \log.\ (1 + R) = \frac{\log.\ 20{,}000 - \log.\ 15{,}000}{10}$$

(11) log. 20,000 = 4.301030
(12) log. 15,000 = 4.176091
(13) difference = 0.124939
(14) $\frac{1}{10}$ difference = 0.012494 = log. (1 + R)

0.012494 is the logarithm of 1.0292; and 0.0292 is, therefore, the annual rate of increase of population.

The population on January 1, 1912, would be 20,000, multiplied by 1.029 squared. The square of 1.0292 is 1.0592; 1.0592 × 20,000 = 21,184 = population on January 1, 1912.

If the problem were, What would the population be on July 1, 1912, it could not be solved by arithmetic, for there is no way of raising 1.029 to the 2½ power by arithmetic methods. Logarithms must, therefore, be used.

Taking formula (4). $A = P\ (1 + R)^N$
N = 2.5 years
P = 20,000
R = 0.0292

Applying logarithms, we have

(15) log. A = log. 20,000 + 2.5 log. 1.0292
log. 1.0292 = 0.012494
(16) 2.5 log. 1.0292 = 0.031235
(17) log. 20,000 = 4.301030
(18) log. A = 4.332265 = log. 21,492
(19) A = 21,492 = population on July 1, 1912

If the population on July 1, 1912, were calculated by the arithmetic method, the result would be

$$2.5 \times 500 + 20{,}000 = 21{,}250$$

The two methods, therefore, do not give the same results. The correctness of the results is tested by their agreement with the figures of the next census. The experience of New York City is that the population calculated by the arithmetic method agrees with the census more closely than that calculated by the geometric method. The geometric method is the more reliable when the rate of growth is uniform over a series of years. When the rate of growth is irregular, the arithmetic method is the more exact. The United States Bureau of Census uses the arithmetic method.

Registration Area.—The rates of marriages, births, and deaths are based on the compulsory registration of the events. The registration is incomplete in many parts of the United States. Those states in which death certificates are required before burial form what is called the ***registration area*** which is recognized by the United States Census Bureau. The registration area now comprises the following states: California, Colorado, Connecticut, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Utah, Vermont, Virginia, Washington, and Wisconsin, together with the District of Columbia.

Marriages.—The marriage rate is expressed by three methods:

1. The number of persons married annually in each 1000 of population.

2. The number of marriages annually in each 1000 of population. This figure will be exactly one-half of that derived by method No. 1.

3. The number of marriages annually in each 1000 unmarried, widowed, and divorced persons over 15 years of age.

Some of the more important influences which affect the marriage rate are:

1. The age at marriage is increasing, with a corresponding decrease in the marriage rate. In Massachusetts the average age at marriage is now twenty-nine years among men and twenty-five years among women.

2. The employment of women tends to reduce the marriage rate by making them self-supporting.

3. Good times and prosperity promote marriages.

4. The marriage rate in cities is greater than in country districts. One reason is that the proportion of persons of marriageable age in cities is greater than in rural districts.

Marriages themselves do not directly constitute a public health problem, and a health officer has little or nothing to do with them. Licenses in New York State are issued by clerks of towns and cities, and after marriage they are returned to the clerk that issued them, and are filed by him with the county clerk, who finally files them with the State Department of Health.

Registration of Births.—The number of births in a community is ascertained by means of the compulsory registration of every child that is born. The public health law of New York State, Section 382, requires that every physician and midwife shall register a birth within five days. The reports of births everywhere in the United States have been incomplete in the past; but the frequent necessity of producing a birth certificate for legal uses is having its effect in the requirements for a complete registration. New York City, after a campaign of prosecutions against delinquent physicians and midwives, has succeeded in getting over 98.5 per cent. of births registered.

Value of Birth Certificates.—Birth certificates are necessary in order that sanitarians and the government may have a complete record of vital statistics. They are also used as the basis for calculating infant mortality rates, and for testing the results of child hygiene work.

Birth certificates often have a great value to those persons whose births are registered. The following are some of the personal uses to which birth records are put:

1. Evidence of age on entering school.
2. Inheritance of property, proof of age and relationship.
3. Proving age of consent in court.
4. Marriage licenses. A birth certificate is required in some European countries.
5. Passports. A birth certificate is required by the United States Government.
6. Obtaining working papers. In many states a child between fourteen and sixteen years of age cannot obtain employment without evidence of age.
7. Entrance into the military or naval service of the United States.

Form of Certificate.—The birth certificate that is used in New York and most other states is that known as the United States Standard Certificate which was designed by a committee of the American Public Health Association. It contains twenty-one items of information regarding the personal and family history of the child. It is a permanent record which is preserved in the office of the Department of Health.

Securing Complete Registrations.—Birth registration laws require physicians and midwives to report births, but in order to compel them to obey the laws the unrecorded children must be found. Some of the means of discovering the unrecorded births are:

1. A comparison of the death record of every child under one year of age with the birth register.
2. Obtaining names and ages of babies by inspectors and visiting nurses, and comparing them with the birth register.
3. Advertisements of births in newspapers, or news items regarding births.
4. The applications for birth certificates.

Birth-rate.—The crude birth-rate is the number of births annually in each 1000 inhabitants regardless of sex or age. The crude rate does not afford a uniform basis for comparing the birth-rates of two localities, for the one in which there is an excess of males would have the lower rate.

One form of refined birth-rate is the number of births annually in each 1000 women between the ages of fifteen and forty-five years. This rate does not express the true condition when a city containing a large number of unmarried women servants is compared with one composed of families of laborers.

A second form of refined birth-rate is the number of births annually in each 1000 married women between the ages of fifteen and forty-five years. This rate is the best basis of comparison between cities differing widely in the class of their inhabitants.

Most birth-rates that are published are the crude rates. What a health officer wants to know principally is who are born and where the children live.

A weekly birth-rate is the rate which would be obtained for a year if the number of births during each week of the year were the same as the number during the given week for which the rate is computed. For example, during the second week in June there were 10 births in a city of 25,000 inhabitants. What is the weekly birth-rate?

The number of births in a year, if 10 occurred each week, could be $10 \times 52.17747 = 522$. This divided by 25 (the number of thousands of inhabitants) gives 20.88 as the birth-rate for that week.

A monthly rate would be calculated in the same manner. If extreme accuracy is necessary, the health officer would use the exact number of days in the particular month for which he was calculating the rate, and the exact number of days in a year (365.24226).

The birth-rates in different countries show a wide variation. The rate in Hungary (36 in 1912) was the highest among people who keep accurate records, while that in France (19) was the lowest. The birth-rate in New York State in 1916 was 23.3. The birth-rate in nearly all countries is falling.

Some of the important factors which influence the birth-rate are:

1. Increase in the age at which marriage is contracted.
2. Decrease in the number of marriages.
3. Ease of obtaining divorces.
4. Economic conditions. Prosperity increases the number both of marriages and of births.
5. Avoidance of child bearing by women at child-bearing ages.

There is much discussion about the decline in the birth-rate. A condition that is as important as the number of births is the quality of the children that are born and reared.

Death Certificates.—Certificates of death are required before burial by most states. Since practically all deaths are known, the certificates form a reliable basis for the enumeration of deaths. The certificates used by New York and other states is that known as the United States Standard Certificate of death. It has twenty items to be filled out by the physician, health officer, or coroner, and these items form the basis on which death statistics are compiled. The certificates are preserved in the office of the Department of Health.

Cause of Death.—Accuracy in diagnosis and uniformity in terms are necessary in obtaining reliable statistics concerning the causes of death. The international list of causes of death is the authoritative standard by which a physician can determine the proper terms to use in making out a death certificate. The list is published by the Bureau of the Census, Washington, D. C., and will be sent to any physician applying for it.

A certificate has two blank spaces for the causes of death, one for the primary cause and one for the contributory or secondary cause. Physicians are sometimes uncertain whether a condition is to be considered a primary or a secondary cause. A cause is to be considered primary when it

1. Is the first to develop or is of the longer duration. Example, measles, primary; bronchopneumonia, secondary.
2. Is a disease of which the other is a recognized complication. Example, scarlet fever, primary; acute nephritis, secondary.
3. Is a general disease affecting the whole system in distinction to a local affection. Example, diabetes, primary; gangrene of foot, secondary.
4. Is the more acute and dangerous of two coexisting conditions. Example, gastric ulcer, primary; tuberculosis of lungs, secondary.

Sudden deaths frequently occur for which no sufficient cause is found. Physicians usually ascribe the cause either to some form of heart trouble or to apoplexy, but this is unsatisfactory unless there is clear evidence of disease of the heart or brain. Acute dilatation of the heart is a favorite diagnosis, but this is merely a terminal symptom and does not explain the underlying cause. The proper statement to make on the death certificate is, "Sudden death. No cause found on investigation."

Insane persons often die as the result of insanity alone. The proper form of certificate is chronic mental disease for the primary cause of death, and general weakness for the contributory cause. If pneumonia or nephritis or other condition was the immediate cause of death, it is to be entered as the contributory cause.

Many different names are often applied to the same condition. A fever of which the typhoid bacillus is the cause has over twenty different names, and tuberculosis has over a dozen, every one of which is often used to conceal the true condition. When a specific germ is the cause of sickness, the disease takes its name from the germ and the part affected. If the disease is typhoid, call it typhoid, and if it is tuberculosis, call it that.

Much is written about inaccuracies of diagnosis, and it is alleged that wrong causes are assigned to over half of the cases that are investigated on autopsy. The value of vital statistics in public health work does not depend upon an accurate pathologic diagnosis so much as upon a clear statement of the general condition of the patient. Ill-defined conditions resulting in death are often due to malnutrition, fatty degeneration, arteriosclerosis, or sudden high blood-pressure following dietary indiscretions; and yet sometimes no definite cause of death can be named when these conditions prove fatal. The rule in these conditions is to state the cause of death as accurately as possible in an explanatory sentence, and not try to name a particular disease.

Death-rate.—The crude death-rate is the number of deaths occurring annually in each 1000 of population. It is found by dividing the number of deaths in a year by the population in thousands. For example, 310 deaths occurred during 1916 in a city having 15,500 inhabitants. The death-rate is $310 \div 15.5 = 20$. A quarterly, or monthly, or weekly death-rate is calculated in the same manner as the corresponding birth-rate (p. 193). The death-rate for the whole year is based on the estimated midyear population. When the expression "death-rate" is used alone, without a qualifying adjective, the crude rate is meant.

The death-rate of a community is influenced by a number of factors, among which sanitation and the prevalence of diseases are the most important. Improvements in sanitary conditions and the application of measures for the protection of health have reduced the death-rate in New York City from 26 to less than 14 within twenty-five years. The crude death-rate is often taken as the standard by which the healthfulness of a place may be judged, but it is not a true index unless all other factors which influence the death-rate are excluded. A death-rate in which allowance is made for other factors besides diseases and sanitation is called a corrected death-rate.

Correction for Institutions.—A factor which may have a great influence on the death-rate of a community is the presence of a large home, almshouse, hospital, or other institution. A state hospital for the insane may have 2000 inmates with 100 deaths annually. The corrected death-rate would be calculated upon the deaths remaining after those of non-resident inmates had been deducted; and the population would be that of the town after the number of non-resident inmates had been deducted. For example, a town has 20,000 population within its borders, 2000 of whom are inmates of a state hospital and come from outside the town. The total number of deaths within the boundaries of the town during 1916 was 350, of which 100 occurred among the inmates. The crude death-rate was 350 ÷ 20 = 17.5. The corrected death-rate based on 250 deaths among 18,000 population was 250 ÷ 18 = 13.9. It would be unfair and misleading to judge the sanitation and prevalence of diseases in a town by the crude death-rate. The rule in calculating death-rates is to exclude non-residents from both the population and the deaths, and to charge the deaths of non-residents to the municipality in which those dying had their residence.

Correction for Age.—An allowance for the age distribution of population, and for deaths among various age groups, must be made in interpreting the death-rate of a community, or in comparing the rate of one municipality with that of another. The following table shows the approximate percentage of population in various age groups of New York City in 1913, and their death-rates:

Ages.	Percentage of population.	Death-rate.
Under 5 years	11.5	40.0
5–14 years	19.0	3.3
15–24 years	19.1	4.0
25–44 years	34.0	9.0
45–64 years	13.6	28.0
65 years and over	2.8	96.0
All ages	100.0	13.76

The death-rates among the different age groups in the table range from less than 4 to nearly 100. The percentage of persons at different ages varies in the various municipalities. If a municipality contains an excess of young persons, it will have a low death-rate. An excess of the number of babies, or of old people, will increase the death-rate. Japan has a large birth-rate, and the great number of young children produces a high crude death-rate. The population of the newer Western States consists largely of young, vigorous persons, among whom the death-rate is naturally small. The differences among cities, states, and countries are so great that the effect of the age grouping of the population must be considered in comparing their death-rates.

The reports of boards of health of the states and larger cities often give both the crude death-rates and the corrected rates. The corrections are usually those which are made for age groupings. There are several methods of calculating a corrected death-rate. The one in common use is that which is recommended by the International Statistical Institute and is based on the age grouping of the population of Sweden, and which is as follows:

Age.	Percentage of population.	Number per 1,000,000 people.
Under 1 year	2.65	26,500
1–19 years	39.81	398,100
20–50 years	38.62	386,200
50 years and over	18.92	189,200
Total	100.00	1,000,000

The corrected death-rate which is based on the population of Sweden is called, a standardized death-rate. The method of computing the standardized or corrected death-rate of a city is as follows:

1. Calculate the death-rate of each age group of the city.
2. Take the corresponding age groups of the population of Sweden, apply the death-rates of the city groups to them, and calculate the number of deaths that would occur in each group.
3. Add the number of theoretic deaths in the groups. This will give the number of deaths that would occur in Sweden if the death-rates of the Swedish age groups were the same as those of the city.
4. Calculate the theoretic death-rate based on the number of theoretic deaths. This will be the corrected death-rate of the city.

The following example will illustrate the method of calculating a corrected or standardized death-rate. A city of 1,000,000 inhabitants has a crude death-rate of 15. The death-rates of its various age groups are as follows:

Under 1 year	100
1–19 years	11
20–50 years	6
50 years and over	40

What will be the corrected death-rate?

Solution.—The number of persons under one year in the standard population of Sweden is 26,500. If the death-rate among these persons were the same as that in the city, the number of deaths would be 26.5 × 100 = 2650.

There are 398,100 persons between one and nineteen years of age in the standard population of Sweden. If the death-rate were 11 the number of deaths would be 398.1 × 11 = 4379.

The following table shows the number of theoretic deaths for all the age groups:

Ages.	Swedish population.	Death-rates of the city.	Number of theoretic deaths in Sweden.
Under 1 year	26,500	100	2,650
1–19 years	398,100	11	4,379
20–50 years	386,200	6	2,317
50 years and over	189,200	40	7,568
Total	1,000,000	....	16,914

The total number of theoretic deaths is found to be 16,914 in a population of 1,000,000. The theoretic death-rate is, therefore, 16.9. This is the corrected, or standardized, death-rate of the city, and is considerably higher than the crude rate. The explanation is that the ages of the people in the city are favorable for a low crude death-rate.

When the death-rate of the various cities and states are standardized and corrected according to a common method, the effect of the age grouping is eliminated, and the differences in the death-rates are then due almost solely to sanitation and health protection measures.

Direct Comparison of Death-rates.—The death-rates of two cities may be compared directly by applying the death-rates of the age groups of City No. 1 to the numbers of people in the age groups of City No. 2. Suppose, for example, that we wish to compare the death-rate of New York City for 1913 with that of City B having a population of 100,000, a crude death-rate of 12.25, and an age distribution and age death-rate as shown in the following table. The table also shows the age distribution in City B, the crude death-rates for the various ages, and the results obtained by applying the New York City death-rates to the age groups of City B.

Age groups.	Population of City B.		Actual number of deaths in B.	Death-rate of City B.	New York City death-rate.	Theoretic number of deaths in City B based on the New York death-rate.
	Percentage.	Number.				
Under 5 years	8.0	8,000	360	45.0	40.0	320
5–14 years	20.0	20,000	80	4.0	3.3	66
15–24 years	24.0	24,000	120	5.0	4.0	96
25–44 years	38.5	38,500	385	10.0	9.0	347
45–64 years	8.0	8,000	160	20.0	28.0	224
65 and over	1.5	1,500	120	80.0	96.0	144
All ages	100.0	100,000	1225	12.25	...	1197

Theoretic death-rate = 11.97.

The crude death-rate of New York City for 1913 was 13.76, while that of City B was 12.25. A comparison of the crude rates would indicate that City B was more healthful than New York, but if the death-rates of New York's age groups held good in City B, the death-rate of City B would have been only 11.97.

Infant Mortality.—The death-rate among children under one year of age is called the infant mortality rate. It is the number of children dying among every 1000 children under one year of age. The population under one year is considered to be the number of births during the year. This figure is more accurate than the number obtained by the census enumerators. Infant mortality is, therefore, the number of children under one year old dying in each 1000 births. It has fallen more than the death-rate in any other age group. It was 288 in New York City in 1890, and 99 in 1914. The fall has been due largely to the education of mothers, but also to improved milk-supplies, and to special work for the benefit of babies.

There is a marked age grouping in infant mortality—42 per cent. of the deaths are among children under one month old, and are due to congenital causes which affect the mothers before the children are born. The following table shows the percentage of deaths among infants at various ages:

Age.	Percentage of deaths.
Under 1 month	42
1 month	10
2 months	8
3, 4, and 5 months	17
6, 7, and 8 months	13
9, 10, and 11 months	10
Total	100

Infants form a special age group which is recognized by the assignment to it of a specialty in medicine, pediatrics, and of a special division, child hygiene, in the departments of health of the states and larger cities.

Special Death-rates.—Death-rates are often calculated for individual diseases. They are usually based on a unit of 100,000 of population in order to avoid decimals, or fractions of a death. The death-rates per 100,000 of population for the leading diseases in New York State during 1916 were as follows:

Pneumonia, all forms	167.1
Tuberculosis, all forms	152.6
Cancer	90.1
Diarrheal diseases of infants	51.2
Poliomyelitis	32.0
Diphtheria	14.7
Measles	8.9
Whooping-cough	7.2
Typhoid fever	5.8

Morbidity Rates.—The statistics which have the most value to a health officer are those relating to the number of cases of communicable diseases in his jurisdiction. Most states require physicians to report cases of contagious diseases to the department of health, but the list of diseases and the manner of reporting vary widely. The New York law requires the reports to be made in writing to the health officer immediately after the discovery of a case, and by the health officer to the state department of health. The reportable diseases in New York State are:

Anthrax.
Chancroid.
Chickenpox.
Cholera, Asiatic.
Diphtheria (membranous croup).
Dysentery, amebic and bacillary.
Epidemic cerebrospinal meningitis.
Epidemic or streptococcus (septic) sore throat.
German measles.
Glanders.
Gonorrhea.
Measles.
Mumps.
Ophthalmia neonatorum.
Paratyphoid fever.
Plague.
Pneumonia.
Poliomyelitis, acute anterior (infantile paralysis).
Puerperal septicemia.
Rabies.
Scarlet fever.
Smallpox.
Syphilis.
Trachoma.
Tuberculosis.
Typhoid fever.
Typhus fever.
Whooping-cough.

It is the duty of every health officer in New York State to keep a list of the cases of the reportable diseases in his district. The records are not complete, for many existing cases are diagnosed as diseases which are not communicable, and many mild cases are not reported at all. It is extremely desirable that every health officer shall have complete statistics regarding all cases of communicable diseases in his district in order that he may compare each year's work with that of other years, and may demonstrate the value and efficiency of his preventive work.

The number of cases of communicable diseases in a community is usually expressed by the number per 100,000 of population. Grave errors may arise from calculating disease-rates and special death-rates based on population of less than 100,000, for the errors are multiplied when the population of the given place is multiplied. Suppose, for example, a city of 10,000 population has two or three scattered cases of typhoid fever each year, and in 1916 there was one death, the first in five years. The death-rate would be ten times the number of deaths, or 10 per 100,000. About 10 per cent. of typhoid cases die, and the number of cases is usually assumed to be ten times the number of deaths. If the death-rates and case-rates were published on the basis of 100,000 population, the city would get a typhoid reputation which would be wholly undeserved. Still, it is often desirable for a health officer to calculate the death and morbidity rates for the various diseases in his district in order that he may compare them with those of the rest of the state or country.

CHAPTER XI

PUBLIC HEALTH NURSING

The Individual vs. the Public.—The health officer works for the benefit of the municipality as a whole, and imposes restraints on individuals for the protection of the community. He often compels those who feel well and strong to stay at home, and he enforces cleanliness in backyards which few can see. Since he causes temporary inconvenience and discomfort to individuals, he is often considered to be an enemy rather than a friend, and his orders are obeyed under protest. The person under restriction frequently does not understand why he should be singled out for restraint, and the health officer has no time to make long explanations of the reasons to him or to sympathetic friends who consider him to be the victim of official wrath. For every minute he spends in the discharge of his scientific duties the successful health officer must spend an hour in the social and educational work of explaining the reasons for his requirements, and of persuading the affected persons to submit voluntarily to his suggestions. The lack of this educative and persuasive work, which a public health nurse can best supply, is the reason for the failure of many public health activities.

Cure or Prevention.—Two weak points in public health administration were formerly that it was concerned only with epidemics and nuisances that were already fully developed, and that the corrective measures were directed against those only who were immediately concerned in the unhealthful conditions. The science of modern public health is often called preventive medicine. It seeks the premonitory signs of impending danger, and considers that every person in the community is in need of instruction and oversight. It detects the smoldering sparks of infection before they break into flame. It removes the rubbish of unhygienic habits and unsanitary surroundings on which contagion feeds, and it makes each individual proof against the consuming fires of disease. The work of suppressing actual epidemics and nuisances will require only a small part of the time of the average health officer, but the elimination of the conditions out of which they develop will require his full-time service, or that of an assistant. Public health nursing is an activity that has been developed for doing many of the details of this preventive work. The nurse is displacing the policeman as the health officer's chief assistant. A municipality of 3000 inhabitants will have abundant work to keep a public health nurse busy.

The public health laws usually empower a health officer to control only those persons who are afflicted with or exposed to certain communicable diseases (New York State Public Health Law, Sec. 25). His police powers are strictly limited to the control of the sick and those in contact with them, but his educational and advisory powers are unlimited and the field for their exercise is boundless. He will attend to the police, medical, and scientific work in the homes of the sick; while the public health nurse will be his agent in the homes of those who are comparatively well. Her duties will be largely educational and advisory to those who through poverty, ignorance, or prejudice would not otherwise receive the benefits of modern preventive medicine.

Need for a Public Health Nurse.—About one-quarter of the people are without regular medical advisors. They call a physician only when they are sick abed, and drop him as soon as they can sit up. They neglect conditions which are painless, and believe they will outgrow ordinary chronic complaints. They overlook physical defects which lead to permanent disability or incompetence. They live amid unsanitary surroundings, and practice unhygienic habits which render them easy victims to contagious diseases. They are often without ambition, and accept their condition and station in life as inevitable. Many are contented with their state and desire nothing better. The preventable physical defects and many of those conditions which may be remedied by social agencies come under the jurisdiction of the health officer. A public health nurse is needed to look after the victims while their defects are in a remediable stage. Her work is to educate, advise, encourage, and inspire the sufferers and those who are responsible for their welfare. She arranges for their medical attention, and teaches them the proper methods of home care. She persuades them to submit to the diagnostic procedures of the health department, to accept prophylactic vaccines and serums, and to adopt active preventive measures against infections. She takes the sufferers to clinics and hospitals, and acts as their friendly guide and counselor.

Physicians are usually willing to donate their medical and surgical services to those in need, provided they do not have the bother of persuading them to undergo examinations and to follow advice intelligently and willingly. The nurse is the field agent of the physicians and the health officer. She makes the preliminary arrangements for examinations and operations, attends to the follow-up inspections, and sees that instructions are carried out. She makes it possible for physicians to give their services with a fair prospect that those who receive them will be permanently helped. She is almost indispensable in the practice of preventive medicine.

Many communities employ visiting nurses to care for the sick poor to whom they are called by physicians. A visiting nurse does the actual work of nursing, has only a few cases at a time, and spends a considerable time with each case. She is an assistant to private physicians, and does little else than bedside work. In contrast with her duties, the public health nurse does preventive work. She does not nurse private cases for physicians except in emergencies, and then only until other care can be provided. She deals with those who require a physician's services only infrequently, but who do require oversight, instruction, and encouragement over considerable periods of time. She has a large number of persons under observation and instruction at one time, and refers each one to the health officer or physician at infrequent intervals. She deals principally with children in whom defects may be permanently remedied, provided the proper home treatment is given or hygienic measures are followed. Although she depends on physicians for diagnoses and for suggested treatments, most of her work is done independently of them. Her work is entirely different from that of the visiting nurse, and their activities overlap only occasionally. There is need for both a visiting nurse and a public health nurse in every city and large village.

Qualifications.—A public health nurse must be a graduate nurse with some practical experience outside of her school. She must be able to recognize the common defects and diseases, and to know the usual methods of their treatment. It is not within the scope of her work to make diagnoses and to suggest treatments, for that is the work of the health officer and the physicians to whom she refers the cases. But she is expected to be correct in her surmises, and to ask the physicians to diagnose and treat only those in whom there is a reasonable prospect of finding a serious condition. She must avoid practising medicine or assuming any of the prerogatives of a physician; and, on the other hand, she must not overlook serious conditions. Nearly every person claims some physician as a family adviser, and it is the duty of the nurse to encourage faith in him. Many persons have lost faith in all physicians largely because they cannot, or will not, or do not give either money or gratitude for the advice which they receive. A public health nurse acts as the agent for both the physicians and the patients. Her great work is to make it easy for physicians to advise and treat needy patients, and for the patients to receive efficient medical assistance. She will remove the misunderstandings between the people and medical men. Her oversight will lead physicians to make accurate diagnoses and to give efficient treatments. One of the indirect effects of a public health nurse's work will be to raise the standard of medical practice in a community.

A public health nurse must be strong physically, for she has to be out of doors in all kinds of weather and to walk considerable distances.

The personality of a public health nurse is as important as her knowledge and physical vigor. She must be sociable, and able to converse readily and familiarly with all classes of people. She must be even tempered and patient, for scolding is fatal to her success. She must possess a high degree of common sense in order to avoid demanding impossible things. She must be willing to render assistance in any capacity. Above all, she must be womanly and sympathetic.

The standards of qualifications of a public health nurse are by no means impossible of attainment. The rewards of gratitude which she receives, and the consciousness of bringing permanent help to the needy, make the work attractive to a nurse who has a love for mankind and a sincere desire to render public service. The number of competent public health nurses keeps pace with the constantly increasing demand for their services.

Methods of Work.—A public health nurse works in homes, in schools, and in clinics. She visits from house to house, talks to the people, and decides who are in need. She seeks cases to whom she may offer her services and those of physicians and the health officer. She observes home conditions, and explains points in hygiene and sanitation which are obvious to the educated and refined, but which are practically unknown to a large proportion of the people. The personal work which she does in homes upon her own initiative requires the greater part of her time.

The public health nurse also works in schools. She observes the children and discusses their condition with the teachers. She gives some treatments and advice directly to the children, but the most effective school work which she does is that of visiting the parents in the homes of the needy children. The school is a convenient place in which she discovers defective children, but she does most of the work of treating and correcting their defects in their homes.

A central clinic is a necessity in doing public health nursing.

It may be only an office, or it may be a fully equipped operating-room with wards and beds. The nurse requires some place to which she may bring cases for treatments and for examinations by physicians.

The method of work which a nurse follows will depend on herself and on the needs of her town. A competent nurse is expected to be a leader and to adapt her methods to the community in which she works. If the work has been previously developed, or if she is one of many nurses in a large city, her work will be systematized and laid out for her; but in a small community she will plan the work in her own field, just as the health officer is the leader in his own line of work.

Activities.—Public health nursing is rapidly becoming a distinct profession, and the work has developed along five standard lines: 1, communicable diseases; 2, tuberculosis; 3, infant welfare; 4, child hygiene; 5, school work. Public health nurses are also employed by the departments of health of states and large cities, and by lay societies, to conduct special investigations, supervise midwives, conduct exhibits, and do other general work.

Communicable Diseases.—When an outbreak of communicable disease occurs, many mild cases will be missed and will remain unknown unless search is made for them. A health officer cannot find these cases without a house-to-house canvass. The public health nurse is the proper person to do this work. She is not supposed to come in close contact with severe forms of disease, such as scarlet fever or diphtheria, for if she did, many persons would object to her presence in their homes. Her duty is to find the cases and to report them to the health officer, who will make the proper disposition of them. This work will occasionally have to be done on a large scale during an epidemic; but the public health nurse will maintain a constant lookout for mild cases, particularly of minor diseases, such as chickenpox, mumps, and whooping-cough.

Tuberculosis.—Effective antituberculosis work cannot be done without the services of a public health nurse. There is a wide-spread belief that consumption is always a fatal disease. Incipient cases delude themselves with the belief that they do not have the disease. They stay away from a physician until they are beyond cure. Advanced cases go from one physician to another seeking relief with pills and powders. A public health nurse is needed, first, to discover cases, and second, to advise and encourage them to persevere in hygienic measures. She visits suspected cases in their homes, secures their examination, supervises their treatment, and arranges for their admission to clinics and hospitals. She is their friend and confidant.

She comforts the advanced cases, and encourages the incipients with the assurance of relief. She educates the people of a community in the meaning of a cough and of loss of weight and strength, and demonstrates to them that tuberculosis is curable and preventable. All this work requires constant visitation and supervision. There are at least 10 or 20 cases of tuberculosis among each 1000 inhabitants, and experience shows that they will not place themselves in the care of physicians unless they are constantly urged by a public health nurse or a similar worker. The efficiency of a public health nurse may be judged by the quality and quantity of tuberculosis work which she does. A public health nurse in every community will be the principal means by which tuberculosis will be eradicated.

Infant Welfare.—The great reduction of death-rates in civilized lands in recent years has been principally among infants and young children. One of the greatest factors in life saving among babies has been the education of mothers, especially in cities and in congested sections of villages. The work has been carried on principally by public health nurses. They visit homes and demonstrate methods of bathing and feeding, the pasteurization and preservation of milk, the clothing of the children, and the ventilation of the rooms. They establish and conduct milk stations and infant welfare centers in which care is given to the babies and instruction to their mothers. They give advice and attention to expectant mothers and secure the co-operation of midwives and practical nurses in the proper care of the infants in their charge. This work has reduced the infant mortality in New York City in a generation from nearly 300 per 1000 to less than 100. There is a field for this work in every community.

Child Hygiene.—The Health Department of New York City plans that a public health nurse shall supervise every needy child from birth to adolescence. She works among children of preschool age in connection with her infant welfare activities, but most work in child hygiene everywhere is done through the schools. Child hygiene is concerned largely with the health of the school child.

School Work.—The supervision of the health of school children and the correction of their defects is rapidly becoming the recognized duty of every department of health. Many states require the medical examination of every school child, but an examination has no value unless the means are provided for correcting the defects. A physician cannot spend the time to visit the parents of every defective child, explain the nature of the trouble, persuade them to have corrections done, arrange for the treatments and operations, and follow up the cases afterward. This is peculiarly the work of a public health nurse, and in it she has the assistance of the teachers and the support of the school officers. At least 1 scholar in every 5 has serious defects of the teeth, eyes, ears, or other organs which will go uncorrected unless a public health nurse secures their correction. One of her principal activities is the inspection of children in schools and consultation with parents in their homes in order to promote the health and correct the defects of the scholars.

Relation to the Health Officer.—The health officer is the person who would naturally direct the work of a public health nurse, but if he is unprogressive, a nurse with initiative will soon become unpopular with him. If she lacks initiative, he may use her to do his own proper work, and her activities will be wasted. But frequently a philanthropic society or civic club will employ a public health nurse to do the work which an unprogressive health officer is expected to do. Success in public health nursing requires an active co-operation between the health officer and the nurse.

Starting the Work.—A public health nurse is one of the most efficient agencies for promoting public health in any community, and the people are willing to support one when the value of her services is demonstrated to them. If it is desired to start the work of public health nursing, a practical method is that the health officer take advantage of an epidemic and secure the consent of his board of health to employ a public health nurse to make a house-to-house canvass of the affected district. While she discovers cases of the particular disease which she seeks, she will also observe unhygienic houses, cases of tuberculosis, defective children, and neglected cripples. If she is successful in the control of the epidemic, the people will be favorably inclined toward her plan for the future work which she will base on her observations. The next step would be that a public-spirited citizen or committee provide her salary for a brief period, with the understanding that the board of health and the health officer will make her an official of the department of health; or that the board of education will authorize her to work in the schools. A reasonable expectation is that at the end of a few weeks or months the people will see the value of her services and will vote the funds for her permanent employment.

CHAPTER XII

PUBLICITY AND EDUCATION

Basis of Public Health Work.—Public health activities may be divided into two classes of work—those which deal with private persons and those which deal with the public collectively. Most contagious disease work is done with individuals. Examples of activities which deal with the public collectively are municipal sewage disposal, milk inspection, and dairy permits. But even those activities which deal with the public collectively depend upon the attitude of a majority of the private citizens of a community. The American system of public health administration is founded upon the principle of individual freedom and responsibility. Public sentiment is the average sentiment of a majority of the individual inhabitants. The fundamental health laws represent the opinions and desires of a majority of the voters of the several states. The kind of work which a health officer can do will be that which a majority of the people wishes to have done. For example, the establishment of a sewer district in a town in New York State requires the signed consent of 51 per cent. of the taxpayers of the district, and in a village the affirmative vote of a majority of the taxpayers.

The basis of the more public phases of health department work is the personal hygiene of the individual. Every person affects a great circle of other persons, and the personal carelessness or ignorance of one may spread disease through a whole community. For example, an epidemic of septic sore throat is usually traceable to a single dairyman who has a mild sore throat. It is impossible for a health officer to make a daily inspection of every workman in every dairy in his jurisdiction. The prevention of septic sore throat, therefore, depends upon the personal hygienic habits of the individual workmen in dairies.

The prevention of smallpox is another example of the dependence of public health work on the attitude of individuals. Vaccination in most health officer districts is not compulsory, but is done or not according to the choice of the individual. If 80 per cent. of the people choose to be vaccinated, an epidemic of smallpox is not likely to develop. The individuals belonging to the 20 per cent. who refuse vaccination are dependent on their neighbors for their protection against the disease. Whether or not a community is threatened with smallpox depends upon the feelings and knowledge of the individuals of that community.

The examples which have just been given illustrate the need of educating each individual person in public health matters. There is constant progress in the sciences of hygiene and sanitation, but a health officer frequently encounters a satisfaction with the old, an opposition to the new, and an incredulity regarding the benefits of the modern order in public health. The education of the public is one of the recognized duties of every health officer, and is written into the public health law of New York State (Sec. 21b).

Sources of Popular Knowledge.—A health officer finds that people have fairly uniform and definite ideas regarding hygiene and sanitation, showing that they think on these matters, although their conclusions may be antiquated and erroneous. For example, he finds that every child who is supposed to have measles is in a dark, hot, close room, and is covered with thick bedclothes in order, as the parents say, to protect the child's eyes, to keep it from taking cold, and to makes the measles come out. One great source of these popular ideas is unwritten tradition preserved in memory and handed down by word of mouth, as in the days of Homer. The traditions represent the teachings of advanced physicians who lived a generation or two ago. It ordinarily takes a generation of time for knowledge of new health principles to permeate the thoughts of the whole mass of people. One of the great problems in public health administration is how to hasten the dispersion of a knowledge of recent advances in public health.

Physicians constitute another source from which people get their ideas of hygiene and sanitation; but their influence for progress is often curtailed by their acquiescence in the opinions of their patients. They often say they will vaccinate if the patient wishes them to do so. They frequently agree with a patient's own diagnosis that he has taken cold on his bowels and is merely threatened with typhoid fever. Easy-going physicians are largely responsible for the persistence of many discredited medical ideas among the laity. A health officer must include the physicians among those who need education.

The newspapers are a third source of popular knowledge in hygiene and sanitation. The function of a newspaper is to print the news. It is news that a group of faddists discusses the relation of smallpox to diet and advocates the use of nuts as a preventive measure. If there are ten meetings of various faddists, and one of a medical society, the readers of the newspaper will get ten erroneous impressions to one of scientific medicine.

When an epidemic is going on, the statements of the health officer soon become commonplace, and cease to have a news value, while every new faddist that comes to town is exploited for a brief period. If there are ten faddists, the readers of the newspaper get the impression that the health officer is only one-tenth as important a personage as he should be. The city daily newspapers and country weeklies have a tremendous effect in educating the public in health matters, and a health officer must include them among his helpers in educational work.

The public school is a fourth source of knowledge in public health matters. Too much is often expected from school instructions in sanitation, and there is much unjust criticism of the failure of older persons to understand modern methods of public health work. The school lessons are comparatively few, and the instruction is interrupted and spread over years. The average teacher is necessarily at least five years behind the progressive sanitary knowledge of the hour. The science of public health becomes almost entirely changed during the ten years in which the child is attending school from the age of seven to seventeen, and the knowledge becomes still more out of date within a few years after a child leaves school. But the school can teach the elementary principles of physiology, anatomy, and infection, and thus give the pupil a foundation knowledge which will enable him to understand public health articles and lectures. The medical inspection of school children and physical training are bringing public health to the people in a concrete, personal way.

The activities of health departments constitute a fifth source from which a knowledge of public health matters is spread among the people. The local departments of health educate the people through the reports of their meetings, and the rules and regulations which they adopt. Health officers promote education by means of their reports and inspections. State departments of health distribute literature and promote lectures and exhibits. Many state departments have organized divisions whose object is to spread a knowledge of health matters among the people. The direct efforts of departments of health are among the chief means of spreading a knowledge of modern public health and preventive medicine, and of securing the co-operation and support of all the people in public health work.

The Health Officer as a Teacher.—Ignorance of modern public health work is not confined to the illiterate, but it is widespread even among the college graduates. The most difficult people with whom a health officer has to deal are the educated whose knowledge of preventive medicine is that of a generation or two ago. Some of the vital topics in which all classes of people show a wide-spread ignorance are the nature of colds, the infectiousness of summer complaints, the danger from healthy carriers, the nature of contact infection, the principles of ventilation, the purity of night air, the value of antitoxins and serums, the need and harmlessness of blood examinations and spinal punctures, and the prevalence and recognition of mild cases of major contagious diseases.

State departments of health may provide the means for combating disease and promoting health, but if the people refuse to use them, they will be of no avail. One of the most important of all the duties of a health officer is the direct education of the people regarding the scientific principles on which his activities are founded. The efficiency of a health officer may be gaged by his success in educating the people and securing their co-operation. Secrecy and mystery have no place in public health work. It is necessary that every health officer shall be a teacher and shall have in mind his duty to educate the people at every opportunity. The successful health officer will create public sentiment if he does not find it ready made.

Publicity and Education.—The educational work of a health officer consists in publicity regarding the scope, objects, methods, and results of his activities, and in education regarding the scientific principles on which his work is based. The natural instincts and training of a conscientious physician impel a health officer to avoid publicity, but he must remember that he is the medical adviser of the public, and that giving advice to the people will result in spreading information through the whole community. A health officer is a public officer, and the very nature of his work requires him to make it known. The people will not respond to appeals which never reach them. Modesty is commendable when it restrains a health officer from talking about himself, but it is not a virtue when it leads him to avoid publicity in regard to his work. Publicity is necessary in health officer work.

Simplicity of Language.—A health officer often fails in giving instruction because he uses an unknown language in talking with people. If he gives orders in words which his hearers do not comprehend, he will fail to obtain obedience. The people need ideas, and not long words. Medical terms give an ignorant man the impression that the diseases to which they apply are as foreign as the words; but explanations given with short, simple words which he understands, dispel the mystery of disease, and at once excite the hearer's interest in the sickness. A fundamental rule in speaking or writing is to use words which the hearers and readers will understand without effort. Diseases and public health matters can be explained with simple words which are used in ordinary conversation. For example: The expression, an injection of the mucous membrane of the pharynx means simply a redness of the throat; enlargement of the cervical glands means a swelling of the glands of the neck; infective organisms invaded the tissues means that disease germs entered the flesh; a negative examination means that nothing was found; the respiratory passages are the breathing tubes; to administer a medicine means to give it; and degeneration means a weakness or inactivity of a part. Most persons will not understand the technical terms without a considerable mental effort or the use of a dictionary, but even the illiterate will understand common terms and simple explanations.

Campaigns for Special Objects.—A board of health usually follows public sentiment, and enlarges the scope of its work only when there is a public demand for the action. The employment of a public health nurse, or the establishment of a tuberculosis sanatorium, or the construction of a sewer system, or the adoption of any new line of work usually requires a majority vote of the people, which can be obtained only after a campaign of publicity and education. The health officer is the person who would naturally be the leader in the campaign. If he is not an organizer and administrator, he will still be expected to contribute his time and thought in promoting the new work. Whenever a campaign for a special object is conducted, the educational influence is felt in all other lines of public health work. The great progress in public health work in recent years has sprung largely from the extensive antituberculosis campaigns of education which have been conducted all over the United States.

Clinical Talks to the Laity.—One of the simplest and most efficient forms of public health work which a health officer can do consists of talks to individuals whom he visits officially. Every case of communicable disease which is reported to him provides him with a subject and with an audience to whom he is expected to explain the nature and source of the disease and the method of preventing its spread. The audience is in a receptive mood, and is intensely and vitally interested in what he says. The people in the surrounding houses are both curious and anxious, and his orders and instructions will be repeated to a wide circle of the neighbors and relatives of the sick person. A health officer who merely tacks up a quarantine card or sends an inspector to do it, misses a great opportunity to spread a knowledge of the nature and prevention of communicable diseases.

Every inspection of a nuisance affords an opportunity to explain the bearing which the condition may have on health and life. When people understand the sources of danger from dirt and decaying matter, they will not be likely to rush to the health officer with unnecessary complaints. If every health officer took pains to educate the people with whom he deals, the mass of people would become educated within a few years.

Reports.—The formal reports of a health officer have a great educational value when their data are complete and comprehensive, and the bearing of the facts on public health is explained. The people of every rural community glory in their low death-rate, the old age to which the people live, and the absence of contagious diseases, except the cases which are imported. These facts mean nothing in themselves. Every community has public health problems, and its healthfulness needs improvement. A health officer who understands the meaning and use of a report can make it an effective means of educating the people; but even a dry, formal report has a publicity value in showing that the health officer is alert and active.

Newspapers.—The newspapers of a town, village, or small city are valuable means of publicity and education which a health officer can use. He is a source of news which editors value. Editors are usually glad to print reports of the activities of the local health department, and to give publicity to its plans for future work. They will use scientific articles which are written in a clear, simple style. They will print editorials on the work of the health officer, and while the comments may not always be complimentary, yet the opposition of the editors is usually inspired by a dislike of the health officer personally rather than to a desire to oppose progress in health matters.

A health officer is often under a great temptation to engage in personal controversies in the newspapers. Public health work requires the co-operation of all classes of people, and public criticism of any person is sure to arouse the antagonism of a large circle of that person's friends. But if a health officer will studiously avoid personal disputes, and will endure public criticisms of himself in silence, he will find the newspapers to be his aids in both publicity and education.

One of the dangers in newspaper publicity is that of exaggeration. If, for example, a proposition to build a sewer is under consideration, there will be a great tendency to exaggerate the threatened danger of epidemics from cesspools, and to minimize the difficulty and cost of maintaining a disposal plant. Truthfulness and accuracy are essential whenever the health officer gives an interview. Bald statements are often dry and produce little impression on the minds of the readers; and, on the other hand, jokes, slang, and alarmist interviews belittle his statements. When a health officer gives an interview, it is a good plan for him to request the reporter to rehearse the salient features of the story which he intends to write.

It is often a question how much information a health officer may properly give out. Some facts cannot be disclosed legally. An editor knows more than he is allowed to print, and it is often necessary that he have unprintable information in order that he may make an article truthful and diplomatic. It is a rule among newspaper men to respect the wishes of those whom they interview, just as lawyers and physicians respect the wishes of those who consult them. A health officer is usually personally acquainted with the editors and reporters of his town, and knows whom he can trust with information.

An editor will often change the form of articles and the wording of interviews in order to make them conform to the style and policy of his newspaper. If a health officer wishes to print matter to which the editor objects, he can get it inserted as a paid advertisement. A board of health is justified in spending money for paid advertising in emergencies.

Handbills and Posters.—A health officer often wishes to spread special information to all the people as soon as possible. It is his duty to give prompt information to the people regarding the ways and means of carrying on a new line of work and of meeting an emergency condition. He can do this with posters or handbills which are distributed from house to house, or are carried home by school children. Some of the subjects with which a health officer may deal by means of handbills are instructions to the public during an epidemic, how to suppress flies, how to exterminate mosquitoes, and what to do with dogs when a case of rabies occurs.

A poster or handbill must be brief and specific in order that its meaning may be grasped quickly and easily. It must be printed in large type which may be read easily.

Lectures.—Public lectures have a twofold value—they directly instruct those who attend them, and reports of them call attention to the activities of the local board. A lecture by a prominent sanitarian gives dignity and importance to local health work. If a health officer can speak or write an address, he will find an occasional lecture to be of great value in impressing people with the importance of his work.

Lantern-slide illustrations are always great aids in producing an impression. Especially valuable are slides of local scenes.

Views taken before and after action by the local authorities arouse civic pride in an effective way.

Moving pictures have an educational value, and still greater value for publicity and arousing interest. Their proper place is subordinate to that of an explanatory lecture. A balanced program consists of a half-hour instructive address followed by a half-hour moving picture.

A lecture will not run itself, but its success will depend on the preliminary arrangements. A health officer or board of health can seldom make one a success without the co-operation of an organized body of people. It is usually best to have a lecture under the auspices of a civic club, Red Cross Society, or other organization that is interested in public health or social work. The roll of members in these organizations usually includes all those persons who would be likely to support a lecture, and from them it is necessary to choose a responsible committee of arrangements.

A health officer can obtain assistance in making up a program from the State Department of Health, and from various organizations, such as the New York State Charities Aid Association. Many of the state departments of health and organizations maintain bureaus of speakers, and provide lantern slides and moving-picture films, and even send out prepared lectures for those who cannot secure the services of experienced speakers. It is usually a good plan to include a local worker on the program. A person who is a poor speaker may be a most efficient worker, and, after all, it is the deeds rather than the words of the speaker that inspire others to work.

Having decided on a program and arranged for a lecture hall, the next thing to do is to advertise the meeting. A lecture is impossible without an audience, and people will not come unless they are urged. The ordinary handbills, posters, and press notices are all necessary, but they will not usually entice an audience unless the promoters of the lecture ask their friends to attend.

The final step in making arrangements for a lecture is to see that a report of it reaches the newspapers. A health officer will personally invite the newspaper men to attend the meeting, will tell them the important points of the lecture, and will outline the work which will be begun or promoted as a result of the lecture. The press reports are necessary in order to apply the lessons of the lecture directly to the community.

Exhibits.—Health exhibits are prepared by the departments of health of states and the larger cities, and by large organizations and societies. Small exhibits are prepared for use by the health officers of small places. They consist of charts, cartoons, photographs, and models, and are usually associated with demonstrations and lectures. The subjects included in the exhibit are infant care, child welfare, the diseases of adult life, mental hygiene, tuberculosis, milk, flies, mosquitoes, and other topics in public health work. The New York State Department of Health plans that an exhibit shall remain in a health officer's district for a few days or a week, and that classes for children and lectures for adults shall be conducted in connection with it. An exhibit is often made the basis of establishing an infant welfare station, or a tuberculosis clinic, or other organized form of popular health work.

Each exhibit requires the use of a hall with a large wall space, and the attendance of a laborer, a demonstrator, and lecturers. The health officer will arrange for an exhibit in the same general way that he would promote a lecture.

CHAPTER XIII

BACTERIOLOGY

Micro-organisms.—Communicable diseases are destructive processes that take place in living things, and are somewhat similar to the processes of fermentation and decay that take place in lifeless substances. Each communicable disease is caused by its own particular poison, or *virus*, which enters the body from the outside. A disease virus has three peculiar characteristics: 1, Its effects do not depend on the amount introduced into the body, for a microscopic quantity produces as much effect as an amount that can be readily weighed or measured. 2, A period of days elapses between the entrance of the virus into the body and the first signs of the disease. 3, The virus does not exhaust itself, but multiplies many millionfold in the body of the sick person. A disease virus, therefore, acts like seed planted and growing in the living body. A microscopic examination of viruses shows that the essential element in some consists of *bacteria*, which are usually classed as plants, and in others of *protozoa*, which are usually classed as animals. In still other viruses no organisms at all can be seen with a microscope. The living organisms of disease are popularly called *disease germs*. About 1200 species of bacteria are known, but only about 50 species will grow in the human body and produce diseases. Living bacteria are the principal causes of decay and fermentation. A study of micro-organisms, especially of those which produce diseases, is called *bacteriology*.

Bacteria are named according to their shape. Some are round, and are called *cocci;* some are rod-shaped, and are called *bacilli;* and some are shaped like corkscrews, and are called *spirilli*. Bacteria are simple in structure, and the various parts of a single organism show but a slight variation in appearance. They multiply simply by each organism dividing into two. This division may occur as often as every half-hour, and each individual organism may become more than 1,000,000,000,000 in twenty-four hours.

Some protozoa resemble bacteria in appearance and method of growth, but others are complicated in form and in their mode of development.

The visibility of disease germs depends principally on their size. They are so small that an oil-immersion lens is needed in order to discern clearly the forms of most bacteria and protozoa. The smaller germs under the highest powers of the microscope appear like minute dots. Other germs are ultramicroscopic and cannot be magnified sufficiently to be seen.

The size of disease germs is usually expressed in micromillimeters, one of which equals $\frac{1}{1000}$ millimeter, or about $\frac{1}{25000}$ inch. A micromillimeter is called a micron, and is represented by the character μ, a Greek m. The smallest visible germs are about $\frac{1}{2}$ micron in diameter, which is about the length of a wave of light.

The size of bacteria or protozoa may also be indicated roughly by their ability to pass through the pores of filters made of unglazed porcelain. None of the visible bacteria can pass through a porcelain filter, but some of the ultramicroscopic germs will pass through a filter unchanged in their ability to produce diseases. Three filterable viruses are those of epidemic poliomyelitis, rabies, and yellow fever. The germs of smallpox, scarlet fever, and measles have not been discovered, but there is some evidence that they are ultramicroscopic and will pass through the finest known filter.

Bacteria and Disease.—All the higher animals are afflicted with communicable diseases, and each disease is caused by its own particular micro-organism. Each kind of disease germ has its own special requirements for growth which must be met before the germ can flourish. Each kind of germ will usually grow only in a particular species of animal or plant. The germs of most human diseases grow naturally only in human bodies; but there are exceptions to the rule. Tetanus, rabies, glanders, anthrax, and tuberculosis are diseases of lower animals whose germs may grow in human beings also.

Disease germs must reach the flesh or blood before they can produce a disease. Each species of germ grows best in some particular part of the body. Diphtheria germs, for example, grow mostly in the throat. The germs will usually be found in those parts of the body that are inflamed.

Bacteria of decay and fermentation may usually be found on the surface of the body, and in every cavity which is connected with the surface; and bacteria that produce diseases often grow with them. Bacteria are found on the skin among the outer, dead layers of epithelium; in the openings of the sweat-glands; in the saliva; in the furry coating of the tongue; in the crypts of the tonsils; in the folds of the mucous membrane of the nose; and in the stomach and intestine. If a person is healthy, no bacteria or disease germs can be found in a closed cavity of the body, such as the peritoneum, pleura, or blood-vessels; or in the blood; or in the living flesh.

Most disease germs that leave the body escape in the natural excretions of the nose and throat and of the bowels and bladder. The chief problem in the prevention of communicable diseases is to prevent these excretions from entering the bodies of other persons.

Disease germs may be carried out of the body by unnatural discharges, such as those from sores on the skin, matter from running ears, and liquids from diseased eyes. Disease germs are not given off from a healthy, clean skin, or with the breath of quiet breathing. A health officer looks for the source of nearly all kinds of disease germs in the liquid or solid discharges from diseased persons. Very few kinds of germs of human diseases grow naturally outside of the human body. Dirt, filth, and decaying substances will not produce disease germs unless the germs from a diseased person or animal are in them.

Persistence of Life.—Disease germs do not usually remain alive for any great length of time after they have left the body, for, like other living things, they soon perish when they are removed from the favorable surroundings under which they have grown. But they may remain alive for hours or days if they are protected against the five destructive agents—sunlight, dryness, starvation, cleanliness, and oxygen.

Sunlight is a great destroyer of disease germs, for it has a chemical action upon them just as it is destructive to the tender skin of a person who is exposed to it. Disease germs do not survive long in a sunshiny room if they are exposed to the light; but if they are enclosed in a mass of excretions, such as phlegm from the throat, the sunlight may not reach them, and they may survive for weeks or months.

Drying kills most disease germs within a few minutes or hours, but the germs may survive for days in damp places, especially in darkness. The germs of tuberculosis contain a wax which tends to protect them against dryness.

After disease germs leave the body, they are usually not able to obtain a proper supply of food, and those of the more tender varieties soon die of starvation, especially when they are also subjected to the destructive influences of drying and sunlight. When food supplies and moisture begin to fail, some varieties go into a resting stage and remain in a dry, quiescent state for days or weeks, but they may resume their growth when conditions become favorable again.

Bacteria which are able to resist starvation and drying may be found in dust when the material in which they grow is dried and ground to powder. Bacteria of fermentation and decay are able to survive in dust, and are found in the air so commonly that they fall on every object and start decomposition in every decomposable substance. Two common dust-borne germs in which a health officer is especially interested are those of tuberculosis and septicemia.

A few kinds of disease germs, such as those of tetanus and anthrax, make special provision to protect themselves from dryness and starvation by forming what are called *spores*. When a spore-forming bacterium becomes somewhat dry, or its food is nearly exhausted, it may condense or concentrate its solid substance into a small part of its body, and in this state it may survive all the common destructive agents of nature and remain alive for months, and be ready to begin its growth again when conditions become favorable. A spore is analogous to the seed of a flowering plant. The principal spore-bearing disease germs in which a health officer is interested are those of tetanus, anthrax, and glanders.

The frequent use of soapsuds, scrubbing brushes, and other means of cleanliness removes disease germs and the dirt and filth in which they are often found, and thus destroys the lives of the organisms. Dirt and filth are universally considered to be disease producers, and cleanliness the great disease preventive. This is true of only that kind of dirt which contains disease germs derived from diseased human beings. For example, fresh ashes contain no disease germs at all, while house dirt is very likely to contain them.

Nature has an effective means of destroying disease germs in decomposable filth. Wherever masses of human excretions or other forms of filth are found, the bacteria of decay and decomposition also grow luxuriantly, and produce conditions unfavorable to the growth of the disease germs.

Another common destroyer of disease germs is an excess of oxygen. Sunlight, dryness, cleanliness, and fresh air naturally go together, and each promotes the action of the others. Health officers depend on these four things more than on any others for the destruction of disease germs outside of the human body.

The time element must be considered in estimating the effect of destructive agents on bacteria. If the destructive agents act on disease germs for only a short time, the virulency of the germs may continue unimpaired. But a health officer who applies all the natural agents of destruction to disease germs in a thorough manner and continuously may be confident that none of the germs will escape alive.

Destruction of Bacteria.—Three artificial means which are used to destroy disease germs are the disposal of excretions from the body, chemical antiseptics, and heat. The health officer will give careful and specific directions that the excretions from those persons who have contagious diseases shall be burned, or buried, or otherwise treated in such a way that they and the disease germs in them are destroyed.

Chemical antiseptics usually act by coagulating the substance of the germs. They must come in actual contact with the germs, and must remain in contact with them for at least a few minutes. Five antiseptics which bacteriologists and health officers frequently use are alcohol, formaldehyd, bichlorid of mercury, carbolic acid, and chlorid of lime.

Alcohol is effective in cleansing the hands either in the laboratory or in the sick room. Formaldehyd is excellent for the health officer to leave for use in a household where there is a contagious disease.

Heat is the most reliable and is often the most easily applied of all antiseptics. A temperature of 150° F. continued for fifteen minutes will kill nearly all kinds of disease germs, but a boiling temperature (212° F.) continued for one-half hour is required to kill the spores of bacteria, either in the laboratory or in the home.

Effect of Low Temperature.—The temperature at which disease germs flourish best is that of the human body. A considerably lower temperature suspends their growth without injuring the germs. A temperature below freezing continued for weeks will kill many disease germs. The common bacteria of decay and fermentation cannot multiply at temperatures approaching that of freezing. This principle is applied in the preservation of foods by cold storage.

Cultures.—Disease germs seldom multiply naturally outside of a living body; but they may be cultivated and grown if the conditions which they require for growth are exactly met. A collection of disease germs growing under artificial conditions is called a *culture*. Disease germs are usually studied and identified by means of their cultures.

Cultures are grown in glass vessels which are usually made in the form of test-tubes, called *culture-tubes*, for solid media; and of bottles or flasks for liquid media. Shallow, covered dishes called *Petri* dishes are also used for solid media. Health officers generally use culture-tubes for taking specimens for diagnosing diseases.

The three conditions which are necessary in obtaining a growth of disease germs in cultures are the proper temperature, moisture, and food-supply. Disease germs grow best at a temperature of about 98.5° F., which is that of a human body. If the temperature rises a few degrees above 100° F., the germs usually die, and if it falls much below 100° F., the germs lie quiescent and do not grow. Growing cultures are kept in a box, called an *incubator*, in which a constant temperature can be maintained at any degree that may be desired. An ordinary incubator for hatching hen's eggs may be used in emergencies as an incubator for growing germs in a culture.

Disease germs require a considerable quantity of moisture for their growth. The food substances in culture-tubes which health officers carry in stock are protected from evaporation by a rubber cap or by a paraffin seal.

Culture-media.—The food substance in which disease germs will grow is called a *culture-medium*. The natural culture-media for disease germs are blood and the tissues of the body. The principal substances which are used in making artificial culture-media are beef-broth, gelatin, sugar, and blood-serum. Beef-broth is the liquid made by boiling beef in water, and contains practically all the various kinds of substances which are found in flesh itself. Gelatin is often added to it in order to make it solid. A vegetable gelatin called *agar* is commonly used.

The culture-medium with which health officers have the most to do is Löffler's blood-serum, on which diphtheria germs are grown. This is a solid medium, the basis of which is the serum of blood obtained at slaughter houses. Beef-broth and sugar are mixed with it to form a medium which imitates the tissues of the body. This is an excellent all-round medium which a health officer can use for obtaining specimens of other disease germs besides those of diphtheria.

Every culture-medium, the inside of its container, the stopper, the articles used in taking the specimens, and everything else that may touch the culture-medium, must be entirely free from living things of every kind, including harmless bacteria, protozoa, and molds. Rendering an article free from every form of life is called *sterilization*, and is usually accomplished by means of heat.

A temperature of at least 140° F. (60° C.) is needed in order to kill the less resistant germs. Some spores may survive a boiling temperature, and so the heating is sometimes done with steam under about 15 pounds pressure in order to obtain a temperature of 120° C., or 248° F. If a temperature at boiling or above will injure the culture-medium, a method of fractional or intermittent sterilization is used. This consists in applying heat for half an hour and then allowing the culture-media to stand for a day at the temperature of the body, in order that the spores which remain alive may develop. The heat is then applied again, and it is allowed to stand as before. This process is repeated on three or four successive days until all the spores have developed.

Contamination of culture-tubes and flasks by air-borne germs is prevented by means of plugs of sterile cotton inserted in the necks of the vessels.

Some bacteria require oxygen for their growth, and will not grow if the air is excluded from the culture. These are called *aërobes*. Others will not grow in the presence of air and oxygen. These are called *anaërobes*. When a culture of anaërobic bacteria is to be grown, the culture-medium may be protected from air by a covering of oil.

Obtaining Specimens.—Disease germs to be planted in culture-media are obtained from the surface of the throat; from sore spots on the skin; from the discharges and excretions of the body; from specimens of flesh removed from the body; from the blood; from milk, sewage, or other liquids; and from other materials in which the germs are suspected. The germs are usually obtained and introduced into culture-media by three methods: 1, by a platinum wire; 2, by a pipet; 3, by a sterile swab of absorbent cotton.

A platinum wire, either straight or bent into a loop, is the ordinary instrument used for transplanting bacteria. Platinum is used because it is durable, is unaffected by chemicals, and is not injured by heat. There are four steps in its use: 1, It is heated red hot in the flame of an alcohol lamp or Bunsen burner in order to destroy all life on it. 2, It is dipped into a specimen or rubbed over the surface in order to pick up the germs. The number of germs that may adhere to the end of the wire may be millions. 3, The wire is dipped into a liquid culture-medium or is rubbed lightly over the surface of a solid one in order to plant some of the germs in the medium. 4, The wire is again heated red hot in order to destroy all disease germs that may be left on it.

Pipets are used for taking up measured quantities of liquid. They are usually made of glass. The larger ones are graduated in cubic centimeters and the smaller ones in $\frac{1}{100}$ c.c. They are usually furnished with sterile rubber tubes which are used for drawing up the liquid by mouth suction. A plug of cotton is inserted in the upper end of the tube in order to prevent the entrance of the liquid into the mouth if too much suction is accidentally applied.

Swabs are made by wrapping bits of absorbent cotton around wires or splinters of wood, enclosing them in a protective case, and sterilizing them with heat. One is removed from the case and rubbed over the surface on which the germs are suspected, and is then passed lightly over the surface of the solid culture-medium in order to transfer some of the germs to the medium. The swab is then discarded or destroyed. The health officers of New York State are supplied with culture-tubes and swabs for taking specimens.

Specimens planted in a culture-medium are placed in an incubator, and are left there to develop for a few hours or days. The growth in a liquid medium is indicated by a cloudiness; and in a solid medium, by a discoloration or fuzziness resembling a spot of mold. A diphtheria germ may become two germs in a half-hour, and at that rate it will have multiplied to 280,000,000,000,000 at the end of twenty-four hours. A diphtheria culture will make sufficient growth for identification in from twelve to twenty-four hours, while a culture of tuberculosis requires from two to four weeks.

Cultures are examined qualitatively to determine the species, and quantitatively to determine the number of bacteria that are present in a specimen. When germs are planted in a solid culture-medium, each individual multiplies and produces a colony which may be seen with the naked eye or with the low power of a microscope. The appearance of the colonies is characteristic for each species of bacterium, and by it alone the species may often be determined.

The number of bacteria in a specimen is determined by counting the number of colonies that develop, but in order to count them the quantity of the specimen must be known, and the colonies must be separated so far apart that they may be counted.

A standard method of obtaining a culture in which the colonies are so few that they will be separated in the culture-medium is to take a measured quantity of the liquid to be tested and dilute it with a known amount of sterilized water. A 1 : 10 dilution is made by adding 1 c.c. of liquid to 9 c.c. of water; and a 1 : 100 dilution by adding 1 c.c. of dilution No. 1 to 9 c.c. of water; and a 1 : 1000 dilution by adding 1 c.c. of dilution No. 2 to 9 c.c. of water. If each cubic centimeter of the original liquid contained 10,000 bacteria, each cubic centimeter dilution No. 3 will contain 10 bacteria, and if it is planted on a culture-medium, the colonies will probably be widely separated, and may be readily counted.

A pipet graduated in tenths and hundredths of a cubic centimeter is used in making the dilutions. A number of pipets are sterilized and each one is used only once, and is then washed and sterilized before it is used a second time.

The standard method of making a culture from a liquid for a quantitative examination is:

1. Liquefy a gelatin culture-medium with heat. The medium will remain liquid after its temperature has fallen below a point at which the disease germs will not be injured.
2. Take a measured quantity of the liquid to be tested in a sterilized pipet.
3. Drop the liquid into the liquefied culture-medium.
4. Pour the mixture into a Petri dish and allow it to solidify.
5. Incubate it in an incubator.
6. Count the colonies that develop.

The number of germs in a liquid that is examined is usually expressed by the number in each cubic centimeter of the substance that is examined. If $\frac{1}{100}$ c.c. of a substance was implanted on a culture-medium and 20 colonies developed, the number of bacteria per cubic centimeter would be 20 times 100 or 2000.

Pure Cultures.—A specimen containing disease germs usually contains other kinds of bacteria, and possibly protozoa, many of which may be transferred to culture-media and may grow there along with the disease germs. A culture in which only one species of germ is growing is called a *pure culture.* Disease germs must be obtained in pure cultures in order that accurate tests and determinations may be made. If a bacteriologist has a number of kinds of germs growing in a culture, he chooses a group or colony that seems to be composed of a single species, picks up a bit of it with a sterile needle, and implants it in a second culture-medium. He repeats the process, if necessary, with successive cultures until he obtains a pure culture. He can then grow the pure cultures in any quantity that he pleases.

Enrichment of Cultures.—A bacteriologist may take advantage of a slight peculiarity of a species of disease germ to facilitate the growth of that species while restraining the growth of other kinds. This increase in the proportion of a particular species of bacteria is called an enrichment of its culture. Two examples of enrichment methods are those employed in the recognition of typhoid fever bacilli and of diphtheria bacilli.

Typhoid fever germs in the intestinal excretions are associated with colon bacilli. A slight trace of the dye called brilliant green, added to a culture-medium, restrains the growth of colon bacilli, but has little or no effect on the typhoid bacilli. If a specimen containing a few typhoid germs and many colon bacilli is inoculated into the dyed medium, the typhoid germs will outgrow the colon bacilli, and may be obtained in nearly pure cultures.

A specimen from a diphtheritic throat contains diphtheria germs mixed with many others. Löffler's blood-serum medium is peculiarly well fitted for growing diphtheria bacilli, and when a mixed specimen of diphtheria and other germs are planted on it, the diphtheria germs usually outgrow the others, and form an almost pure culture; but after a few hours the other germs may catch up with the diphtheria germs and mingle with them in an indistinguishable mass.

Recognition of Bacteria.—A diagnosis of the species of disease germ that is present in a culture is made: 1, by the appearance of the colonies in the culture-media; 2, by the microscopic appearance of the individual germs; 3, by the products resulting from their growth; 4, by the results of inoculating animals with the disease germs; 5, by testing the germs with serums.

Appearance of Colonies.—The appearance of the colonies in pure cultures and the manner of their growth are characteristic for each species of disease germ, and by observing them a bacteriologist is often able to identify a micro-organism.

Staining.—Individual disease germs are naturally almost colorless, transparent, and invisible. When a specimen is prepared for examination with a microscope, the germs are generally colored with stains or dyes to make them visible. Various disease germs and various parts of the same germ differ in their staining qualities, and these differences, together with the forms of the germs, make their recognition possible. The common stains are analine dyes.

The method of preparing a stained specimen from a culture for examination with a microscope is as follows:

1. Pick up a small quantity of germs from a colony with a platinum wire.
2. Smear the germs in a thin layer upon a microscope slide.
3. Fix, or coagulate, the smear with heat or by immersion in alcohol.
4. Apply the stain.
5. Wash and dry the slide.

Bacterial Products.—Some bacteria may be recognized by the products which are formed by their growth. Bacteriologic examinations of water and sewage are made principally for the detection of colon bacilli, or common intestinal bacteria, which are recognized by their production of acids and gases when they are grown in media containing sugar.

The test for the production of acid is made with a neutral or faintly alkaline medium of agar and lactose containing a trace of phenolphthalein as an indicator of acidity, for it is red in an alkaline medium and colorless in an acid one. This medium is mixed with a specimen to be tested and is poured into a Petri dish. Each colony of acid-producing bacilli forms a colorless spot in a field of unchanged red agar.

The test for the production of gases is made by inoculating lactose broth with the specimen, and placing it in a double tube, one part of which has a closed end. If gas is produced, it collects in the closed part of the tube. This is called a fermentation test. If both the acid and the fermentation tests are positive, the specimen may be considered to contain colon bacilli.

The species to which bacteria belong may often be recognized by their ability to produce fermentation in various kinds of sugar, such as dextrose, lactose, saccharose, dulcite, and mannite. Sugar fermentation tests are often used to identify the various kinds of colon bacilli and of streptococci.

Tests of Animal Inoculations.—When disease germs are introduced, or *inoculated*, into a susceptible person or animal, they may grow and multiply and produce the disease in that person or animal. The following four conditions must be met in order to prove that a particular organism is the cause of a disease:

1. The particular organisms shall be found in the diseased part of the body of the person or animal having the disease.

2. The organisms taken from the sick person or animal shall be grown in a succession of pure cultures until they are entirely free from every particle of matter from their original source.

3. The inoculation of the pure culture into a susceptible person or animal shall produce the disease.

4. The germs shall be found in the diseased parts of the inoculated animal.

The statements of these four conditions are known as Koch's postulates.

The diagnosis of some diseases may be made with certainty by inoculating some of the cultures from a susceptible person into a lower animal. The specimens taken from a human being may contain several kinds of organisms, but the only ones that grow are those which are particularly well adapted to growing in the inoculated animal. The growth of the germs in an animal is similar to that of wheat sowed as seed. Many kinds of weed seeds also are emplanted in the soil, but only the wheat grows and produces an uncontaminated crop. A guinea-pig is especially susceptible to the germs of tuberculosis, and if a specimen containing the germs is injected into the animal, the pig will almost surely develop tuberculosis. The diagnosis of rabies is often made by the inoculation of suspected material into rabbits; and of pneumonia by inoculation of the sputum into white mice.

Serum Tests.—The blood-serum of a person who has a communicable disease has definite effects on pure cultures of the organisms of that disease. These effects will be described in the chapter on Immunity.

Molds are microscopic plants which consist of elongated cells joined end to end, called mycelium. The plants multiply in three ways: 1, by division of the cells; 2, by the branching of the cells, and 3, by the formation of spores. The fuzzy growth which we call mold on bread consists of the spore cases of molds. The spores float everywhere in the air, and are ready to grow whenever they fall upon the proper food substances.

Molds cause decay and decomposition on the substances on which they grow. Ringworm and sporotrichosis are diseases which are caused by molds growing on the human skin.

Yeasts are oval plants each of which consists of a single cell. They multiply by means of buds which are put forth on the sides of the parent cells. Yeast plants become dry and float in the air, and are ready to grow when they fall upon the proper food substances. They cause fermentation in sugary solutions and change the sugar to alcohol and carbon dioxid.

Yeasts and molds are of special interest to the health officer because of their relation to the preparation and preservation of food.

CHAPTER XIV

IMMUNITY

EVERY living thing has the power of resisting and overcoming the common bacteria, molds, and other micro-organisms that assail it; but when life ceases, its substance is soon destroyed by these same organisms. There are many kinds of micro-organisms, but only a few are able to grow in the living human body. Those which concern a health officer number only two or three dozen. The ability of the living body to resist micro-organisms or their products is called *immunity*.

Very few communicable diseases are always fatal, but the body is usually able to overcome the organisms that invade it, and to expel them, and to repair the damage which they have done. We say that the body of a person who has defensive forces ready to repel an invading organism is *immune* to the disease that would be produced by that organism. The body may be unprepared to resist micro-organisms at the time of their invasion, and yet after a time it may be able to collect its forces and manufacture the munitions with which it finally expels the invaders. Those who die from a communicable disease were unprepared for resisting the organisms, and were unable to muster sufficient forces to overcome the microscopic foes.

Phagocytosis.—A considerable degree of resistance to disease germs exists in every cell in the body; but it exists to a very great degree in the white blood-cells, or leukocytes. One of the special duties of leukocytes is to envelop and destroy bacteria and other micro-organisms that enter the body. They visit every part of the body with the blood. They have the power of changing their shapes and of moving independently of the other cells and fluids of the body. They can pass through the walls of the capillaries and enter the intercellular spaces with the lymph. They are attracted by any substance which does not normally belong among the cells of the body, and especially by clumps of bacteria in the tissues. They collect in great numbers around disease germs that enter the flesh. A white blood-cell, meeting a bacterium, envelops it and proceeds to dissolve it by a process of digestion which is similar to the action of the pepsin ferment of the stomach on food. The action of white blood-cells on bacteria may have originally been one of nourishment, which, in the course of ages of evolution, has developed into a means of defense for the body. The process is called *phagocytosis*, and the white blood-cells themselves are often called *phagocytes*, meaning eating cells.

Regeneration in Excess.—If bacteria are extremely poisonous, they may kill numbers of the phagocytes; but an excess of the protective cells develops and reinforces those in the danger zone until their number in the blood may be several times the normal. A count of the number of white cells in the blood is often made in order to determine the probable presence of infectious organisms in the body, and to form an estimate of its defensive powers.

Regeneration in excess of immediate needs after an injury or unusual action is a principle which lies at the basis of the explanation of many familiar processes in the body. For example, a muscle increases in size after exercise; and a broken bone produces an excess of callus during the reparative process. This is also a basic principle in the explanation of nearly all the processes in producing immunity.

Action of Blood-serum on Bacteria.—The phagocytes and other cells give off a portion of their digestive substances, or *enzymes*, and so the blood-serum itself has a dissolving or digestive action on bacteria. This process is called the *bactericidal* (bacteria killing) property of the serum. The action is a chemical one upon the substance of the invading organism, and is the same whether the organism is alive, or dead, or is crushed to pieces. It is an action upon the protein of the organism and takes place upon any protein that is strange, or *foreign*, to the tissues or blood. A foreign protein is one whose composition differs from the composition of the natural proteins of the tissues of the animal into which it is injected. An example of a foreign protein is horse-serum when it is injected into a human being.

Parenteral Products of Digestion.—Most food proteins are not poisonous in themselves, but they may become poisonous after they have been acted upon, or digested, by any ferment or enzyme including that which ordinarily exists in the blood. The digestive action which takes place in the blood or tissues is called *parenteral* digestion, or digestion outside of the intestine. The crude products of any digestion of protein are poisonous to the body until they have been subjected to a further action by the living cells or their enzymes, and have become changed to the forms of protein which are naturally found in the blood and tissues. For example, the peptone produced by intestinal digestion is poisonous, but the cells which line the intestine have a special power of changing it to the harmless and useful forms in which protein exists in the blood.

The enzymes that are naturally found in the blood are usually small in quantity. If a foreign protein is injected into the body, the enzymes may digest it so slowly that no poisoning effects of the products may be apparent. But the principle of regeneration to excess here comes into operation. The presence of a foreign protein in the blood may stimulate the body cells to produce an excess of enzymes. If now the same foreign protein is injected a second time, the enzymes that were produced by the first injection may be sufficient in quantity to act at once and to produce a dangerous quantity of poisonous products. Making the body sensitive to the poisonous effects of a protein is called *sensitization*. A foreign protein which is used to produce sensitization is called an *antigen*.

Specific Sensitization.—There are many forms of protein and each form requires a special, or specific, enzyme for its digestion. For example, the injection of the white of a hen's egg into a guinea-pig sensitizes the pig to the egg by stimulating the body cells to produce the enzyme that digests the white of egg and no other form of protein. If a second dose of white of egg is given about two weeks after the first one, the animal will be poisoned quickly; but if horse-serum is given, there will be no effects, for the enzyme which digests white of egg will not digest the protein of horse-serum. Sensitization, therefore, is not general and does not affect all proteins, but it is specific and applies only to the particular one by which the sensitization was produced.

Anaphylaxis.—An increased susceptibility to poisoning following sensitization with a protein is called *anaphylaxis*. An example of anaphylaxis is the itching and redness which appears in a vaccinated spot within two or three days in a person who had been vaccinated a short time previously. The defensive substances produced by the first vaccination attack and destroy the germs of the second vaccination within a short time after they have been introduced, and the large quantity of poisons suddenly liberated produces the redness and itching.

Other examples of anaphylaxis are the sensitiveness to pollen in a person who is subject to hay-fever, and the skin eruptions which sometimes occur after eating certain foods, such as strawberries or shellfish.

Anaphylaxis is of special interest to a health officer in its relation to the serum sickness that sometimes follows the injection of antitoxin. The symptoms are due to the fact that horse-serum, in which antitoxin is contained, is a foreign protein to man. There are two forms of serum sickness. The common form is a red and itching skin eruption that begins about a week after the antitoxin has been given. It is harmless and lasts for only a few days. It is now becoming rare, for manufacturers remove a large proportion of the proteins from the serum.

The other form of serum sickness is a collapse that comes on with great suddenness a moment after the horse-serum is given. It is extremely rare except in those persons who have what is called horse asthma. This asthma resembles the asthma of hay-fever, and is produced by the inhalation of particles that are given off by horses. If antitoxin must be given to a person who is subject to asthma, inject 2 or 3 drops and wait two hours. If no unpleasant signs appear, the rest of the antitoxin may be given with safety.

A person who has recovered from an infectious disease is sensitized to the germs of that disease and may be in the state of the guinea-pig that has been sensitized with white of egg. If germs of that disease should invade his body again, their effects would depend on their quantity. If an ordinary infection should occur, the quantity of germs that would enter the body would be microscopic and so small in amount that their destruction would produce no apparent effects. If a large quantity of germs should be introduced artificially, their sudden destruction and digestion would probably liberate an amount of poison that might produce sickness and death. Thus the means which produce immunity to a disease may be a source of danger when the poisons of that disease are introduced into the body in excessive amounts, as is often done in animal experimentation.

Development of an Infectious Disease.—The germs of an infectious disease act like a foreign protein. If the bacteria of a disease enter the body of a person whose blood has no enzymes for defense against that particular form of germ, the bacteria may grow and multiply; but they produce no sickness for some days, for at first there is no digestion or destruction of the bacterial proteins. But the presence of the proteins stimulates the body cells to prepare the enzymes which will digest the foreign substances; and signs of poisoning and of sickness appear as soon as the active destruction and digestion of the bacteria begin. When all the bacteria have been destroyed, and the products of their digestion have been thrown off from the body, the disease is at an end.

Immunity.—After a person has recovered from an infectious disease, the protective enzymes often remain in his blood, and are ready to destroy the germs of that disease which may afterward enter the body. A person who has had an infectious disease is, therefore, immune to it as long as the defensive substances remain in his body. The immunity may last a lifetime, as after smallpox, scarlet fever, and measles; or it may be brief, as after pneumonia and diphtheria. The defensive substances may not remain in the body at all, or there may even be an increased susceptibility after one attack of a disease, such as malaria, for example.

The opposite condition to immunity to a disease is called *susceptibility*. This condition exists when the defensive substances are insufficient in quantity or quality to destroy the disease germs when they enter the body.

Toxins.—A poison which is produced by disease germs is usually called a *toxin;* but the word toxin is strictly applied to a poison which is given off by bacteria; while the word *endotoxin* is applied to a poison that is retained in the bodies of bacteria. There are very few true toxins. The toxins with which a health officer is chiefly concerned are those of diphtheria and tetanus. The bacteria of diphtheria and tetanus are only slightly poisonous, but if the toxin of either of these diseases is injected into the body, it produces the signs and symptoms of the disease.

A toxin has the characteristics of a protein substance, but no toxin has been isolated in pure form. What is called diphtheria toxin is the broth in which diphtheria bacilli have grown. Toxins are intensely poisonous and yet they do not begin to affect the body until some hours or days after they have entered it.

Antibodies.—The substances which protect the body against the germs of infectious diseases and other foreign proteins are called *antibodies*. Three kinds of antibodies in which a health officer is especially interested are antitoxins, agglutinins, and lysins.

Antitoxins.—When a toxin is injected into the tissues, it causes the cells to produce an antibody called an *antitoxin*. The composition of antitoxins is unknown. The effect of an antitoxin is to combine with its toxin, if any is present in the body, and render it inert. The principal factor in bringing about recovery in diphtheria or tetanus is the antitoxin which is produced in the body. There is also a production of substances which kill and destroy the bacteria themselves, as in other diseases. The antitoxins for diphtheria and for tetanus may be produced in animals and be used for the prevention and cure of the diseases in mankind.

Manufacture of Antitoxin.—When an animal receives an injection of toxin, it produces an antitoxin in excess of that required to neutralize the toxin. When the injection is repeated several times, increasing quantities of antitoxin are produced, and are contained in the blood. A horse is generally used for producing antitoxin because it forms a large quantity in proportion to its size, and also because the effect of its serum is seldom harmful to man.

A standard method of manufacturing diphtheria antitoxin is as follows: A horse is given an injection of $\frac{1}{5}$ drop of diphtheria toxin, which is about all that an untreated horse can endure. The injection is repeated with increasing doses of toxin every third day, until about 1 pint of the toxin is given at the end of about two months, and the blood contains its maximum amount of antitoxin. About 3 gallons of blood are then drawn from the horse and allowed to clot. The serum is taken and sufficient ammonium sulphate is added to make a solution that is 30 per cent. of saturation. A precipitate falls, which is discarded. More ammonium sulphate is added up to 50 per cent. of saturation. The precipitate which then forms contains the antitoxin. This precipitate is pressed free from the excess of liquid and is placed in a bag of parchment paper and suspended in running water to dialyze for several days. The ammonium sulphate passes into the water, and the water enters the bag and dissolves the precipitate. The solution is the concentrated and purified antitoxin which is used in human beings.

Antitoxin is tested in the following manner: Minute quantities of toxin are injected into a series of guinea-pigs in order to determine its smallest fatal dose, which is ordinarily about $\frac{1}{15}$ drop of a pure culture. A series of minimum fatal doses of toxin, prepared by mixing them with variable quantities of antitoxin, is then injected into another series of guinea-pigs in order to determine the smallest quantity of the antitoxin that will exactly neutralize one fatal dose of toxin. The quantity of diphtheria antitoxin which will exactly neutralize 100 times the quantity of toxin that is fatal for one guinea-pig is called a *unit* of diphtheria antitoxin.

Tetanus antitoxin is produced in the same manner as diphtheria antitoxin, but the tetanus antitoxin unit will neutralize 1000 times the quantity of tetanus toxin that would kill a guinea-pig.

Agglutinins.—Some bacterial antigens give rise to antibodies whose effect is to cause the bacteria to cease their movements and to collect in clumps. These antibodies are called *agglutinins*. An agglutinin in the blood does not kill bacteria, but it may have some effect in causing them to collect in clumps which renders them susceptible to the attacks of the phagocytes.

Agglutination is a specific action and affects only the bacteria which are of the same kind as those which caused the development of the agglutinin in the blood. For example, the agglutinin produced by typhoid germs in the body acts on ty-

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phoid fever germs and not on the germs of pneumonia, or diphtheria, or those of other diseases. It is also quantitative, and a given quantity of serum will agglutinate a given quantity of bacteria. The test is usually made with serum diluted with normal salt solution, and the strength of agglutination is expressed by the degree of dilution at which a serum will act; as, for example, in a 1 : 10 or 1 : 1000 dilution.

A practical application of agglutination is made in the diagnosis of a disease by testing the blood-serum of the suspected patient with known bacteria. For example, the test for typhoid fever is made by taking a drop of blood from the suspected person and observing its agglutinating power upon a pure culture of typhoid bacilli. If typhoid fever is present, the blood will agglutinate the typhoid bacilli.

A serum which contains a known agglutinin may be used to identify an unknown variety of bacteria. If a guinea-pig or rabbit is injected with a pure culture of bacteria, its blood-serum will contain an agglutinin which will act on that variety of bacteria, and only slightly or not at all on other kinds. One practical application of the test is made in the diagnosis of pneumonia. A number of kinds of pneumococci may produce the disease. The pneumococci may be recovered from the sputum and subjected to agglutination tests with the serum of animals that have been injected with known varieties of pneumococci. The variety present is indicated by the serum with which agglutination is produced.

Laboratories keep a supply of animals that have been injected with known bacteria, and whose serums have been tested for their agglutinating powers.

Methods of Testing Agglutination.—When a considerable quantity of serum and bacteria is mixed in a test-tube, the agglutinated bacteria are visible with the naked eye, and appear as a white flocculent precipitate. When a test is made by this method, a series of tubes is set up each containing 0.1 c.c. of bacteria in suspension. Then to each tube except the last there is added 0.9 c.c. of a series of dilutions, 1 : 10, 1 : 50, etc., of the serum in normal salt solution. The salt solution only is added to the bacteria in the last test-tube as a control test. The tubes are placed in an incubator, and after about an hour they are removed to an ice-box to allow the precipitate to settle. The liquid in the tubes in which complete agglutination has taken place will be clear, while the other tubes will be cloudy from the bacteria which remain in suspension. The strength of the agglutination is indicated by the greatest dilution at which a complete clearing of the liquid takes place. The test may also be done upon bacteria which have been dissolved or disintegrated. It is often called a precipitin test.

Another method of doing an agglutination test is to observe the clumping of bacteria in a hanging-drop under a microscope. A test requires the use of a microscope slide on which a deep hollow ½ inch in diameter is ground. The glass around the hollow is smeared with vaselin to prevent the evaporation of the specimen. The serum and bacteria are mixed, and a drop is placed on a cover-glass, which is then inverted over the center of the hollow. The drop is examined with a ⅙-inch objective. Bacteria at first will be uniformly scattered over the field of view, but if agglutination takes place, they will soon collect in clumps of twenty-five or more. The degree of agglutination is measured by the greatest dilution at which the clumping takes place.

The Widal Reaction.—The principal agglutination test in which a health officer is interested is that for typhoid fever. The germs of typhoid fever growing in the body, or injected into it, act as an antigen and produce an agglutinin which has a strong action upon typhoid fever germs, and only a slight action, or none, on other kinds of germs. In order to perform the test take some blood-serum from a person who is suspected of having typhoid fever and mix it in varying dilutions with a pure culture of typhoid bacilli. The test is usually made by the microscopic method. A clumping of the bacilli indicates the presence of typhoid agglutinins. This test is called the *Widal reaction.* The test is considered positive if it takes place with a serum dilution of 1 : 40 or greater within thirty minutes.

Group Agglutination.—The reaction of agglutination is caused by the proteins of bacteria. A group of closely related bacteria may have a certain kind of protein in common. The serum of a person or animal that has been injected with bacteria belonging to any species of the group will agglutinate the bacteria of all the species; and the strength of the agglutination will be in proportion to the amount of the common protein in the bacteria that are tested. For example, the typhoid, paratyphoid, dysentery, and colon bacilli form a group. An individual bacterium of each group is composed principally of its own particular kind of protein, but it also contains a small quantity of the particular protein of each of the other bacteria in the group. If a typhoid serum will agglutinate typhoid bacilli in a high dilution, say 1 : 200, it may also agglutinate colon bacilli in a low dilution, say 1 : 10.

Group agglutinations must be considered in the interpretation of a report of a Widal reaction. A positive reaction with a dilution of 1 : 20 might mean an infection with paratyphoid or colon bacilli, but a prompt reaction with a dilution of 1 : 40 is proof of infection with typhoid bacilli.

Lysis.—The digestive action of blood-serum on foreign protein is called *lysis*, and the substances which perform the digestion are called *lysins*. The action of a lysin is similar to that of the gastric juice. It will take place upon any mass of foreign protein, or upon bacteria, or upon red blood-cells of an animal of a species different from that of the one supplying the serum. The destructive action upon red blood cells of the foreign species is called *hemolysis;* and that upon bacteria is called *bacteriolysis*. This action is largely obscure, but one phase has been traced and applied in what is known as the *complement-fixation* test.

A great difficulty in reading literature relating to lysins is the confusion of terms and expressions. The following definitions will aid in understanding the subject:

Foreign Protein.—A protein whose composition differs from that of the protein of the person or animal into which it is injected. Horse-serum is a foreign protein to man; and red blood-cells of a sheep are to a rabbit.

Sensitize.—To make the body sensitive to the poisonous effects of a protein, or to cause the body to produce substances which will destroy a particular protein that is introduced into the body (see p. 142).

Antibody.—A substance which protects a body against germs of infectious diseases or other foreign protein.

Lysin.—An antibody which will destroy a foreign protein.

Antigen.—A foreign protein, such as bacteria or red blood-cells, which will excite the production of antibodies, or amboceptors, when it is introduced into the body of a living animal.

Complement.—That part of a lysin which exists normally in the blood-serum of all higher animals.

Amboceptor.—That part of a lysin which is produced when an antigen acts upon the body.

Nature of a Lysin.—A lysin is a double substance and consists of two parts, called complement and amboceptor. Complement is the actual ferment and is like the pepsin of the gastric juice. Amboceptor is like the hydrochloric acid of the gastric juice, and its use is to enable the complement to act.

Complement is found in the blood-serum of all higher animals, and has the same nature in all of them. Amboceptor is not normally found in the blood, but it is a specific substance which is produced as a result of the introduction into the body of the foreign protein, bacteria, or other antigen. Each kind of antigen produces its own amboceptor which acts only on that particular antigen. Neither a complement nor an amboceptor can act alone, but the action of each depends upon the presence of the other. An amboceptor is not affected by a degree of heat which destroys the complement.

Complement Fixation.—When bacteria grow in the body, they act as an antigen and stimulate the body to produce an amboceptor which connects or fixes the complement of the blood to the bacteria. The action of the amboceptor in joining the complement to the antigen is called complement fixation; and its result is the digestion and destruction of the antigen by the complement. The principles of complement fixation are applied in tests for the diagnosis of diseases and for the identification of unknown bacteria. When the test is made for the diagnosis of a disease, the antigen consists of known disease germs or their products, the complement is that in the fresh blood-serum of a normal guinea-pig, and the amboceptor, if present, is that in the blood-serum of the suspected person.

When the test is made for the identification of bacteria, the antigen is the bacteria to be tested, the complement is that in the serum of a normal guinea-pig, and the amboceptor is that in the serum of an animal which has received injections of a known variety of bacteria. If the bacteria of the antigen are of the same variety as those producing the amboceptor, complement fixation will take place.

When the red blood-cells of a sheep are injected into a rabbit, they act as an antigen which sensitizes the rabbit and causes it to form an amboceptor which acts only on the red cells of sheep's blood. If the blood-serum of the sensitized rabbit is mixed with the red blood-cells of a sheep, its amboceptor and the complement in it will destroy the sheep's cells. The process by which the serum of an animal destroys the red blood-cells of another animal is called *hemolysis*, and is a form of complement fixation.

The action in a complement-fixation test is similar to that in hemolysis. The antigen usually consists of disease germs or their products. The amboceptor consists of the blood-serum of a patient or a sensitized animal. The complement in the serum is destroyed, or inactivated, by heat, and in its place a known quantity of complement is supplied in the form of fresh serum from a normal guinea-pig. Hemolysis is used in complement-fixation tests as an indicator of the reaction, for its effects can be seen, while most other actions in lysis are invisible.

The materials for a complement-fixation test for the diagnosis of a disease are two known antigens, one known complement, one known amboceptor, and one amboceptor whose presence is uncertain (that of the suspected person). These substances are arranged in two series which may be indicated as follows:

Disease Products Series:		*Hemolytic Series:*
1. Antigen. (Disease germs.) 2. Amboceptor. (Blood-serum of the person to be tested heated to destroy its unknown quantity of complement.)	3. Known complement. (Guinea-pig serum.)	4. Antigen. (Sheep red blood-cells.) 5. Amboceptor. (Blood-serum of a rabbit that has received an injection of sheep red blood-cells, and has been heated to destroy its unknown quantity of complement.)

A mixture of Nos. 1, 2, and 3 is first made, and is set aside for some time in order to allow the antigen, the amboceptor if it is present, and the complement to combine. No. 4, or the antigen of the hemolytic series, and amboceptor No. 5, are then added. If the person has a disease, amboceptor No. 2 will be present and the complement No. 3 will become fixed to antigen No. 1, and will exhaust itself in destroying the disease germs, and will not act on the blood-cells or antigen No. 4. A positive test is thus indicated by a failure of the red blood-cells to be dissolved.

If the person is free from the disease, there will be no amboceptor present in his blood, and the complement will not act on the disease germs, but it will unite with the amboceptor of the hemolytic series, and will dissolve the red blood-cells. The absence of the disease will be indicated by the dissolving action on the red blood-cells.

Complement fixation is the basis of the Wassermann test for syphilis, and is also used in diagnosing gonorrhea, tuberculosis, and other diseases.

The health officers in New York State are supplied with outfits for taking blood for the Wassermann and other tests. Each outfit consists of a sterile glass tube and a sterile hypodermic needle. When blood is to be drawn, tie a band around the upper arm in order to obstruct the flow of blood and distend the veins. Paint the skin over a vein with tincture of iodin in order to disinfect it. Thrust the needle into the vein with the slanting side of the tip upward, and remove the band as soon as the blood appears. Allow 2 or 3 drams of blood to flow into the tube, cork the tube tightly, and send it to the laboratory.

Opsonins.—Blood-serum usually contains substances, called *opsonins*, which act on bacteria and change them in such a way that the phagocytes digest them readily. If opsonins are absent, the phagocytes have little or no action on bacteria in the body. The bacteria of a disease will usually stimulate the body to produce the specific opsonins which will act on that kind of bacteria.

The amount of opsonins in a person's blood compared with the amount in the blood of a normal person is called the opsonic index of that person. The material for finding the opsonic index consists of—

1. White blood-cells from a normal person.
2. A pure culture of bacteria.
3. Blood-serum from the person to be tested.
4. Blood-serum from a normal person.

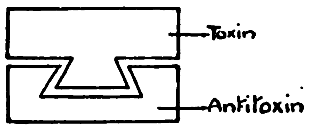
Mix equal parts of 1, 2, and 3 and allow them to stand for fifteen minutes. Prepare a microscope specimen of the mixture and count the average number of bacteria that are enveloped by each phagocyte. Prepare another specimen, using serum No. 4 instead of No. 3. The opsonic index is found by dividing the number obtained from the first specimen by that from the second. The opsonic test is inexact owing to the lack of a standard by which to estimate the value of normal serum and leukocytes.

Ehrlich's Side-chain Theory.—Ehrlich's side-chain theory is a means employed in teaching the nature of some of the factors that are concerned in immunity. It makes use of arbitrary diagrams to indicate invisible and unknown chemical actions and products, and their relations to one another and to the cells of the body.

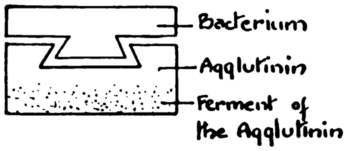
Ehrlich represents the cells as having protrusions, called *receptors*, which receive the food and toxins and other foreign substances that enter the body. Each receptor has a peculiar shape and will fit one kind of substance only, like a key in a lock. If a receptor fits a substance, it holds the substance and binds it to the cell. This combining, or chaining, action of the receptors gives the name to the theory. A cell, for example, takes a particle of food because its receptor fits that particle of food. It fails to make use of another kind of food substance because it has no receptor which fits that food.

A toxin has a poisonous action on a cell because the cell has receptors which fit the toxin. When the toxin joins a receptor, it destroys that particular receptor and injures the cell, but the cell repairs the injury by producing more receptors than were destroyed. The cell also gives off receptors, which then float free in the blood, and are ready to seize the toxin before it can reach the cells and injure them. The receptors floating free in the blood are *antibodies*. They may be considered to be parts which have left the cell and gone in search of the enemies of the cell. There is an analogy between the action of the cast-off receptors of cells and that of the phagocytes.

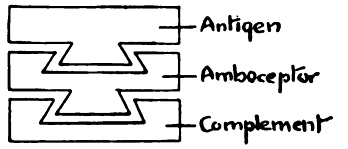
The simplest form of receptor is an antitoxin, for its only action seems to be to combine with the toxin like a key in a lock, so that the toxin is unable to attach itself to the cells. It may be represented by the following diagram:



A second form of receptor is an agglutinin. An agglutinin receptor has one part which combines with a foreign substance and another part which acts on that substance and restrains its motion. An agglutinin may be represented by the following diagram:



An amboceptor consists of a receptor which has two combining parts, one of which combines with the complement and the other with the foreign substance. It is represented by the following diagram:



Resistance to Disease.—The resistance which a person has to an infectious disease and the growth of disease germs depends: 1, on its general health and vigor of the body; and 2, on the presence of specific antibodies in the blood.

The diseases in which bodily health and vigor are specially important factors in prevention and recovery are sepsis and wound infections, and the common respiratory diseases, such as colds, pneumonia, and tuberculosis. The principal means of protection in these diseases is the direct action of the living cells, and especially of the phagocytes, upon the disease germs in the body.

General health and vigor afford little protection against infection with smallpox, scarlet fever, measles, typhoid, and most other diseases that are usually classed as contagious. The resistance of the body to any one of these diseases depends principally on the presence of the specific antibodies of that disease.

Effect of Cold and Dampness.—Cold and dampness, especially the two combined, are popularly supposed to be the principal causes of colds and other respiratory diseases. If disease germs do not enter the body, cold and dampness will not produce a cold or pneumonia. Explorers in Arctic regions and sailors on long voyages do not have colds, although they are exposed to extremes of coldness and wetness; but they readily take cold when they return home where they are exposed to disease germs.

There is little scientific evidence concerning the methods by which cold and dampness harm the body. Anthrax germs will not grow in a normal fowl, but they may grow and produce the disease if they are introduced into fowls that are kept standing in cold water. The germs of colds and pneumonia are often found in the noses and throats of carriers, and are unable to grow until something upsets the balance between their virulence and the resistance of the body. When a cold or pneumonia follows an exposure to cold and dampness, at least three possible explanations may be made: 1, that the defenses of the body may have been impaired; 2, that the ordinary germs of the nose or throat may have acquired an increased virulence; or 3, that a new supply of virulent germs may have entered the body. The purpose of a health officer is to destroy disease germs so that cold and dampness and other harmful influences cannot produce infections.

Fatigue and Infection.—Experiments with rats, guinea-pigs, and rabbits have proved that fatigue lessens the resistance to most kinds of infection. Cells that are exhausted are poisoned by their own products and are unable to produce a full quota of defensive substances.

Fatigued persons often neglect the finer points of cleanliness and of precautions against disease germs, and thus they render themselves liable to infection. The only means of control which health officers have over the fatigue factor in infection is through some degree of supervision over working conditions in factories and workshops, and indirectly through advice and education.

Food.—A considerable deficiency of an essential element in the diet, as in scurvy, impairs the resistance of the body to a marked degree. The impairment is far less when the diet is deficient in quantity and yet contains all the varied substances that the body needs. Tuberculosis is a common disease in which insufficient or improper food has a direct effect in decreasing the resistance of the body. Improper nourishment is often associated with poverty, shiftlessness, uncleanness, and other unhealthful conditions that accompany or underlie vicious feeding habits. Alcohol especially lessens the resistance of the body to disease.

Foul air, poor ventilation, and the overheating of rooms are conditions which have a great influence in lowering the resistance of the body to tuberculosis, colds, pneumonia, and other respiratory diseases. These conditions also favor infection through dust and droplets of excretions from the nose and mouth. A health officer has a considerable degree of control over these conditions through his work among tuberculosis cases and through his inspection of school rooms and other places of public assembly.

Abnormal Conditions of the Mouth.—Enlarged tonsils and adenoids lower the resistance of the body because of their evil effects on breathing, nutrition, and general bodily vigor. The bacteria of tonsillitis and sepsis growing in cavities in the tonsils and decaying teeth produce poisons which exhaust the protective powers of the body and thus permit the growth of any kind of disease germ which may enter the mouth. A dirty mouth is also a culture place for many kinds of poisonous bacteria. Persons with adenoids, enlarged tonsils, decayed teeth, and unclean mouths are far more likely to catch diseases than those persons whose mouths are normal and clean. A health officer can discover those defects by his inspection of school children, and can use his influence to have the conditions remedied.

Natural Immunity.—The immunity to most diseases that are classed as contagious depends principally on antibodies in the blood. Some persons naturally have so great a degree of immunity to certain diseases that they do not catch the diseases when they are exposed to them. For example, about half of all persons have diphtheria antitoxin in their blood in sufficient amount to protect them against ordinary modes of diphtheria infection. No person is entirely immune. An immune person ble to overcome the few germs that are taken into his body ne time during an ordinary exposure to infection. But any on will take a disease if a sufficiently large number of the ns of that disease enter the body at one time.

Acquired Immunity.—Immunity may also be acquired. An uired immunity is *passive* when the antibodies are injected into the body, and *active* when the antibodies are produced by the body itself.

Passive immunity is produced by the injection of antitoxins which are taken from another person, or from lower animals. It lasts for only a few days or weeks, for the substances which are injected are foreign to the body and are soon expelled, and no new ones are produced. An active immunity may last for months or years, for the antibodies are native to the body and a new supply is continually formed by the cells.

Active Immunity.—An active immunity may be induced by

1. An attack of a disease.
2. The injection of the living germs of a disease.
3. The injection of the dead germs of a disease.
4. The injection of a toxin.

Recovery from an attack of a disease is necessarily based on the ability of the body to overcome the germs of that disease. The body usually retains that ability for a considerable length of time after recovery. The immunity after smallpox, measles, scarlet fever, mumps, whooping-cough, and chicken-pox usually lasts a lifetime. Immunity after diphtheria lasts for only a month or two. Immunity after pneumonia, septic infections, and malaria lasts for only a few days, and is often followed by an increased susceptibility to the disease.

Inducing immunity by producing an attack of a disease was often practised with smallpox before the discovery of vaccination. It is still followed by many persons with the milder forms of contagious diseases, such as mumps, measles, and chicken-pox, on the theory that every person must have the disease and that the sooner it is over the better. This mistaken attitude retards progress in suppressing all forms of diseases.

Immunity After Injections of Living Germs.—A mild and harmless attack of a disease will protect the body as fully as a virulent form of a disease will protect it. The body will be protected by the introduction of living disease germs whose virulence and power of growth have been diminished to such a degree that they are barely able to grow. Yet these weakened or attenuated germs may stimulate the cells of the body to produce antibodies in as great a quantity as an attack of the disease will produce. A preparation of living germs used for injection into the body is called a *virus*. Two diseases which a health officer may be expected to prevent by the use of injections of living germs are smallpox and rabies. The virus that is used in vaccination against smallpox consists either of smallpox germs, or of organisms similar to those which produce smallpox. They are grown on a calf, and are thereby weakened to such a degree that they produce only a single sore when they are introduced into a person. Antirabic virus contains germs which have become weakened by drying, or freezing, or other means.

Vaccines.—A virus does not act until the few germs that are introduced into the body have multiplied to millions. A danger in the use of living germs is that they may multiply too much. The use of killed germs avoids this danger, and yet produces immunity. A preparation of killed disease germs used for an injection into the body is called a *vaccine*. Vaccines are used for the prevention of diseases, for their cure, and for the preparation of serums. A common example of the use of a vaccine for the prevention of disease is vaccination against typhoid fever.

Vaccines are of doubtful value in curing a severe case of disease. When a disease is developing and the body is not producing antibodies, the introduction of a vaccine may rouse the body to produce defensive substances. But there is a danger that the body may fail to respond to the stimulation. If it does not respond and produce antibodies, the vaccine will increase the amount of poison in the body, and may do harm.

When disease germs grow in a restricted part of the body and are surrounded by a wall of defensive tissues, few antibodies may be produced. A vaccine may then stimulate the body to produce antibodies, and thus it may cure the disease. An example of the good effects of a vaccine in this class of diseases is the vaccine treatment of boils that come in successive crops.

Killed bacteria are often injected into lower animals in order to produce serums and antitoxins.

Preparation of Vaccines.—The usual method of producing a vaccine is to grow a pure culture of bacteria on a solid medium, wash the bacteria off with salt solution, and kill them with heat, carbolic acid or other disinfectant, and put them in bottles, each containing a definite number.

The dose of a vaccine is reckoned according to the number of bacteria that are given—100,000,000 to 1,000,000,000 is the usual dose. The injection of this number of bacteria produces some soreness at the place of injection and a slight fever which passes off in a few days. The dose is repeated every two or three days. Antibodies begin to appear in the blood in two or three days after the injection.

The number of bacteria in a given quantity of vaccine is determined by the following method:

Using a capillary pipet, take a small quantity of vaccine and an equal quantity of fresh human blood, and mix the two on a microscope slide. Count the number of bacteria in several fields and the number of red blood-cells in the same fields. There are 5,000,000 red blood-cells in each cubic millimeter of blood. The number of bacteria in each cubic millimeter of vaccine may be estimated by the following proportion: The number of red blood-cells counted is to the number of bacteria counted as 5,000,000 is to the number of bacteria in a cubic millimeter of vaccine. If we know how many bacteria there are in a cubic millimeter of vaccine, we can make a dilution which will contain the proper number of bacteria in a convenient quantity of vaccine.

Autogenous Vaccines.—Some disease germs which are classed under a single name may be composed of subgroups which differ widely. Each subgroup may produce a special poison of its own, and the injection of the bacteria may give rise to an antibody which acts on that particular subgroup and on no other. When a stock vaccine is used for treatment, it may not contain the variety of bacteria that are causing the disorder. This difficulty may be overcome by growing a pure culture of the bacteria taken from the body of the person to be treated, and using it to make a vaccine. A vaccine made from germs taken from a person's own body is called an *autogenous* vaccine. These vaccines are of special value in the treatment of chronic boils and of suppurating cavities.

Mixed Vaccines.—Vaccines are often manufactured containing several varieties of bacteria in the hope that one of them will be identical with the variety that is producing the sickness. There is no exactness in this method of treatment, and there is danger of adding to the quantity of poison in the body instead of overcoming that of the disease. If the right kind of bacteria are present in the vaccine, their number is likely to be too small to do good.

Serums.—The injection of bacterial vaccines into suitable animals causes the animals to produce far more antibodies than they need. A few ounces of their serum may then contain enough antibodies to immunize a person when the serum is injected into his body.

A serum is either antitoxic or bacteriolytic. Two antitoxic serums are those of diphtheria and tetanus. They act only upon the toxins of bacteria, and do not destroy the bacteria themselves. Bacteriolytic serums act by dissolving bacteria. One of the most successful bacteriolytic serums is that used in treating epidemic cerebrospinal meningitis. Serums are also produced for the treatment of certain forms of pneumonia and of streptococcic infections.

A serum is potent only against the variety of bacteria with which it is produced, but if the variety of bacteria in the body is known, its serum may have great value.

Sensitized Vaccine.—Immersing a bacterial vaccine in a serum made by injecting the bacteria into an animal may reduce its poisonous nature without impairing its protective value. The theory of the action of the serum is that it neutralizes the poisons of the bacteria. A vaccine treated with its protective serum is called a sensitized vaccine. Several kinds of sensitized vaccines are on the market, and the principal value that is claimed for them is that they may be used in larger amounts than the untreated vaccines.

Focal Infections.—A collection of disease germs growing in a small part of the body is called a *focal infection*. The germs may not produce pain at their point of growth, and yet they and their products may continuously poison the body and produce headaches, valvular heart disease, arthritis deformans, and other chronic disorders. The white spots which are often seen on tonsils are the openings of crypts filled with pus or poisonous matter. These tonsils are usually painless, and their dangerous nature is often unrecognized. If pus or plugs of matter can be pressed from a tonsil, that tonsil is diseased, and is a dangerous source of focal infection.

Another common source of focal infection is a painless abscess at the root of a tooth. This may usually be recognized by means of an *x*-ray photograph. Another source is Rigg's disease, or pus between the edge of the gums and the teeth. The recognition of focal infections, especially those of the tonsils and teeth, is becoming more and more the work of the health officer and of the medical school examiner.

CHAPTER XV

THE PUBLIC HEALTH LABORATORY

A PHYSICIAN of the eighteenth century could recognize only the gross outward signs of fully developed diseases. He was guided almost entirely by his clinical observations, and was like a watchman standing at the edge of the sea and detecting only a few large objects upon a vast expanse of unknown waters. The discovery of exact methods of physical examination beginning early in the nineteenth century gave the physician an enormously increased range of vision. He became like an observer upon a lighthouse tower and was enabled to detect hidden diseases in their incipiency and to institute measures for their prevention. When the science of bacteriology developed late in the nineteenth century, the physician became like an observer upon an aëroplane equipped with telescopes and wireless telegraphy, and provided with life-lines for those in danger, and bombs for the destruction of his enemies. General practitioners of medicine who do not avail themselves of laboratory helps are like soldiers who do not avail themselves of aëroplane service. A few skilled workers in a laboratory may supply the diagnostic eyes for an army of family physicians who have neither time, skill, nor equipment for doing bacteriologic and pathologic work.

Clinical observation, physical examination, and the detection of bacteria and other abnormal substances in the tissues and body fluids form a trio of means by which a modern physician establishes his diagnoses and bases his treatments; and a neglect of any one of the three may lead to loss of reputation to the physician, death to the patient, and wide-spread disease among the people. Since a health officer deals principally with communicable diseases, he is especially dependent upon a laboratory for the conduct of his work. He cannot perform the duties of his office unless the service of a public health laboratory is at his disposal. Laboratories have changed public health work from uncertain guesswork and extravagant measures of prevention to exact knowledge of the nature of diseases and accurate methods of prevention adapted to each individual disease. One of the duties of a health department is to provide laboratory facilities for dealing with the communicable diseases which are prevalent within its jurisdiction.

The communicable diseases over which the health officers of New York State have official jurisdiction are twenty-eight in number, as follows: anthrax, chancroid, chickenpox, cholera (Asiatic), diphtheria, dysentery (ameba and bacillary), epidemic cerebrospinal meningitis, epidemic or streptococcus (septic) sore throat, German measles, glanders, gonorrhea, measles, mumps, ophthalmia neonatorum, paratyphoid fever, plague, pneumonia, poliomyelitis, puerperal septicemia, rabies, scarlet fever, smallpox, syphilis, trachoma, tuberculosis, typhoid fever, typhus fever, and whooping-cough. To these other health departments add hookworm disease, malaria, and tetanus. A laboratory is of direct and essential assistance in the diagnosis or treatment or prevention of all these diseases excepting chickenpox, German measles, measles, mumps, scarlet fever, and trachoma. But these six exceptional diseases are being investigated in laboratories with a fair prospect that their causes and natures will soon be discovered and methods of their direct control will be developed.

Lines of Work.—A public health laboratory usually conducts six lines of work; 1, bacteriologic examinations; 2, chemical analyses; 3, the production of vaccines and serums; 4, field work; 5, research; 6, education.

The greatest number of individual specimens received for examination and analysis in a public health laboratory are those which are derived from the human body, and which are examined for the presence of disease germs, or the products of disease. A laboratory also makes bacteriologic examinations of substances by means of which disease germs may be spread, and particularly of water, sewage, milk, food, and air. The laboratory may sometimes examine these substances on economic grounds also, especially if they have an indirect bearing on public health. Specimens of foods are often examined for the detection of objectionable impurities and adulterations, and for lowered standards of composition; but the usual rule is that a laboratory of a department of health shall examine only those specimens which have a bearing on public health. It will examine all specimens sent by physicians from persons suspected of having a communicable disease, or of being carriers of disease germs, and specimens of water and milk in which disease germs may reasonably be suspected. It is not the function of a department of health laboratory to make free examinations of water, or milk, or food for private persons. A public health laboratory, for example, will make routine examinations of public water-supplies, but not of wells used as private supplies.

Vaccines and serums are produced: 1, for the diagnosis of diseases, as in the Widal test for typhoid fever; 2, for the immunization of well persons against various diseases, such as typhoid fever, diphtheria, and smallpox; and 3, for the treatment of diseases, such as tetanus and cerebrospinal meningitis.

Field work is done in order (1) to obtain specimens by the more difficult or unusual operations, such as spinal puncture or drawing a quantity of blood; (2) to give unusual serums, such as those of pneumonia, intravenously, and of tetanus intraspinally; (3) to make an accurate examination of specimens which will not stand transportation, such as the spinal fluid from a poliomyelitis case; (4) to advise and instruct physicians, health officers, and other public health workers.

Research work is carried on for the purpose of finding a solution of difficult problems relating to the causes, prevention, and treatment of diseases; and also of testing and confirming the new methods that are announced by other investigators. The most accurate and skilful workers conduct these investigations and most great advances in modern medicine are due to their painstaking efforts. Health officers and physicians can assist in the research work by reporting unusual and interesting cases and conditions for special investigations by the laboratory, and in supplying specimens from diseased lower animals which are suspected of having diseases which may be communicated to man. It may happen that any health officer may be able to supply the data and specimens which will lead to the settlement of an obscure point regarding the cause, diagnosis, treatment, or prevention of an important disease.

It is not the function of the laboratory to conduct investigations and researches simply on account of their scientific interest. Research work and all other activities of a public health laboratory supported by public funds must produce practical results in saving lives and preventing diseases. The ideal worker in a laboratory is one who frequently comes in contact with physicians and health officers in the field and tests the practicality of his scientific laboratory work by clinical experience at the bedside.

It is the policy of public health laboratories to secure the widest possible use of the means of diagnosis, prevention, and treatment which they can offer. Educational work is conducted along three principal lines:

1. The announcement of results of research work in technical journals.

2. Demonstrations before medical societies and articles in medical journals on new methods which physicians, health officers, and public health nurses can use.

3. Lectures before popular audiences and articles in educational journals, magazines, and newspapers, in order to overcome popular prejudices and misapprehensions, and to arouse a popular demand for the use of the means of prevention and treatment which laboratories alone can furnish.

Co-ordination of Activities.—The bureaus of laboratories, communicable diseases, and sanitary engineering of a department of health are the three divisions with which health officers, physicians, and other public health workers come into the closest contact. A health officer may frequently be in doubt as to which division he shall refer a matter, such, for example, as the investigation and control of a water-borne epidemic of typhoid fever. These three divisions are closely interrelated, and each depends upon the other for information and decision, and for the execution of the measures which are indicated by their findings. In the investigation of water-borne typhoid, for example, the division of communicable diseases investigates the cases and their sources; the division of sanitary engineering investigates and controls the water-supplies and methods of sewage disposal; and the division of laboratories makes the bacteriologic and chemical analysis of water, sewage, and human specimens, and supplies the preventive vaccines. The co-ordination of their activities and the harmonious co-operation of the staffs are necessary in securing efficiency in public health work.

Diagnostic Work.—A health officer sends specimens from the human body in order to determine (1) a diagnosis at the beginning of a disease; (2) the termination of the disease; (3) carriers of disease germs.

When a health officer is called to a suspicious case of sickness he must consider the following questions:

1. Is the disease infectious; and if so, what is the diagnosis?
2. Can the laboratory assist in its treatment?
3. Can the laboratory supply the vaccines or serums for cure, or for preventing the disease in other persons?

The answer to these questions will often depend upon the results of the examination of specimens which are sent to the laboratory.

When a person has recovered from a disease, the health officer will wish to know if the patient is free from disease germs, and if the danger of spreading infection is passed. The determination of these points may require the examination of one or more specimens taken from the patient after his apparent recovery.

A few persons continue to have disease germs in their bodies after they have recovered from a disease; and a few others have disease germs in their bodies without contracting the disease. These two classes of persons are called carriers. Almost the only method by which carriers may be recognized is the laboratory examination of specimens taken from their bodies. The existence of healthy carriers was not suspected until it was demonstrated by laboratory methods.

Specimens of water are examined both chemically and bacteriologically for evidences of pollution with human excretions. They are also examined chemically for the presence of substances which make the water unsatisfactory for household use in any respect.

Specimens of sewage are examined in order to determine the completeness of the process of purification.

The purity and wholesomeness of milk are determined principally by a bacteriologic examination.

Method of Sending Specimens.—Specimens are sent to a public health laboratory on the authorization of a health officer or other employee of a department of health. Physicians are considered to be unofficial diagnosticians for the department of health, and it is their privilege and duty to communicate directly with the laboratory and to send specimens and cultures taken from their patients. A report is sent to the health officer as well as to the physicians, and such a report is not considered to be a violation of the confidential relations between a physician and his patient.

Cultures and specimens are made with special outfits, and are enclosed in special containers which are supplied by the laboratory. The outfits are in the standard forms which are best adapted for the preservation and transportation of the specimens, and for easy examination by the laboratory workers. These outfits are always to be used except in an emergency when they cannot be obtained. The containers are designed to secure the safety of the specimen during transportation. The postal laws require the use of certain forms of containers for specimens whose breaking might endanger health. The health officer is the distributing agent for the outfits and containers. Every health officer in New York State is expected to maintain a supply station for the free distribution of the standard outfits which are likely to be used in his jurisdiction.

Every specimen sent to a laboratory must be accompanied by a statement of the essential facts regarding its source, and by a request for the special examination which is desired. A specimen is of very little value without this information, for the laboratory worker may not know what to search for or how to

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Every specimen sent to a laboratory must be accompanied by a statement of the essential facts regarding its source, and by a request for the special examination which is desired. A specimen is of very little value without this information, for the laboratory worker may not know what to search for or how to interpret the findings. Every standard outfit sent out by a department of health contains a printed form with blank spaces for the required information.

A health officer comes in contact with a public health laboratory principally by sending specimens for the diagnosis of communicable diseases over which he has jurisdiction. He is also the official agent for the distribution of serums and vaccines which the laboratory produces. The services which a laboratory can render a health officer or family physician in each disease may be enumerated as follows:

Anthrax.—The bacteriologic examination of blood for diagnosis.
The preparation of a curative serum.

Chancroid.—The examination of the discharges in order to exclude syphilis.

Cholera.—The bacterial examination of the intestinal discharges for diagnosis.
The preparation of a vaccine and serum for prevention and cure.

Diphtheria.—The bacteriologic examination of specimens for diagnosis.
Testing the virulency of the bacilli in carriers.
The preparation of antitoxin for prevention and cure.
The preparation of toxin for the Schick test for immunity.
The administration of antitoxin to difficult cases that can be reached by the laboratory workers.

Dysentery.—The bacteriologic examination of intestinal discharges for diagnosis.
Examination of blood for diagnosis.
The preparation of a vaccine for preventive inoculation.
The preparation of a curative serum for certain types of dysentery.

Epidemic Cerebrospinal Meningitis.—The bacteriologic examination of the spinal fluid for diagnosis.
The examination of nasal excretions for diagnosis.
The preparation of a curative serum.
The administration of serum in cases accessible from the laboratory.
The establishment of a temporary laboratory in a locality in which an outbreak occurs.

Epidemic or Streptococcus (Septic) Sore Throat.—The bacteriologic examination of throat cultures for diagnosis.
The examination of milk suspected to be the source of infection.
Research work among affected persons and dairies in order to determine the exact nature of the infection.

Glanders.—The bacteriologic examination of discharges.
The preparation of mallein for diagnostic injections.

Gonorrhea.—The bacteriologic examination of discharges for diagnosis.
The preparation of curative vaccines and serums.

Hookworm Disease.—The examination of intestinal discharges for parasites and their eggs.

Malaria.—The examination of blood for the malarial organisms.
The examination of mosquitoes for the identification of the carriers of malaria.

Ophthalmia Neonatorum.—The examination of eye discharges for diagnosis.
The preparation of packages of silver nitrate solution for prevention.

Paratyphoid Fever.—The bacteriologic examination of intestinal excretions for diagnosis.
The bacteriologic examination of suspected food for diagnosis.
The examination of blood for diagnosis.
The preparation of a preventive vaccine.

Plague.—The bacteriologic examination of discharges or blood for diagnosis.
The preparation of a vaccine for prevention and serum for cure.

Pneumonia.—The bacteriologic examination of sputum for the determination of the type of the bacteria.
The preparation of a curative serum.
The administration of serum in accessible cases.

Poliomyelitis.—The examination of spinal fluid for diagnosis.
The preparation of a curative serum.

Puerperal Septicemia.—The bacteriologic examination of discharges for diagnosis.

Rabies.—The examination of the brain tissues of a lower animal for diagnosis.
The preparation of material for preventive injections.

Smallpox.—The preparation of a vaccine for preventive inoculation.

Syphilis.—The examination of discharges for diagnosis at the beginning of the disease.
The examination of blood for diagnosis during the course of the disease (Wassermann reaction).
The preparation of a curative chemical compound.

Tetanus.—The bacteriologic examination of discharges from infected wounds for diagnosis.
The preparation of antitoxin for prevention and cure.
The intraspinal injection of antitoxin in accessible cases.

Tuberculosis.—The bacteriologic examination of sputum and discharges, and of milk, for diagnosis.

The preparation of tuberculin for skin tests, and for diagnostic injections.

Typhoid Fever.—The bacteriologic examination of intestinal discharges, and of blood for diagnosis.

The examination of blood for diagnosis (Widal reaction).

The preparation of a preventive vaccine.

Typhus Fever.—The bacteriologic examination of blood for diagnosis.

The examination of body lice for signs of infection.

Whooping-cough.—The preparation of a preventive vaccine.

Supply Stations.—A health officer is expected to maintain a supply station at which physicians may obtain the laboratory outfits and preparations. The following is a list of the laboratory supplies which a health officer may profitably carry:

Diagnostic Outfits in Mailing Cases:

- Diphtheria culture-tubes.
- Sterile bottles for feces from typhoid, paratyphoid, dysentery, and cholera cases.
- Sterile bottles for blood in the Wassermann test for syphilis. (These may also be used for spinal fluids and other liquids.)
- Sputum bottles for tuberculosis examinations.
- Slides for collecting blood for the Widal test for typhoid fever and other similar tests.
- Slides for smears of blood and abnormal discharges.
- Containers for water for chemical and bacteriologic examinations.

Preparations for Cure and Prevention:

- Diphtheria antitoxin, usually 3000 or 6000 units in each bottle.
- Tetanus antitoxin, 1500 units for prevention, and 10,-000 units for cure.
- Packages of silver nitrate solution for the prevention of ophthalmia neonatorum.
- Typhoid vaccine.
- Whooping-cough vaccine.
- Antimeningitis serum.
- Smallpox vaccine.

Preparations which do not keep well, or which are seldom used, may be obtained by telegraphing or telephoning to the nearest laboratory.

Organization.—The modern practice of medicine centers around the laboratory, and a physician is skilful and efficient in direct proportion to his use of laboratory methods. The facilities of a public health laboratory for the benefit of those who cannot pay for the services of a private laboratory are necessary both in the prevention of disease and also in the prompt restoration of the sick to health. It is a measure of direct economy to expend public money in order to bring laboratory facilities within the reach of all the people, thereby increasing their health, vigor, and productive capacity. New York State outside of New York City meets the need by the establishment of a state laboratory, and ten county and twenty city laboratories. While these are independent units, the state laboratory exercises supervision over them, insures a standard of skill and efficiency among the workers, and provides them with standard serums and cultures for their diagnostic work.

An ideal plan of organization is that each county or convenient group of counties shall make provision for the prompt examination of routine specimens, such as those from cases of diphtheria, typhoid fever, and tuberculosis, while the state laboratory does the more difficult and unusual examinations, and prepares the vaccines and serums whose manufacture requires an elaborate outfit.

CHAPTER XVI

EPIDEMIOLOGY

Definitions.—The suppression and prevention of diseases that spread from person to person was the original duty of a health officer, and is still his most evident work. A disease belonging to this class is known by the four names, catching, contagious, infectious, and communicable, all of which now mean about the same thing, and signify that the disease may be produced by a minute quantity of material transferred from an affected person to a well one. The word *preventable* describes these diseases, but it also applies to many bodily diseases and conditions which are not communicable.

The words *epidemic* and *endemic* refer to the prevalence of a disease in a locality. An epidemic disease which continues for months or years in one locality is called an endemic disease, and its existence in any community is an indication either of gross carelessness or of ignorance.

A study of the causes, means of transmission, and control of infectious diseases is called *epidemiology*. Three or four known cases of disease in a community may be called an epidemic. When an epidemic breaks out, it is the immediate duty of the health officer to discover its cause, and to institute efficient means for its control. His broader duty is to prevent cases of communicable disease from developing at all.

Cause of Communicable Diseases.—The old theory of the transmission of disease was that epidemics and pestilences were the result of influences which were invisible, unrecognizable, unknown, and mysterious. These influences were supposed to be emanations or exhalations from the bodies of the sick, or of impalpable miasms, spirits, or gases from the soil, stagnant water, and filth. They were believed to have a constant tendency to escape from their places of origin, and to fasten themselves upon innocent human victims who came within their reach. The supposition was that they spread in circles, like the waves from a stone dropped into a still pond of water; that they were mostly air-borne; and that their spread was dependent largely upon cold, damp, stormy weather. This theory is still held by many people.

A health officer does not deal with uncertainties, but with definite facts and procedures with which he must be familiar.

The modern theory of the cause of communicable diseases may be summarized in the following statements of general principles to which there are a few exceptions:

1. Communicable diseases are caused by living organisms which may be seen, recognized, and measured.

2. The sources of the organisms of human diseases are the bodies of diseased human beings. But tetanus, rabies, glanders, and anthrax are four human diseases whose germs usually originate in lower animals.

3. The organisms leave the body with the liquid and solid excretions, and with abnormal discharges.

4. A communicable disease results from the transference of excretions and abnormal discharges from the sick to the well over a short and direct route in which the disease germs are able to survive natural destructive influences.

Portals of Entry.—The portals of entry of disease germs into the body are wounds, and the natural openings into the cavities of the body, especially the nose and mouth. The outer layer of the skin is a protective sheet of epithelium which is thick, horny, oily, and water-proof, and is impervious to living organisms. Disease germs cannot enter the body through healthy skin, but they may enter the flesh and blood wherever the epithelium is cut or injured, or they may be carried through the epithelial barrier by the prick of a needle or splinter or insect's bill that makes a wound too small to be noticed.

A continuation of the protective layer of epithelium extends through the nose and throat and forms an inner skin lining the cavities of the body, but in the interior of the body the epithelium is thin and delicate, and readily absorbs liquids. Yet the protection afforded by healthy epithelium is very great and is usually efficient unless it is injured in some way, as by the retained poisons of intestinal diseases or by prolonged contact with disease germs and their poisons.

Enlarged tonsils and adenoids are frequently the entrance places of disease germs into the body, for their protective layer of epithelium is often thin and deficient; they are composed of unhealthy tissue; they lie in the direct path through which food and air enter the body; and they often contain crypts and folds in which disease germs and bacteria of fermentation and decay may multiply and produce poisonous substances. Enlarged tonsils and adenoids are of great importance from the point of view of the health officer.

Cleanliness of the Mouth and Nose.—The mouth always contains bacteria which find an excellent culture-medium in the saliva and mucus and in the furry coating on the tongue. A dirty mouth is often the breeding-place of disease germs which would not find lodgment if it and the teeth were clean. Disease germs often lodge in cavities in the teeth.

Cleansing the tongue by rubbing the tooth-brush over it when brushing the teeth is an efficient means for preventing the accumulation of disease germs. This procedure is especially important during epidemics of colds, sore throats, and any other form of contagious disease. Brushing the teeth and cleansing the mouth regularly is an essential measure of personal hygiene in preventing infectious diseases.

Abnormalities of the nose often produce pockets in which disease germs may lie and multiply. A stopped-up nose is a menace to health. The treatment of nasal abnormalities, blowing the nose, and the use of a handkerchief are measures of the first importance in the prevention of contagious diseases.

Modes of Transference of Disease Germs.—The prevention of communicable diseases consists in preventing the excretions and discharges of any person from entering the body of any other person. A health officer must be familiar with the life-histories of disease germs, and with the routes which the germs follow in passing from the sick to the well. The routes of transmission of communicable diseases are either private or public. The private route is that known as personal contact. The principal public routes are those by means of water-supplies, milk-supplies, food, and insects.

Contact Infection.—The most common and direct method of spreading disease germs from one person to another is by contact with a person who produces the germs. The list of diseases which may be spread through personal contact includes nearly every one which is communicable. A health officer must pay special attention to this method of spread in measles, scarlet fever, and other eruptive fevers; in colds, sore throats, pneumonia, and other respiratory diseases; and in diphtheria, typhoid fever, and dysentery.

The three principal ways in which contact takes place are: 1, face-to-face or droplet infection; 2, through the hands; 3, through articles soiled by excretions.

Droplet Infection.—Most communicable diseases may be spread by means of the excretions blown from the nose and mouth of an affected person upon the face of another. The germs are not expelled by acts of quiet breathing, but by violent explosive expirations, such as coughing, sneezing, spitting, and loud talking. Two persons face to face are in favorable positions for the exchange of germs. Actions which frequently bring persons face to face and favor contact infection are holding an infected child on the lap, kissing on the mouth, wrestling, and sleeping in bed with another person. The distance which germs ordinarily travel is not great. A person is usually safe from infection if he remains 3 or 4 feet away from one who has a contagious disease. He may come nearer with safety if the face of the sick person is kept turned away from him. The principal diseases which are spread by droplet infection are colds, sore throat, bronchitis, pneumonia, grip, and other diseases of the respiratory system.

There are many opportunities for contact infection among children, for they often put their faces close together in playing games, they laugh and shout into one another's faces, and they do not observe the distant formalities of polite society as adults do.

Hand Infection.—Contagious diseases are often spread by means of the hands soiled by excretions of the sick. Those who come in contact with the sick and then handle food are especially likely to carry germs to the food. The habit of placing the hands to the mouth and nose is frequently the cause of carrying infections. Two fixed rules for doctors, nurses, and all others who care for cases of contagious diseases are:

1. Do not touch your nose, or mouth, or food, or drink if there is any suspicion that your hands are soiled.

2. Wash your hands immediately after touching a sick person or anything that he has soiled.

It is surprising how great a tendency there is of most persons to touch and handle things unnecessarily. A good rule for those calling on the sick is to place their hands in their pockets and keep them there through the whole time of the visit.

Freshly Contaminated Articles.—Articles which have recently been soiled with fresh discharges from the sick may carry infection. Examples of this method of infection are drying the face on a towel which a sick person has just used, and eating from a spoon from which he has just eaten. Anything which passes from the mouth and nose of one person to another without being cleansed may carry the germs of contagious diseases. Some articles which often carry infectious material are handkerchiefs, dishes, napkins, towels, and bed clothing. An efficient method of preventing infection by means of soiled articles consists in washing and boiling the articles after they have been used by the sick, and before they are used by anyone else.

Common towels and common drinking-cups in public places often spread communicable diseases. Their use is forbidden by the sanitary codes of the City and State of New York, and there is a growing public sentiment for the observance of the laws.

Contact infection is probably the cause of most epidemics which now occur in the most enlightened sections of the United States. An epidemic in which the disease is transmitted by contact will be irregular in the time and place of its appearance; there will be a series or chain of cases developing from previous cases; and there will be an absence of exposures to infected milk, water, and other public means of the transmission of infection.

Fomites.—Closely connected with the transmission by contact is the principle of transmission by fomites. It was formerly believed that disease germs were frequently carried on money, clothes, furniture, and other articles which were in a sick room, and yet were never touched by the diseased person or by excretions from his body. Things which were supposed to attract contagious material and to become persistent carriers of disease germs under ordinary conditions were called *fomites*. The theory of the transmission of disease by fomites has been almost abandoned, and with it has gone the necessity for oppressive quarantine and the destruction of property.

Wounds are the usual portals of entry for the pus-forming germs and those of septicemia and syphilis. The principal disease caused by wound infection with which a health officer has to deal is tetanus. The germs of ordinary fevers, such as measles, scarlet fever, and typhoid fever, seldom or never enter the body through wounds in the skin. Anthrax, glanders, and rabies are lower animal diseases whose germs may enter the body through wounds.

Water-borne Infection.—A common public means of transmitting communicable diseases is that by the agency of public water-supplies. Almost the only diseases which are spread by impure drinking-water are typhoid fever, dysentery, cholera, and other forms of intestinal disturbances. The source of disease germs in drinking-water is nearly always sewage or the excretions and discharges from human beings who are either sick or are carriers of disease germs. When a private water-supply is the cause of a disease, the source of the pollution may nearly always be found by an inspection of the houses and ground within a few hundred feet of the source of the water. A chemical and bacteriologic examination of a water-supply will reveal the presence of small quantities of sewage and of harmless germs from the human intestine when they are present in extremely small amounts before the disease germs, which are usually less resistant than the harmless living germs, can enter the water. If the common intestinal germs are present in water, it would be possible for germs of intestinal diseases to have entered it also.

Water-borne diseases were formerly common, but they are now becoming rare on account of the supervision over water-supplies, and of the installation of efficient sewage disposal plants.

A health officer is charged with the duty of supervising public water-supplies. If a water-supply is impure, it is the duty of the health officer either to secure a wholesome supply or to warn the people of the dangerous condition of affairs and to instruct them how to make their drinking-water safe. Boiling an impure water is the simplest and most efficient method of killing disease germs in it.

If an epidemic is water-borne, it will break out rather suddenly and will be confined to the district which is supplied by the water, and will affect persons of all classes who drink the water, regardless of their other actions or associations. Most public water-supplies are now supervised by the health departments of states and cities.

Milk-borne Diseases.—Communicable diseases are frequently transmitted by means of milk. The cow disease which is most likely to be transmitted to human beings by means of milk is tuberculosis. Nearly all other kinds of disease germs that are found in milk are put into it by human germ producers or carriers among the dairymen and milk dealers. The disease germs may multiply in milk, and this is almost the only natural culture-medium in which a multiplication of disease germs takes place outside of the body. This peculiarity of milk makes it necessary for a health officer to maintain an efficient inspection of milk-supplies. The means of safeguarding milk supplies are: 1, the control of all cases of communicable disease and of carriers on milk farms and among milk dealers; 2, inspection and sanitary control of dairies and creameries; 3, the pasteurization of milk that is sold.

The diseases which the New York State Department of Health considers milk likely to carry are cholera, diphtheria, epidemic sore throat, epidemic cerebrospinal meningitis, scarlet fever, typhoid fever, and smallpox.

Milk-borne epidemics are becoming more frequent owing to the increased complication of the manner of handling milk. A single diseased person on one of the farms which is producing milk for a large milk dealer may be the means of spreading disease germs through the whole milk-supply, and of causing an epidemic of dozens or hundreds of cases. A milk-borne epidemic may be recognized by its being confined to persons who take milk from a particular dealer, by the sudden development of a number of cases at once, and by the subsidence of the epidemic when the milk is stopped or the supply is pasteurized.

Food.—Other foods than milk may transmit diseases when they are prepared, or served, or handled by some one who is a carrier of disease germs. The list of diseases which are transmitted by milk will apply to those transmitted by other foods. In addition to these, human beings may get trichinosis by eating the meat of hogs that had the disease. Preventive measures against food-borne infectious diseases is through cooking, and the exclusion of infected persons from all places in which food is handled.

Insect-borne Diseases.—Insects that bite may introduce disease germs into the body by means of their bills which pierce the protecting barriers of epithelium. The principal diseases which are produced by biting insects are malaria and yellow fever by mosquitoes, typhus fever by lice, and plague by fleas. It is probable that bedbugs and any other biting insects may also carry disease germs and introduce them into the body, especially since they infest dirty persons who are likely to be diseased.

House-flies are often carriers of disease germs which adhere to their bodies when the flies crawl over filth. Flies are accidental carriers of disease germs. They would not have disease germs on their bodies if human beings had no garbage heaps or foul collections of excretions on which the flies can crawl. House-flies do not bite or scratch, and so they do not introduce the germs directly into the body, but they leave them on food on which they alight, and on the mouths and eyes of babies. The principal fly-borne diseases are typhoid fever, infantile diarrhea, and infections of the eyes.

Air-borne Diseases.—It was formerly thought that nearly every communicable disease was air-borne; but experience and scientific investigations prove that the air is almost entirely free from disease germs, except the foul air of very close and dirty rooms. Even in foul air the disease germs are usually associated with gross particles of matter which may be seen. Most infective particles in the air consist of moist droplets of mucus and saliva, but dry dust may also contain living bacteria of disease under favorable conditions.

Disease germs usually die when they are dried, but they may remain alive for a few minutes or hours. When a crowd gathers in a close room, some diseased person is likely to spit on the floor. The sputum may quickly dry, and its dust may be scattered through the air before the disease germs have time to die. The dust in the air of that room is very likely to contain living disease germs. Any dust which has been recently made from human excretions may contain living disease germs. Such dust may often be found in the foul air of close, crowded rooms, especially if the persons in it are dirty and careless.

Foul odors are popularly supposed either to cause diseases or to indicate the presence of disease germs. A foul odor usually indicates the presence of a putrefying substance. But putrefaction usually takes place only in the presence of an abundance of moisture, and neither disease germs nor bacteria of any kind pass into the air from moist surfaces. Even sewer-gas is nearly always free from living organisms and cannot produce an infectious disease. The principal significance of foul odors from the standpoint of public health is that they may indicate the presence of human excretions, or of decomposable matter in which house-flies may breed.

Drafts of air in a warm room are often supposed to produce colds, sore throats, and pneumonia. Drafts themselves cannot produce a cold or other infectious disease unless disease germs enter the body. Drafts are especially noticeable in hot, close rooms, but in them disease germs, which are likely to be present, are sufficient to account for a sickness which may seem to have been caught from the air.

Drafts have some effect on the body at critical times, and may disturb the balance between the invading disease germs and the resisting forces of the body so that the disease germs may obtain a slight foothold and produce the mild diseases which we call colds. But any other influence that weakens the body, such as overwork or indigestion, may act upon the body to weaken it as a draft does. Colds are caught in hot, close rooms without drafts as frequently as they are in drafty rooms. There is very little scientific knowledge of the effect of drafts on the body, for it is almost impossible to conduct experiments in which all the various conditions that exist in close, drafty rooms may be estimated and controlled.

Wet feet and damp clothes are also supposed to produce colds and other respiratory diseases; but the evidence that they do so is as unscientific as the evidence that drafts produce disease.

Climate and Weather.—Physicians formerly supposed that the climate and the weather had a dominating influence on health, and was an efficient means of producing colds, pneumonia, and other respiratory diseases. That theory has been almost entirely abandoned except its application to tuberculosis. Even in tuberculosis, factors which are controllable have a far greater influence than the climate and weather. When weather conditions are unfavorable, most persons remain indoors as much as possible where there are abundant opportunities for infection from dirt, foul air, and close contact with diseased persons. Colds and all other forms of communicable diseases are more prevalent in winter than in summer largely because in winter people remain indoors where the opportunities for infection are manyfold greater than they are out of doors.

Carriers.—It would be expected that a knowledge of the nature of communicable diseases and of their transmission would enable a health officer to prevent the development of all communicable diseases by the efficient control and treatment of every effected person. Health officers probably would be able to eradicate contagious diseases if they could know of the existence of every case. But refined methods of diagnosis, especially those of the laboratory, have shown that many persons in good health produce disease germs in their bodies. These persons mingle freely with others without taking precautions against the spread of the germs. Well persons who produce disease germs are called *carriers*. Persons who have a communicable disease in such a mild form that they continue to mingle with other persons as usual, are also classed as carriers.

Disease germs in carriers are found in at least three locations: 1, in cavities, such as the gall-bladder and the crypts of the tonsils; 2, in the outer layers of the epithelium; 3, in abscesses, running sores, and discharging ears. In all these locations the germs are outside of the flesh and blood, and yet in a position in which the conditions of food-supply and warmth are favorable to their growth.

Most persons who are carriers are themselves proof against the disease. The defensive forces of their bodies are principally in the blood, and are able to overcome the germs wherever the blood flows. Blood is absent from the cavities of the body and from the outer layers of epithelium. Disease germs may therefore grow in these parts of the body without being able to penetrate the flesh, or they may persist there after the blood has overcome them in the flesh.

The principal diseases which are spread by carriers are diphtheria, typhoid fever, scarlet fever, and epidemic cerebrospinal meningitis.

The number of carriers in a community is often considerable. Diphtheria carriers may probably be found in every village, and during an epidemic of the disease the number of carriers may be several times greater than the number of persons who are known to be sick with the disease. About 1 per cent. of persons who have had typhoid fever continue to produce germs of the disease for weeks or months after their recovery.

When an epidemic of a disease occurs, there is likely to be a number of mild cases in whom the signs of the disease are vague and uncertain, or even almost absent. For example, many cases of sore throat are caused by unsuspected diphtheria or scarlet fever, and many stomach aches are due to unsuspected typhoid fever. Carriers and missed cases account for the infection of a very large proportion of those who have communicable diseases.

The danger from a carrier is the same as the danger from a person whom the germs have made sick. Carriers usually produce fewer germs than the sick, but the lesser danger on account of the number of the germs is counterbalanced by the freedom with which carriers mingle with other persons.

The virulency of the germs in carriers is sometimes less than the virulency of germs in persons who have a disease in a severe form, but sometimes it is fully as great. A deadly form of scarlet fever is sometimes caught from a person who has had the disease in an extremely mild form. The virulent strain of diphtheria germs which are used by the New York City laboratories was originally taken from a person who had only a mild sore throat.

Diphtheria carriers constitute the greatest number of carriers with whom a health officer has to deal. The danger from these carriers depends largely on whether or not the germs are virulent. The virulency of the germs may be determined by injecting a culture of the germs into a guinea-pig or other animal, and noting their poisonous effects. If the test shows that the germs are not virulent, the carrier is not considered to be dangerous.

The duty of a health officer is to discover carriers whenever he possibly can do so. His further duty is to control them so far as may be necessary. A health officer can choose between two measures: 1. He can subject carriers to quarantine and other procedures which are enforced against persons who are actually sick. Experience has shown that this extreme degree of control is seldom necessary or practical. 2. A health officer can advise the carriers concerning the nature of their trouble and the means of preventing the germs from spreading to others, and he can keep them under supervision to see that they observe his advice. This is the proper method to adopt when the carrier is a reliable person.

The means of freeing carriers from their disease germs will be discussed in the description of the individual diseases.

How to deal with carriers is one of the greatest problems which confronts a health officer. Carriers are not sick, and they often resent any interference with their liberty. The detection of disease germs in their bodies is usually made by a laboratory test which the carriers cannot understand. They often ascribe measures of control to personal animosity on the part of the health officer. It is difficult to make people realize the danger from carriers, for they do not see how disease germs can grow in the body when the ordinary signs of sickness are absent. The control of carriers will remain unsatisfactory until people become educated concerning the problem.

What measures can the people take to protect themselves against the uncontrolled carriers which are in every community? The answer is that an observance of modern standards of cleanliness, decency, and the rules of polite society are usually efficient protections against infection. For example, typhus fever was common in the days when a louse on the body was considered no more of a disgrace than a fly is today. It disappeared when people began to consider it a disgrace to be lousy. People are fairly well protected from infection when they observe cleanliness of their persons, houses, and yards, and practice the customs of polite society regarding the contact of one person with another.

Contacts.—When persons have been exposed to communicable diseases, it is often a problem what control to exercise over them from the time of exposure until the onset of the sickness. Many cannot tell whether or not they have actually been exposed, and many who have been exposed do not contract the disease. The health officer will make his decision according to the following principles:

1. Immune persons who are not carriers may be dismissed from supervision.
2. Non-immune persons may be allowed their freedom up to a day or two before the expiration of the shortest period of incubation of the disease.
3. If necessary a culture shall be taken or a serum test made in order to determine if the exposed person is a carrier or has had the disease.
4. A protective serum or vaccine shall be given if possible.
5. The exposed person shall report to a physician or the health officer upon the first signs of sickness.

Procedure of Investigation.—If there is an epidemic in a community, a health officer or epidemiologist will investigate and control it by certain standard methods of procedure, which are: 1, to discover all the cases; 2, to obtain uniform data from each case; 3, to analyze the data in order to determine the source of the infection; 4, to apply the remedy.

Finding Cases.—The first duty of a health officer in the suppression of an epidemic is to discover all the cases of the disease in his jurisdiction. The probability is that physicians report only those cases which are well marked; that many mild cases go undetected; that many cases have no doctor call to see them; and that there are a number of carriers who have not been sick at all. It is the duty of the health officer to discover as many of the mild, missed, and carrier cases as possible.

One of the reasons that epidemics develop is that they usually begin with cases which are mild and do not resemble well-marked cases. For example, smallpox now usually gives only mild symptoms, and the eruption only partially develops as compared with the virulent form of the disease of years ago. The epidemic is usually well under way before the disease is recognized.

One of the first things which a health officer will usually have to do in the presence of an epidemic of one of the rarer diseases is to instruct the physicians in the methods of recognizing the disease. He will endeavor to retain their goodwill and respect. He will not chide them for ignorance, but will explain to them the new and unfamiliar forms which diseases assume in the new conditions of modern civilization. He will also explain to them the use of modern methods of diagnosis, such as lumbar puncture in poliomyelitis. When the physicians are all educated in the recognition of cases, and are willing to co-operate with the health department and report all their cases, the health officer may feel that he has laid a sure foundation for the suppression of the epidemic.

Another thing which the health officer must do is to make an inspection for the discovery of cases which are not seen by the physicians. There are a number of mild cases and of carriers in nearly every epidemic, and their presence explains the mysteriousness of the origin of many of the known cases. A public health nurse making a house-to-house canvass is a great aid in finding cases which have been missed or concealed. Rumors of cases and common gossip are clues which are worth following up, for they lead to the detection of many cases which otherwise would not be discovered.

Uniform Data.—The second step in the investigation of an epidemic is the collection of answers to uniform questions which are put to each sick person. The object is to obtain a history of the person extending backward beyond the possible time of receiving the infection. The questions will vary according to the disease that is under investigation, but they will be along the following general lines:

1. Personal history, name, address, age, and sex.
2. Date of onset of the sickness.
3. Contact with known cases.

4. Source of supplies of water, milk, groceries, green vegetables, and other foods that are eaten raw.

5. Places visited, and meetings, dinners, and other gatherings attended.

6. Visitors received.

7. Sanitary condition of the home and working place. A health officer will obtain this data from the reports of physicians, by the investigations of public health nurses, and by his own inspections. A health officer will need a considerable degree of skill and diplomacy in obtaining the data, and of judgment in judging the truthfulness and value of the information.

Analysis of the Data.—The third step in the investigation of an epidemic is to analyze the data in order to discover something in common with all the cases which will point to the source of the infection and the method of its transmission. The health officer will tabulate the cases according to the dates of their onset, their geographic distribution, their school attendance, their supplies of milk and water, and their association with previous cases. He will take into consideration the period of incubation of the disease, and will lay special stress on the actions of the cases at the time when infection most probably occurred. There may be a large number of possible sources of infection in each case. The source or route which is common to all, or to a considerable number, will probably be the principal source or route which the health officer will have to control. The original source of infection may be evident from the outset of the investigation, or its detection may require a high degree of skill and judgment, especially in those diseases which are spread by contact. The details of the methods of investigation will vary according to the nature of the epidemic. They will be enumerated in the discussion of each disease.

Two valuable devices in investigating and reporting an epidemic are the graphic chart and the spot map. An excellent form of chart is that in which the number of cases developing during each day or week or other period of time is indicated by the height of a series of black columns, one for each period of time. Such a chart shows the progress of the epidemic and the results of the various methods for its suppression. The chart also has an educational value to the public, especially when explanatory remarks are printed on it. A model form of graphic chart is that contained in the New York State Health News for July, 1914, illustrating an epidemic of septic sore throat.

A spot map indicates the location of the individual cases by means of circles or disks. A line connecting each case with its source of infection shows at a glance the origin of the case, and the chains of secondary and tertiary cases that have developed from each focus of infection. Such a map is a great convenience in recalling the sources of the cases and in demonstrating their origin and the methods to be adopted for the control of the

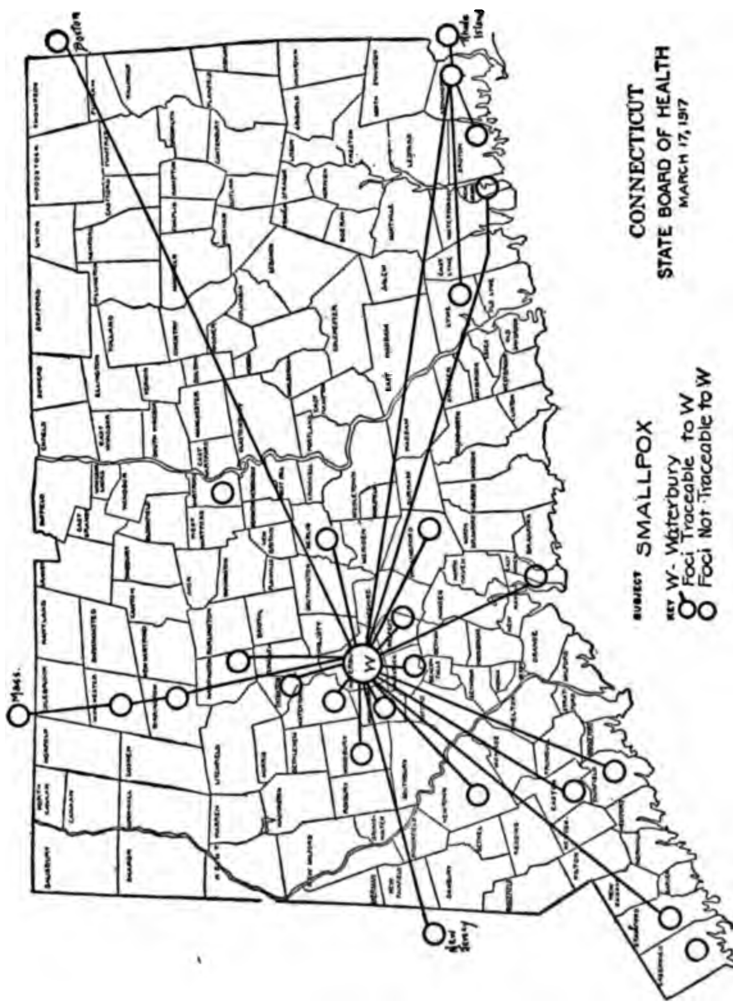

Fig. 2.

epidemic. A good example of a spot map is that in the monthly bulletin of the Connecticut Board of Health for March, 1917, illustrating the spread of smallpox from a single center.

Control of an Epidemic.—When a health officer has discovered the cases in an epidemic and has determined the modes of their transmission, the method of controlling the disease will be evident. It may be extremely simple, as, for example, the exclusion of a person with a sore throat from a dairy; or it may be extremely difficult, especially when the disease is spread by

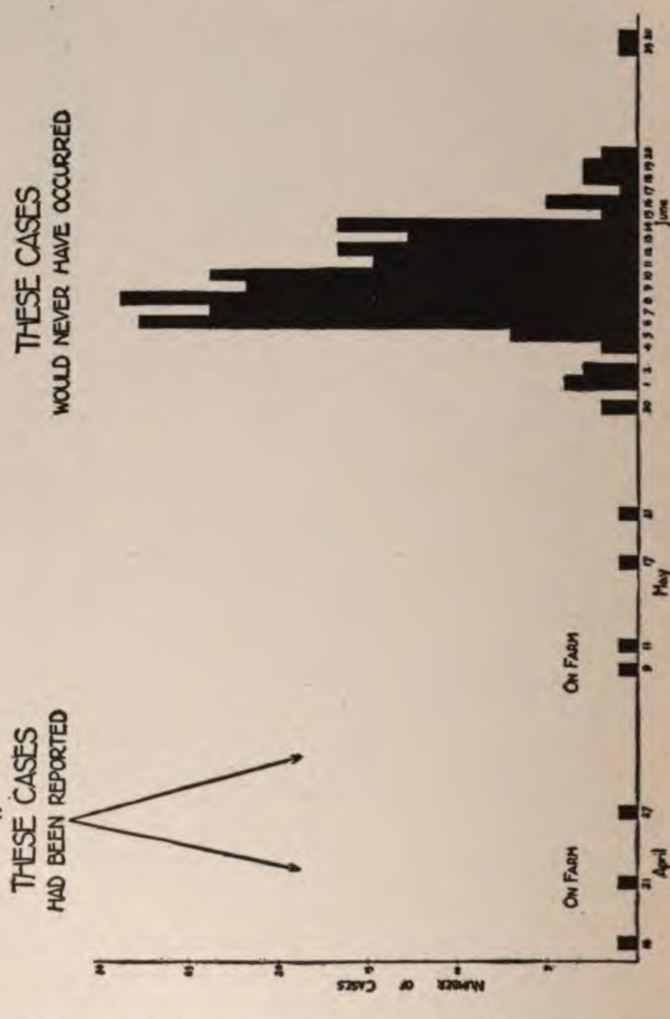

Fig. 3.—The story of an epidemic of septic sore throat.

contact with carriers. The control of an epidemic, like that of a fire, is easy at the beginning, but is hard when it has produced a number of mild cases and carriers which are difficult to discover. The time to begin active measures for the discovery and suppression of a contagious disease is when it first appears.

CHAPTER XVII

THE MANAGEMENT OF A CASE OF COMMUNICABLE DISEASE

Duties of a Health Officer.—The law charges a health officer with the duty of protecting the public against communicable diseases. A former interpretation of the duty was that it meant principally the maintenance of a forcible quarantine of well-defined cases. It is now interpreted to include the diagnosis of suspicious cases, the discovery and control of contacts, and giving expert advice regarding the treatment of the sufferers. Diagnosis and treatment are often considered to be the exclusive rights and prerogatives of family physicians. But many sick persons do not call physicians, and many physicians are unable to give their patients the benefits of the best methods of treatment without the assistance of the health department. It is the duty of the health officer to assist the family physician in the diagnosis and treatment of infectious diseases. The jealousies and disputes which frequently arise between health officers and family physicians might be avoided if every health officer had the knowledge and skill which entitle him to recognition as a specialist in communicable diseases and in other lines of public health work.

Discovery of Cases.—A health officer learns of the existence of cases of communicable disease in three ways: 1, by the reports of physicians; 2, by the reports of laymen, including teachers, parents, and other persons in authority; 3, by means of his own investigations and those of the State Department of Health.

1. The laws of the states usually require physicians to report cases of communicable diseases to which they are called. Some physicians interpret the laws to mean that they shall report only those cases in which they are sure of a diagnosis. But many cases cannot be surely recognized until laboratory tests are made or until the disease is fully developed. Physicians frequently delay their reports for some days during the early stages of a disease when it is most infectious; or else, in mild cases, they delay until the symptoms subside and a diagnosis is impossible. The intent of the law is that a physician shall report every case as soon as he has a well-grounded reason to think that it may be one of a communicable disease.

The health officer is usually the official diagnostician of the local health organization, and the family physician has a right to demand that he assume some of the responsibility of diagnosis. If the health officer is not an expert, the best way to compel him either to become one or to resign his office is for family physicians to insist that he assume his share of the responsibility in the diagnosis of every reported case. This means that the health officer must see and examine every case of the more important diseases. If he does this, he will not only aid the physicians, but he will also be able to obtain a full knowledge of conditions in the home, and to adopt measures that will most effectively protect the public, and at the same time will be least irksome to the members of the afflicted family. If the health officer makes no comment unfavorable to the family physician, but discusses the case freely with him in private, there will be little opposition to his visits. In New York City an expert diagnostician examines every reported case of a major communicable disease.

Physicians often refuse or neglect to report cases because they wish to protect the family from annoyance. They argue that the first duty of a physician is to promote the comfort and peace of mind of the persons who employ them. Some physicians seem to think that their only duty is to their employers. But every physician owes a duty to the state which gives him a monopoly of the practice of medicine. The people look to private physicians for protection against pestilences. The Sanitary Code of New York State requires every physician to instruct his patients in the methods for preventing the spread of diseases. If a physician gives this instruction, there will be no occasion for undue interference by the health officer.

2. A second method of discovering cases is by following up reports that come to the health officer from teachers, nurses, parents, and others than physicians. There are great numbers of mild cases to which no physicians are called. These missed cases are the means by which communicable diseases are usually spread through communities of intelligent people, for the severe cases are in bed and do not mingle with other persons.

Some persons deliberately neglect to call a doctor to mild cases of contagious disease because they fear that they will be quarantined. Drastic methods of quarantine may promote this feeling, but the fear of the health officer is disappearing with the institution of rational procedures of isolation, and with the spread of popular knowledge of the dangers which come from neglected mild cases of communicable disease. The New York State Sanitary Code provides penalties for the failure of parents or others in authority to report communicable diseases among those under their charge.

Common gossip and rumors are prolific sources of information regarding the existence of cases of communicable disease. A health officer neglects his duty if he fails to follow up these rumors. He will find it extremely embarrassing later to deal with an epidemic whose source is a neglected case which was known to everybody except himself.

3. Health officers must often make systematic investigations to discover unsuspected cases of communicable disease, especially during epidemics. The importance of mild and walking cases of infectious diseases is becoming more and more recognized. The refinements of modern diagnostic methods and tests render possible the early detection of nearly every case.

One of the most efficient agents in the discovery of mild cases is the public health nurse. Her information may be obtained through the schools or by house-to-house visitations. She will often obtain information from neighbors when members of afflicted families try to conceal cases. Her tact and persistence will enable her to secure information where the health officer would perhaps fail.

A health officer is deeply concerned with discovering the source of every case of communicable disease. Each case has an ancestry that extends backward in time like an ancestral line of parents and grandparents. Its source is a previous case of the same disease. It may sometimes be traced to a lower animal in a few diseases, such as in rabies, anthrax, and the bovine type of tuberculosis; but the parent case is nearly always that of a human being. The source of the disease is a previous case even when the disease is traced to water or sewage or filth, for these things produce communicable diseases only when they receive germs from afflicted persons. When a communicable disease makes its appearance, a health officer knows that it has a recent case for a parent, and that he is likely to find other cases with the same parentage.

When an epidemic occurs in a community, it is a great problem for the health officer to discover the living persons who are spreading the germs of the disease. These disease spreaders are usually either persons who have had the disease in a mild, unrecognized form, or who are carriers of the germs (p. 177). It is important that a health officer should be familiar with the signs of mild cases and of those which have apparently recovered in order that he may recognize and control them.

Means of Diagnosis.—It is the duty of a health officer to secure a diagnosis of every suspected case of communicable disease, for the final decision rests with him. If he cannot make the diagnosis, he must know where and how he can have it done promptly and accurately. The diagnosis of the family physician will be accepted in most cases, but if he and the health officer cannot agree, they can prevent ill feeling and promote satisfaction and co-operation by leaving the decision to a third physician in whom both have confidence, or they can appeal to a member of the staff of the State Department of Health.

A health officer can nearly always secure the assistance of an expert diagnostician from his State Department of Health. Since an obscure disease in a rural district may be a menace to the people in the cities, a health officer in an emergency can usually obtain the services of an expert from the nearest large city.

A physician is sometimes inclined to yield to the wishes of a family and to pronounce a disease to be non-contagious unless it has all the classic symptoms of the disease. The health officer may prevent embarrassment and ill feeling in such a case by asking the family to produce the written statement of the family doctor that the patient cannot give the disease to another person. A physician will not be inclined to give such a statement. If a physician says that there is no proof that a patient has a communicable disease, the health officer may rightly answer him by requiring him to give proof of the absence of disease.

The diagnosis of many communicable diseases is made with certainty only by means of laboratory tests. A health officer is not expected to be able to perform the tests, but he is expected to know how to secure the material on which the tests are made, and where to send the specimens. The New York State Laboratory supplies the health officers with outfits for taking material for tests in about a dozen diseases, and especially in diphtheria, typhoid fever, and tuberculosis. The procedures for taking the specimens are simple, and a health officer has no excuse for failing to make full use of the laboratory for obtaining diagnoses.

Preventive Measures.—After a case of communicable disease has been discovered and diagnosed, the next duty of a health officer is to prevent the disease from spreading to other persons. The American principle of personal independence does not allow a health officer to compel the observance of measures to prevent the spread of a disease through the family of the sick person; but American laws and customs prescribe that he shall prevent its spread outside the family. The preventive measures include: 1, the control of the sick; 2, the discovery and control of contacts; 3, the disposal of infectious material that comes from the sick person; and 4, the disinfection of rooms, furniture, clothing, and other things that are used by the sick.

Control of the Sick.—Since the source of the germs of human diseases is the body of a sick person, the most obvious measure for preventing the spread of a disease is to restrain the liberties of the sick, and to keep them away from other persons. The restrictive measures arranged in the order of their degree of restraint of liberty are: 1, hospitalization; 2, quarantine; 3, isolation; 4, modified isolation; 5, special restrictions.

Hospitals for Contagious Diseases.—The simplest method of controlling afflicted persons is to remove them to a special hospital for communicable diseases. This plan is economic in large cities where a supply of cases exists continuously, but it is not usually practical in the smaller cities and rural districts where cases are infrequent. Most health officers must allow their cases of communicable disease to remain at home. It is a troublesome and difficult problem for a health officer to impose extreme restrictions on sick persons in their own homes without subjecting them and the members of their families to great inconvenience.

Quarantine.—The greatest degree of home control and restraint is the quarantine. It requires that the patient and all those living in the house or apartments with the sick person shall remain on the premises, and that all other persons, except the physician and nurses, shall be excluded. It is directed not only against the sick person, but also against the well members of the family who happen to be at home, and against the house and premises. The method of control by a strict quarantine is crude and often cruel, and is usually unnecessary. Yet it may be efficient, and is the simplest and easiest of all the methods of control. It is the method of brute force, and would be naturally adopted by a health officer who is ignorant and lazy, for all that he needs to do is to post a policeman at the premises, and to give an order on a storekeeper to supply the necessities of life to the imprisoned household. Still, this form of a strict quarantine is often necessary when the members of the family are rebellious and refuse to follow the directions of the health officer. It may also be necessary in controlling those diseases whose causes are not definitely known. The list of diseases in which strict quarantine may be necessary includes smallpox, typhus fever, yellow fever, plague, and cholera.

Isolation.—Another method of separating the sick from other persons is called *isolation*. It requires (1) that the sick person and the nurse shall remain in a room that is separate from the rest of the house; (2) that no other person, except the medical attendant and nurse, shall enter the room, and (3) that everything which leaves the sick room shall be properly cleansed and made free from disease germs. It is a quarantine of the sick person in his room while the adult members of the household who are well are allowed their freedom, provided they do not handle food or come in close contact with children. This method of controlling an infected person requires that the members of the isolated family have a considerable degree of intelligence and reliability, and are willing to follow directions. If the people are uncleanly or unreliable, the health officer will have to give them the choice of obeying his instructions or of submitting to a strict quarantine of the house and all the members of the family.

If isolation is imposed on a person who has a communicable disease, the health officer must tell the family what to do and what not to do. He must visit the home more than once, for few persons will remember or grasp all the directions which he will give unless he repeats or demonstrates them. It is the duty of the family physician also to give these directions, but the health officer is responsible that they are carried out, and he must see that the household receives them. Many sick persons have a physician only once or twice, and in these cases it is certainly the duty of the health officer to see that the directions are carried out.

The list of diseases in which the method of control by isolation of the sick may be followed includes scarlet fever, diphtheria, cerebrospinal meningitis, septic sore throat, and measles.

Modified Isolation.—A strict isolation is not usually necessary in pneumonia, typhoid fever, paratyphoid fever, and dysentery. The restrictive measures that are necessary in these diseases are that—

1. Well members of the family do not come into close contact with the sick.
2. The proper disposal of the excretions of the sick is carried out.
3. A high degree of cleanliness of the sick person and of the whole household and house is observed.

A modified form of isolation may also be permitted in the minor communicable diseases, such as German measles, chickenpox, mumps, and whooping-cough. The restrictive measures in these diseases are:

1. The sick shall remain on their home premises.
2. Those persons who have not had the disease shall be excluded from the premises.

Special Restrictions.—Some diseases are not likely to spread unless the sick come into close association with well persons or their fresh excretions, as by sleeping in the same bed, using the same toilet utensils, or eating from the same spoon. A person sick with one of these diseases may be allowed to mingle with other members of the household, or with the public, provided the special rules which are necessary for that disease are followed. Tuberculosis is an example of a disease in which freedom in most respects may be allowed to a patient provided that special precautions adapted to the individual are observed.

Discovery and Control of Contacts.—Persons who have not had a disease and have been closely associated with a case are called contacts, and are to be considered as in danger of coming down with the disease. It is the duty of the health officer to discover these persons and to inform them of the possibility of their having contracted the disease, and to keep them under observation during the period of its incubation. If they have left town, it is his duty to inform the health officials of the municipality to which they have gone. The health officer must be the judge of the likelihood of their being infected, and of the degree of restriction that must be imposed on them.

Those who have been in close contact with a case of communicable disease and have not taken the precautions to cleanse their hands and clothing, may carry disease germs on their persons, although this danger is not nearly so great as was formerly supposed.

Special precautions are taken with children living in the house with an isolated person because (1) they are much more susceptible to most diseases than adults, and (2) they do not have sufficient knowledge and experience to carry out the health officer's directions of their own accord. Well children who are contacts and who have not had the disease, must be held under some degree of isolation and control during the period of its incubation in order to be sure that they do not come in contact with others if they come down with the disease. They may be allowed to go to the house of a relative or friend where there are no children, provided they are isolated there. Child contacts who have had the disease may be permitted to have their freedom, provided (1) that they take a full bath; (2) that they put on clean clothes, and (3) that they leave the premises of the sick person and remain away during the whole period of isolation.

Conduct of an Isolation Period.—In choosing a room for quarantine or isolation, select one that is large, light, and airy, and, if in winter, make provisions for warming it. If there is one person whose sole duty is to care for the patient, the room had best be up stairs and as far removed as possible from the kitchen and living room. If the mother must care for the patient and also do the housework, the sick room had best be on the ground floor, while the other members of the family use the up-stairs rooms.

Remove the carpets, window hangings, clothes, and unnecessary furniture from the room. Cover the floor with old newspapers, and use bed covers that can be washed. Provide a wash bowl, towels, comb and brush, and other toilet articles for the exclusive use of the patient, and another set for the attendant. Provide the patient with newspapers, toys, and books that can be destroyed at the end of the isolation period. Have an abundance of small squares of muslin torn from old sheets or other discarded muslin, for use instead of napkins and handkerchiefs, and provide paper bags or newspapers for wrapping them up before taking them away to be burned.

Instruct the nurse or attendant to wear a special cap and gown in the sick room, and to wash her hands every time she touches the patient or his excretions. Instruct the attendant to keep her fingers away from her own mouth and nose.

Disposal of Excretions.—Nearly all the germs that escape from the bodies of sick persons will be found in their discharges and excretions. Anything that is soiled by them may also contain the germs. The principal discharges and excretions which require attention are those from the nose and mouth, those from the intestine and bladder, and those from sores on the skin. The breath is free from disease germs except when it bears tiny drops of saliva or mucus which are expelled by violent acts of breathing, such as coughing or loud talking. The vapors that pass off from the skin do not contain disease germs. The touch of an unbroken skin cannot cause a disease unless the skin is dirty and soiled with the excretions of the body.

A simple method of disposing of the discharges from the nose and throat is to receive them upon paper napkins or rags which are to be burned; or upon handkerchiefs which are to be boiled and then washed. Warn the sick persons and their attendants against spitting on the floor or walls, or anywhere else than into containers for the sputum.

A simple method of disposing of the discharges from the bowels and bladder is to bury them at once in the back yards. Dig a hole about 2 feet square and deep. Empty the discharges into it and cover them with a few inches of soil. Such a hole may be used for several days until it is nearly full. Do not empty the discharges into an ordinary water-closet unless it has an underground vault which is tightly closed against flies and vermin. It is usually safe to empty the discharges into a public sewer, or into a cesspool that is properly located and covered. Scald the vessel with boiling water after emptying it.

Disinfection.—Three natural disinfecting agents on which the health officer depends are sunlight, fresh air, and dryness. Disease germs are plants which flourish in darkness and dampness. Very few kinds can survive upon curtains, windows, and smooth walls that are exposed to the light and air. A wise health officer will direct that a sick room be kept well ventilated, and that it be filled with as much sunlight as will be comfortable for the patient.

Cleanliness.—Three artificial agents for disinfection are cleanliness, heat, and chemicals. Whatever is soiled with the discharges from the body of a sick person may contain germs of disease, and so the things which the sick person uses might transmit the disease unless they are cleansed. The danger consists in the presence of living germs and not of the dirt itself. Disease germs as well as dirt will be removed by the use of soap and water, the scrubbing-brush, and the wash-tub. A fundamental condition on which a health officer will insist is cleanliness. This includes cleanliness of the body, especially of the hands and face; of the bed-clothing, bedding, dishes, and everything else in the sick room; and of the attendants as well as the sick persons.

Heat is the most reliable and efficient disinfecting agent that we have. It is also one of the cheapest and most easy to apply. A boiling temperature, 212° F., will kill most disease germs in a few seconds. If only a small quantity of boiling water is poured over articles, the water will be cooled and the temperature of the disease germs will be much lower than that of boiling. A temperature of at least 140° F. is needed to kill ordinary disease germs. The highest temperature which a person can usually endure with the hands is only 120° F. A safe order which a health officer may give is to direct that dishes, towels, handkerchiefs and bed-clothes, and all other articles in common use shall be boiled before they are washed. After they have been boiled, they will be free from disease germs, and may be put with the household articles that are used by the other members of the family. A good method of applying heat is to keep a large kettle of hot water boiling on the kitchen stove, and to place in it all small articles, such as knives, forks, dishes, and napkins, as soon as they are taken from the sick room. Laundry articles may be placed in a wash-boiler in the sick room, and then boiled at once on the kitchen stove.

Chemicals.—Chemical disinfectants are great aids in destroying disease germs, but they cannot entirely take the place of cleanliness and heat. They may be unnecessary if a high degree of cleanliness is observed, but yet it is well to use a chemical disinfectant in the water which is used in cleansing.

Formaldehyd is an excellent disinfectant for household use in a communicable disease. It is the least poisonous of the common disinfectants, and the least harmful to clothes and metals. A 2 per cent. solution is to be used in washing the hands and in scrubbing floors and furniture. Soiled clothes may be soaked in a pail of this solution.

It is a good plan for the health officer to have a large supply of formaldehyd on hand, and to deliver a quart to each family in which there is a communicable disease. The disinfection is for the benefit of the public as well as of the afflicted family, and it is therefore proper that it should be provided at public expense to those who cannot well afford to buy it.

Other good disinfectants are chlorid of lime, bichlorid of mercury, and substances belonging to the carbolic acid and cresol groups. It is the duty of the health officer to give specific directions for the preparation and use of each kind of disinfectant that he orders.

Terminal Disinfection.—If the proper care is taken continuously during the course of a sickness, there will be no disease germs left in the sick room at the end of the disease. But in order to make sure that all the disease germs have been destroyed a health officer will require that the room and its contents shall be disinfected before the sick person is released. There are three common methods of disinfection: first, a thorough housecleaning; second, scrubbing with a disnifectant; and third, fumigation with a disinfectant. A health officer seldom has the facilities for doing a thorough fumigation; and if it is not thoroughly done it leads to a false idea of security. But a health officer can always get a thorough housecleaning done, and can have a disinfectant added to the water which is used. A liquid disinfectant rubbed upon the floors and furniture is far more effective than a gaseous one blown upon them.

Personality of the Health Officer.—A quarantine or isolation usually requires that the ordinary home life be upset. The details of the isolation will often depend on the arrangements which the health officer and attending physician can make with the family. Each case must be judged by itself, and due consideration must be given to the character, personal habits, occupation, and financial means of the wage-earners. Imposing an isolation or quarantine requires tact, diplomacy, and good judgment on the part of the health officer. If he is imperious in his manner and loud voiced in his talk, he is sure to arouse antagonism, and to encourage the concealment of cases and the evasion of restrictions. He must be willing to devote a considerable time to educating those who are subjected to his orders, and to take the trouble to explain the reasons for the particular restrictions which he imposes.

Methods of Legal Procedure.—The restrictions upon a person who has a communicable disease are serious legal procedures in which the health officer is the prosecuting officer, the chief witness, and the judge. A health officer deprives a person of his liberty without going through the slow form of a trial; but the quarantined person may appeal from the decision and bring a court action for illegal detention. The health officer must be prepared to show, first, that he complied with the forms of law in all his acts; and second, that the evidence was sufficient to have led a judge of a court to impose the restrictions if the case had originally come before him for trial.

The legal procedures which a health officer must follow in the control of a case of communicable disease are: 1, securing evidence of disease; 2, informing the sick person or the family regarding the preventive measures; and 3, supervising the control of the disease during its whole course.

Diagnosis.—The evidence of the existence of a communicable disease will usually consist in the report of the family physician; but it may be supplemented by his own examination and that of an expert diagnostician, and also by the examination of a specimen in a laboratory. If this evidence proves the existence of disease, the health officer may impose the proper restrictions without fear. If the evidence is insufficient or obscure, the health officer cannot legally compel the observance of the restrictions unless his Board of Health especially authorizes him to apply them in suspicious cases; but it is his duty to inform the family of his suspicions, and to advise them regarding the protective measures to adopt while a decision is being reached.

Imposing Restrictions.—The second formal procedure which a health officer must take to make the restrictions legal is to make a proper record and report of the case, and to inform the afflicted persons of his decision and tell them exactly what they must do. This action is similar to that of sentencing a prisoner in a law court. Troubles with quarantines and isolations frequently arise from a failure of those affected to understand what is required and the reasons for the requirements. A health officer must usually spend a considerable time in giving detailed directions in each case of communicable disease. Many departments of health require health officers to give each afflicted person a printed pamphlet which describes the measures to be followed in his disease. Most boards of health require a health officer to post a placard informing the public of the existence of a contagious disease in a house. This notice is necessary in order to relieve the quarantined persons of responsibility if any one enters the house without their knowledge. It also serves as a formal notice to those quarantined that they must obey the law.

Supervision.—A third legal procedure is the execution of the judgment or sentence. It is the duty of the health officer to supervise the restrictions during the whole period in which they are in force. He may leave the details of this duty to the family physician, or to the public health nurse, or to an inspector, or he may receive frequent reports from some member of the family. Misunderstandings, quarrels, and lawsuits often develop from a failure of a health officer to inform afflicted persons of the course of the disease, and of the varying restrictions that are needed. A wise health officer will make every effort to secure the intelligent co-operation of all the members of the family who are under quarantine or isolation.

Restrictions are usually imposed for an indeterminate period, and a release depends not only on the recovery of the patient but also on the absence of disease germs from the patient and from everything around him. The health officer is the judge of the time for release, but many health boards fix minimum periods for the continuance of the restrictions in each disease. The health officer may accept the evidence and the opinion of the family physician, but the final permission for the release from restrictions lies with him and not with the family physician.

Since persons under restriction for a communicable disease may be deprived of their means of livelihood, it is a principle of law that the public shall supply them with food, fuel, and other means of subsistence that are needed.

If a person refuses to obey restriction, the health officer may employ guards to enforce his orders, but if he does so, he must be doubly sure of his legal evidence. In extreme cases, a health officer may have to obtain a warrant for the arrest of an offender, and if he does, he must observe the forms of the law in all his acts. Most persons are willing and anxious to observe the rules and regulations of the Department of Health. A health officer has recourse to the law courts so seldom that he is likely to forget the forms of law, and to neglect some formal procedure which is necessary to make his acts legal beyond question.

Justices of the peace sometimes refuse to hear evidence against quarantined persons, fearing that they will catch the disease. A judge can hold court in any place that he pleases, and can conduct a trial on the sidewalk in front of a quarantined house as legally as he can in a court room. It is the duty of every officer of a court to give the health officer every possible assistance. The court officer is in no more danger than the health officer.

CHAPTER XVIII

THE MINOR COMMUNICABLE DISEASES

MEASLES

MEASLES is caused by an invisible virus which has been shown to pass through porcelain filters. The disease may be given to monkeys by the injection of blood from a person who has measles. The virus is also contained in the discharges of the nose and mouth, and may be conveyed to a distance of 4 or 5 feet by droplets expelled during coughing or sneezing. Measles is the most infectious of all the common diseases, and nearly all non-immune persons catch it after direct exposure to a person who has the disease. A lifetime immunity usually follows an attack of measles, but people often report that a child who has the measles has had the disease previously. Some

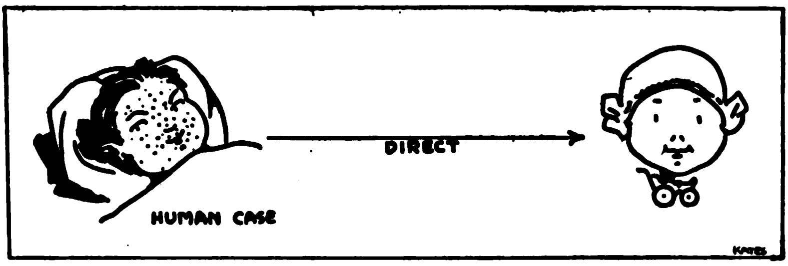

Fig. 4.—Method of transmission of measles, German measles, mumps, and chicken-pox.

people pronounce any marked skin eruption accompanied by fever to be measles. They frequently confound hives and German measles with measles.

Course of Measles.—The period of incubation after exposure to measles is about two weeks, but may be scarcely more than one week. The first symptoms of the disease are those of an ordinary cold in the head, and consist of sneezing, coughing, running nose, and red eyes. A fever is present within a few hours after the beginning of these signs. These indefinite symptoms last for four or five days, and then an eruption of red papules appears on the forehead, and soon spreads over the body. But an eruption on the inner surface of the cheeks usually appears on the second or third day after the signs of cold appears. This early eruption consists of Koplik spots, each of which is rose red, is about $\frac{1}{16}$ inch in diameter, and has a minute whitish center. They are usually few in number and are located opposite the molar teeth, but they may be abundant and confluent. They are best seen in strong daylight by pressing the cheeks open with a spoon handle. They usually disappear soon after the skin eruption appears.

The eruption on the skin lasts from four to six days, and is followed immediately by a fine desquamation of the skin. This desquamation is in contrast with that in scarlet fever, in which the desquamation appears after two weeks or more, and is coarse and often consists of sheets of skin.

Complications.—Measles often produces pneumonia, kidney diseases, and earache and running ears, especially in poorly nourished children. These complications frequently cause death. More deaths in New York State are caused by measles than by scarlet fever. The disease is dangerous, and there is good reason for taking all possible precautions against its spread.

Management of a Case.—Measles is a reportable disease, and every case requires isolation from all persons who have not had the disease. The sanitary code of New York State requires the placarding of a house in which the disease exists. The period of isolation is seven days from the appearance of the rash, and until all discharges from the nose, ears, and throat have disappeared, and until the cough has ceased. The virus is not long lived, and strict cleanliness is sufficient to kill the germs that are given off from the patient.

Epidemiology.—Health officers often express their feelings of helplessness when they are confronted with an epidemic of measles. They usually expect an epidemic to continue until every child who has not had the disease previously shall have come down with it. But it is possible to control an outbreak by the application of modern methods for its suppression.

The prevention and control of measles are peculiarly difficult for two reasons: First, many persons neglect to co-operate with the health officer in suppressing the disease because they believe it to be more annoying than dangerous. Those who fear vaccination will often expose their children to measles in order that they may have the attack which it is supposed will certainly come at some time in their lives. Securing the co-operation of the public is the first essential procedure in suppressing an epidemic of measles.

A second obstacle in the suppression of measles is the difficulty of recognizing the disease during the first four or five days after its onset. This is the period when the germs are given off in the greatest abundance and most virulent form. Most cases are caught from children who mingle with their playmates during the period when their symptoms are those of a common cold. When measles is prevalent in a community, every child with an acute cold must be considered to be a possible case of measles, and an observational isolation in its home must be imposed.

Many cases of measles have no physician in attendance, and the health officer himself must make inspections or employ a public health nurse to make them in order to discover cases. The sanitary code of New York State requires householders and school teachers to report all cases with which they have to deal.

The measures for the suppression of an epidemic of measles may be summarized as follows:

1. Isolate every person who is known to have the disease.

2. Institute an observational isolation of every child that has signs of an acute cold, until the nature of the sickness is determined.

3. Take the temperature of every person that has suspicious signs. A rise in temperature of 1 degree is sufficient to require an observational isolation.

4. Employ a public health nurse to investigate suspicious cases, to visit the cases in isolation, and to instruct parents in the nature of the disease.

If an epidemic occurs among school children, closing the school will usually be both unnecessary and unwise, for the school will afford an excellent opportunity for the observation of the children and the detection of suspicious cases. There will be no danger of spreading the disease if those children who show evident signs are observed and excluded. The measures to be taken at school are:

1. Observe every pupil as soon as it arrives at school. If any child has signs of a cold, take its temperature and send it home if its temperature is 1 degree above the normal This may be done by the health officer, the school physician, the school nurse, or the teacher.

2. Investigate all absent children.

3. Exclude every non-immune child in the family in which there is a case.

If a health officer has the co-operation of the teachers, medical examiner, school nurse and attendance officer, and is himself active, he can readily control an outbreak of measles.

GERMAN MEASLES

Infectiousness.—Little or nothing is known about the micro-organism that causes German measles. The incubation period is from two to three weeks. The disease is caught by contact, and is rarely recognized except during epidemics. Cases that occur between epidemics are usually called plain measles. The eruption and sickness lasts about three days. The preventive measure consists in the isolation of the patient during the continuance of the rash.

Recognition.—There are few signs previous to the appearance of the rash, and seldom a marked sickness following it. The first symptom noticed is usually red spots on the face, followed quickly by their appearance on the body. The spots resemble those of measles, but they are likely to be somewhat darker in color. They are usually abundant, and are often so close together that the whole skin is red as in scarlet fever. A diagnostic sign of considerable value is an enlargement of the lymph-glands on the back of the neck, especially those immediately behind the ear. The recognition of the disease is often exceedingly difficult and even impossible, especially in the presence of an epidemic of another disease. Many cases of so-called scarlet fever without desquamation are German measles. If a supposedly scarlet fever case has an abundant rash and only a slight sickness, German measles may be suspected.

The sickness of German measles is mild, and the importance of the disease lies in its being confused with scarlet fever or measles. No harm to public health will come from treating German measles as scarlet fever or measles, but grave harm may result from treating either of them as German measles. The duration of the disease is short, and in case of doubt, the health officer can require an observational quarantine of the case.

CHICKENPOX

Infectiousness.—Chickenpox is a disease of childhood and youth. Some say that it never occurs in adults, but it does occur now and then. Its micro-organism is unknown, but is contained in the vesicles and dried scabs of the skin eruption and in the saliva and nasal mucus. The disease is readily communicated by contact. The incubation period is from two to three weeks. The preventive measure is the isolation of the patient until all the scabs have fallen.

Symptoms.—Chickenpox rarely produces severe sickness. The first sign is usually the appearance of red spots on the forehead. There may be a slight fever just before the rash. The fever is usually mild during the rash, and disappears in a day or two. The importance of the disease lies in its resemblance to smallpox.

Recognition.—Chickenpox may be recognized by the following points:

1. The duration of the signs preceding the eruption is hours, while in smallpox it is days.

2. The sickness and weakness accompanying the onset are slight, while in smallpox they are severe and painful.

Fig. 5.—Chickenpox, showing the distribution of the eruption.

3. There is a rapid development of the individual spots of the eruption, followed by drying and scabbing in less than a week, while in smallpox the development is slow.

4. A typical spot of the rash is a vesicle, which is superficial and soft; while in smallpox it is deep and hard, and develops into a pustule.

5. The spots of eruption come in crops, and all stages, from spots of redness to dried vesicles, may be seen at once; while in smallpox the individual spots of the eruption are uniform in the time and stage of their development.

6. The distribution of the eruption is the most valuable diagnostic sign. It is most marked on the trunk, and least on the face, hands, and feet; while in smallpox it is most marked on the face and extremities, and least on the trunk. It is sometimes stated that chickenpox never produces an eruption on the palms and soles, but eruptive spots do sometimes appear in these locations in chickenpox as well as in smallpox. Eruptive spots on the hard palate are common in chickenpox and infrequent in smallpox.

When a health officer is called to a case of chickenpox in a grown person, it is his duty to examine the case thoroughly, and, if necessary, on successive days. Inquire about the previous vaccination of the patient. Impose a provisional quarantine until the diagnosis can be made beyond a doubt. If in doubt after an observation of twenty-four hours, request the aid of an expert diagnostician from the State Department of Health.

MUMPS

Infectiousness.—Mumps is an infectious disease of the salivary glands, especially of the parotids. Its micro-organism is unknown, but is contained in the saliva. It is not greatly contagious, and when an epidemic occurs, it is usually confined to the children of a single section of a town for a considerable period. It usually produces only a mild sickness, and boards of health usually make little effort to prevent its spread. The preventive measure is the isolation of cases for two weeks, and for a week after the disappearance of the swelling of the salivary glands.

Mumps frequently produces an inflammation of the testicles and ovaries. Rarely it produces meningitis, which is nearly always mild.

Recognition.—People often confuse mumps with other conditions in which there is a swelling of the neck. Severe cases of diphtheria, septic sore throat, scarlet fever, and cervical adenitis are sometimes called mumps, and no physician is consulted. Diseases have been spread, and deaths have occurred, from a neglect to recognize the true nature of the condition. Mumps is a reportable disease in New York State, and when epidemics occur, many cases of erroneous diagnosis are found. It is important that every case that is not seen by a physician shall be visited by the health officer or public health nurse, and an accurate diagnosis made.

CHAPTER XIX

SMALLPOX

SMALLPOX is one of the best known and most ancient of diseases. It was formerly as common as measles now is. It was classed as a disease of childhood, and everybody expected to have it, just as they now expect to have measles. Epidemics of the disease came in waves as often as there was a sufficient supply of susceptible persons. The proportion of deaths which it caused was greater than that which tuberculosis now causes. It still threatens people of all classes in every country.

Infectiousness.—We have little knowledge regarding the identity and nature of the virus of smallpox. The epithelial cells of the spots of eruption are found to contain small, round masses called vaccine bodies, which may be the peculiar germs of the disease, but nothing definite has yet been proved. The virus is contained in the pustules of the eruption on the skin, and in the natural excretions of the body. The usual mode of entrance of the virus into the body is also unknown, except that it may be inoculated into the skin; but when it is inoculated, it produces a local pustule like that in vaccination, and no such beginning lesion has ever been found in the nose or internal organs. The period of incubation is about two weeks, but varies from ten to twenty days. It is possible for a person to transmit the disease before the eruption appears.

Symptoms.—The symptoms of smallpox show a great variableness. Severe cases are usually recognized easily, but cases which are mild or irregular are puzzling to the best diagnosticians. Mild cases are commonly mistaken for chickenpox, and the severe forms with an irregular or confluent eruption are often diagnosed as measles, or scarlet fever, or typhus fever. The disease now usually appears in a mild, irregular form which is very different from that described by the older physicians. A physician who has not seen a number of cases recently will be likely to find that his previous experience will lead him astray. A health officer is not likely to have an extensive opportunity to learn the fine points of diagnosis, and when a suspicious case occurs, his duty is to call an expert. The diagnostic signs and symptoms which are most constantly in evidence are as follows:

1. The onset is sudden, and the signs of illness are severe. There is a chill with fever, and an intense headache and backache, and often nausea and vomiting. These symptoms persist for three or four days before the eruption appears, decrease markedly when the skin breaks out, and increase again when the vesicles become pustules. The severe and lengthy onset is in contrast with the mild and rapid onset of chickenpox.

2. The eruption of smallpox begins on the forehead and wrists, and is slow in developing. Each spot begins as a red

Fig. 6.—Smallpox, showing the distribution of the eruption.

macule, and soon becomes a hard papule beneath the skin. It becomes a vesicle about the fifth day, and a pustule about the seventh. The pustules persist for about a week, and dry up during the next week or two. This is in contrast to the development of the individual vesicles of chickenpox within a few hours.

The older diagnosticians laid stress upon the exact appearance of the individual spots—their shotty feel, their red areola, and their umbilication—but these signs vary so much that they are not conclusive.

3. The eruption of smallpox is distributed the most profusely upon the exposed surfaces of the body—the face, hands, and arms—and is less in amount on the trunk. This is the opposite to the distribution of the eruption in chickenpox. The distribution of the eruption is probably the most reliable and constant of all the diagnostic signs in smallpox.

4. All the eruptive spots of smallpox appear at about the same time, and the vesicles and pustules are all of about the same age. There may rarely be two or three crops of papules at the beginning of the disease, but when the eruption is fully developed, the spots will be uniform in age and appearance. The eruption in chickenpox appears in successive crops, and macules, papules, and vesicles will be scattered over the skin at one time.

There is a hemorrhagic type of smallpox in which hemorrhages occur in the skin during the early days of the disease and produce areas of a red or purple color. These cases are malignant, and resemble severe cases of scarlet fever.

A common type of smallpox is that in which the disease is extremely mild, and has only a few spots of eruption—in some cases only a dozen. These cases are usually overlooked except during an epidemic. The frequent existence of these unsuspected cases is an argument for the constant observance of measures to prevent the development of smallpox.

A distinction is often made between variola, or smallpox in an unvaccinated person, and varioloid, or the disease in one who has been vaccinated. The distinction has no practical value. Varioloid means simply smallpox in which the symptoms are mild.

Another term that was formerly used was "inoculated smallpox," which meant smallpox that was produced by the intentional inoculation of smallpox virus. The inoculation produces a large sore at the site of the introduction of the virus, and a mild form of the disease which is identical with varioloid.

Protective Measures.—The protective measures against smallpox are: (1) isolation and (2) vaccination; and the greater of the two is vaccination. Neither age, nor health, nor strength, nor social state, nor cleanliness will protect a person who has been exposed to the disease. If all cases were promptly discovered and isolated, the disease would cease from lack of fresh seed to start a new case; but this ideal has never been reached. Cases of smallpox are constantly being missed, just as are cases of all other infectious diseases. The danger from smallpox is as threatening now as it ever was. The only reason that it does not now appear in epidemics is that the departments of health of the great cities are vigilant and enforce vaccination as an effective measure of prevention which is aimed directly at the disease itself.

Smallpox is one of the most contagious of all diseases, and a quarantine of every case is required. The period of quarantine is fourteen days after the beginning of the eruption, and until all the scabs have separated and the scars healed. It is proper to peel the scabs from the palms and soles, for otherwise they might remain in the thick skin for weeks.

Epidemiology.—Smallpox is spread by contact with active cases or their fresh excretions. When smallpox is suspected, the procedures which a health officer is to follow are:

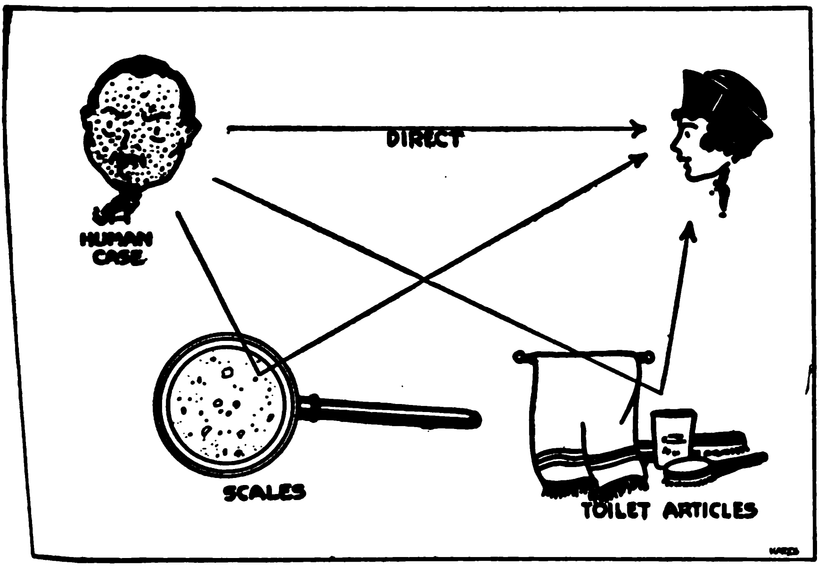

Fig. 7.—Method of transmission of smallpox.

1. Make a diagnosis, calling in expert assistants from the state department of health if necessary.
2. If the case is smallpox, quarantine the sick person.
3. Ascertain who have been in contact with the case since the eruption, and whether or not they have been vaccinated within a year. Release those who have been vaccinated.
4. Vaccinate the unvaccinated contacts, and allow them to go about as usual, provided they report to the health officer or their family physician for twenty days, which is the maximum incubation period of smallpox.
5. Enforce a twenty-day quarantine on the contacts who refuse vaccination.

6. Provide a supply of vaccine that is fresh and active, and offer free vaccination to everyone in the community. The charge for vaccination is a proper one against the municipality.

7. Try to find the parent case from which the patient caught the disease. Keep a record of the names and addresses of suspects in order to follow up rumors, and verify the items of information which will be freely offered to the health officer.

8. Secure the co-operation of the board of health and the authorization for the details of the management and investigation of the outbreak.

It may be necessary to provide a temporary isolation place for cases who are in boarding houses and hotels, or who cannot be properly isolated or given adequate care at home. There is less ground for fear of contagion from an isolation hospital than from a private house that is quarantined. The limit of air-borne infection in smallpox is 4 or 5 feet, and even within those distances the danger is only from direct droplet infection following coughing. Still, a health officer must expect a violent opposition to an isolation place, but he will have law and reason on his side if his board of health authorizes the hospital.

Vaccination.—The production of artificial immunity was often practised during the 18th century by inoculating persons with smallpox virus while they were in good health. This method was valuable during the times when everybody expected to have the disease, but it had two disadvantages: 1, it sometimes produced severe sickness and even death; and 2, an inoculated person could give smallpox as readily as a person who took the disease in the ordinary way. It was superseded by the present method of vaccination after the announcement of the discovery of the protective value of cowpox inoculation by Dr. Edward Jenner, about 1798. The new method had two great advantages: 1, it produced only a mild discomfort; and 2, the inoculated person could not spread a contagion to another person unless an inoculation of matter from him was made deliberately.

The identity of the germs of cowpox with those of smallpox has been demonstrated, for typical cowpox may be produced by inoculating calves with the smallpox virus. The cowpox germ seems to be that of smallpox permanently modified by its growth upon a lower animal. The lesions of natural cowpox are sores about $\frac{1}{4}$ inch in diameter scattered over the teats and udder. When a minute quantity of matter from a cowpox sore is inoculated into the skin of a person, it produces a single sore spot which induces an almost complete immunity to smallpox and to revaccination. The quantity of antibodies in the blood must usually be considerable, for vaccine becomes inert when it is mixed with an equal quantity of blood-serum from a vaccinated calf. The immunity begins on the eighth or ninth day after vaccination, and lasts for years, and often for a lifetime. Susceptibility to revaccination returns sooner than susceptibility to smallpox. About one-half of all persons may be successfully revaccinated after an interval of five years. Revaccination after an interval of twelve years is effective in preventing epidemics of smallpox.

Method of Vaccination.—A standard method of vaccination recommended by the New York State Department of Health is as follows:

Fig. 8.—A vaccination sore produced by the scratch method, showing the slight effect on the surrounding skin.

1. Cleanse the skin over the insertion of the left deltoid muscle with alcohol.
2. Place a small drop of vaccine on the skin.
3. Take a sterile needle and make a single scratch $\frac{1}{4}$ inch long upon the skin through the vaccine.
4. Allow the vaccine to dry.
5. Do not place a shield or a dressing of any kind over the spot. The dried serum that exudes is the best kind of dressing.

Methods by deep scarification and by cuts with a knife are to be condemned, for they produce open wounds which are liable to become infected.

Course of a Vaccination.—The course of a successful vaccination is as follows:

First to fourth day—nothing.

Fifth day—slight redness along the line of scratching.

Sixth day—a vesicle begins to appear.

Seventh day—the vesicle is well formed, and a red areola begins to surround it.

Eighth and ninth days—the vesicle is fully formed. It is about ½ inch in diameter, and its areola about 1½ inches. Its appearance fits the original description of Jenner that it is like a "pearl upon a rose leaf."

Fourteenth day—it has dried to a brown, raised scab, which looks like a button upon the skin.

Twenty-eighth day—the button has fallen, leaving a scar.

The extent of the scar depends upon the depth and area of the sore. A typical vaccination scar left by a vaccination sore that has not been contaminated with bacteria will not exceed ½ inch in diameter, and will often be smaller. A scar 1 inch or more in diameter is usually evidence that the sore has been infected.

Vaccination in Immunes.—When a person who has recently been vaccinated is revaccinated, a small red papule appears at the site of the scratch mark within three or four days. The papule itches, but is not sore. It disappears within a week, and leaves no mark. The papule is a manifestation of anaphylaxis, and is produced by the sudden destruction of the virus by the antibodies that were produced by the first vaccination. The appearance of the itching papule is an evidence of immunity to vaccination and to smallpox.

Vaccination after Exposure.—Antibodies begin to appear in eight or nine days after vaccination. The initial fever of smallpox begins on the twelfth to the fourteenth day after exposure to infection. There is a period of four or five days after infection with smallpox when a vaccination will have a chance to prevent smallpox from developing; and experience shows that vaccination will usually do so. This fact constitutes the reason for promptly vaccinating all persons who have been exposed to smallpox. If vaccination is done after an interval of four or five days following exposure to smallpox, but before the beginning of the fever, it will not prevent the development of smallpox, although it will tend to lessen the severity of the smallpox. A vaccination done after the fever of smallpox has begun will not be successful.

Preparation of Vaccine.—The living virus of vaccine is contained in the liquid matter and the dried scab of a vaccination sore. The original vaccinations were made by the transfer of the virus from a cow to a person; and then came the methods of transmitting it from one person to another; and then that of from a person to a calf and back to a person. The fresh virus or scabs were first used, then virus dried on bone splints, and then virus preserved in a 50 per cent. solution of glycerin. The present method of production adopted by the Department of Health of New York City is as follows:

1. Fresh virus from a healthy person is inoculated into a calf.
2. The calf virus is inoculated into a rabbit.
3. The rabbit virus is transferred to a calf, and the virus then produced is that which is distributed for vaccinating human beings.

One of the principal objects in passing the virus through three animals is to exclude the possibility of the transfer of human disease germs from one person to another. It might be possible that some of the original germs would survive if they were passed through only one animal, but hardly probable if they are passed through three. It is conceivable that some human germs might live in a calf, but it is extreemly improbable that any human germs would survive in both a calf and a rabbit.

The calves on which the commercial virus is grown are young stock. They are fed on milk alone, and are placed without bedding in concrete stalls which are kept as clean as a surgical ward in a hospital. All the operations on the calves are done in an operating-room with tile floors and walls, and are performed with the same cleanliness and asepsis as operations on human beings. When a calf is inoculated, the skin on the hinder part of the abdomen and inner surface of the thighs is shaved and cleansed, and the virus is introduced with the same care that would be observed in operating on a human being. The contents of the vesicles are collected on about the sixth day. The pulp is mixed with four times its bulk of a solution of 50 per cent. glycerin, 49 per cent. water, and 1 per cent. carbolic acid, and is allowed to stand at least five weeks while the glycerin and carbolic acid slowly kill the bacteria that may be present. Bacteriologic tests by plating and fermentation methods are made frequently until no growth is obtained on the media. Inoculation tests are also made for tetanus bacilli and streptococci. If all the tests are satisfactory, the vaccine is tested on fifteen unvaccinated children. All must be successful before the vaccine is distributed to physicians. Every known precaution is taken that the vaccine shall be active and free from bacteria.

Vaccine entirely free from bacteria may be produced by inoculating the virus directly into the testes of a rabbit. The virus consists of the whole organ ground to a pulp.

Vaccine virus deteriorates rapidly when it is kept at a temperature of 70° F., but it remains potent for months when it is kept at a temperature below 40° F. The failure of commercial virus to produce a successful vaccination is often due to its being kept by the druggist for too long a time or at too high a temperature. The commercial vaccine that is made for the market is produced under the supervision of the Federal Government, and by the same methods that are followed in New York City.

Sources of Danger.—Vaccination produces an inflammation of the skin and a sore which is subject to the same accidents and dangers as any other sore. The dangers are those of infection with germs of human diseases, but they are less than those which threaten an ordinary cut finger. The possible sources of danger are well known, and may readily be prevented.

The first source of danger is from virus that is contaminated with bacteria and germs of human diseases. The use of fresh vaccine that has been produced by modern methods and under modern tests excludes all danger from the virus itself.

The second source of danger is the introduction of disease germs during vaccination. This may be prevented by methods of surgical cleanliness which every physician is expected to follow in his dealings with patients.

The third source of danger is the introduction of disease germs into the sore after it has developed. The prevention of this danger depends upon the persons who are vaccinated or upon those who care for them. A child who is allowed to play roughly in dirty places is likely to injure the sore accidentally, and to introduce dirt into it. Most of the accidents following vaccination happen in that way. For example, a child who had tetanus following vaccination had been allowed to play constantly in a pile of soil that was thrown up during the construction of a street sewer, although street dirt is usually contaminated with tetanus germs. No method of the after-care of vaccination is fool-proof, but the danger is very slight if the sore receives ordinary care.

Opposition to Vaccination.—The rarity of cases of smallpox leads many persons to regard vaccination as an unnecessary and even dangerous procedure. One of their arguments is that vaccination is unsound in principle. They argue that it is wrong to introduce matter from a loathesome sore into the body. They seem to believe that the matter remains in the body. Not only does it not remain in the body, but it excites the body to produce defensive substances which destroy it and then remain in the blood ready to destroy any other collection of similar matter that may enter the body. A very few persons have the defensive substances in their blood from birth, but most persons will not produce it until their bodies are in actual contact with the virus. Those who oppose vaccination are like parents who are unwilling that their children should go into the water until they know how to swim. A very few children are able to swim at the first trial, but most children have to learn to swim by subjecting themselves to the discomforts of the water. In the same manner, the body learns to produce defensive substances against smallpox by its experience with the harmless virus of vaccination.

A second argument against vaccination is that a vaccination sore produces more discomfort and sickness than smallpox itself. Those who give this argument believe that smallpox has changed its character and has ceased to be a deadly disease. They also believe that vaccination necessarily produces great discomfort and sickness. It is true that most cases of smallpox are now mild, but the virulence of all contagious diseases varies from year to year. Scarlet fever now exists in a mild form, while infantile paralysis is ten times more fatal than ever before. The modern vaccination produces only a slight discomfort, and its dangers can be readily foreseen and prevented.

A third argument against vaccination is that it may transmit diseases such as septicemia, tetanus, tuberculosis, and syphilis. The precautions which are now taken insure the purity of the virus, and ordinary surgical cleanliness prevents the introduction of germs during the operation.

A fourth argument against vaccination is that it is unnecessary since smallpox has nearly disappeared from civilized lands. This same kind of argument would hold against the purchase of an apparatus for fighting fire, and against making buildings fireproof. Absence of fire for a year, or for ten years, does not mean an absence of danger that a fire will occur. Experience shows that smallpox is likely to break out in an unvaccinated community just as fires occur among wooden buildings.

CHAPTER XX

DIPHTHERIA

Nature of Diphtheria.—Diphtheria is one of the most common diseases with which a health officer has to deal. Its nature and the manner in which it spreads have been ascertained with a considerable degree of exactness. The methods of its prevention and control have been standardized and can readily be applied by every health officer and physician.

Diphtheria is a disease of the throat, nose, or trachea, caused by a germ called the Klebs-Löffler bacillus. The bacilli produce a white or yellow membrane which is usually plainly visible when it is on the tonsils and surrounding parts, but it may be so thin that it can scarcely be noticeable. If it is in the nose or trachea, its location prevents it from being seen. Other bacteria often grow with the diphtheria bacilli and produce swellings and abscesses. The disease will usually develop within a few hours or days after infection with the germs.

The danger in diphtheria is from two causes: 1, a poisoning by the toxins of the bacilli; and 2, an obstruction of the trachea interfering with breathing. The toxin of diphtheria produces a rapid and general poisoning of the cells of the body, and especially those of the heart. A poisoning of the nerves is also likely to occur, leading to paralysis, especially of the motor nerves of the throat.

Recognition of Diphtheria.—Diphtheria may be suspected if any throat trouble is present; or if the breathing is obstructed; or if there are signs of a paralysis of the throat, such as difficulty in swallowing. There is usually a fever and a great weakness of the body. There may be a sore throat, although the worst cases are often painless, owing to the paralysis of the nerves. If there is no soreness, there may be no special signs to call attention to the throat, and the disease may reach a dangerous stage before its existence is suspected.

There are two methods of recognizing diphtheria: 1, by looking into the throat for a membrane; and 2, by taking a culture from the throat or nose.

When a doctor is called to see a sick child, the invariable rule ought to be that he look into the child's throat. Doctors sometimes yield to the desires of the child or of its parents and do not examine the throat, and thus they often fail to recognize diphtheria in its early stages while it may readily be cured. The presence of spots or a membrane on the tonsils or other situation in the back part of the throat is strongly suggestive of diphtheria, but it is not always a proof of the disease, for they may be due to other causes, such as simple tonsillitis, or septic sore throat, or Vincent's angina.

Cultures.—The only sure indication of diphtheria is to find diphtheria bacilli in a culture from the throat or nose. The New York State Department of Health requires a culture to be taken of every case having a membrane in the throat, whether

Fig. 9.—Method of holding a struggling child in order to obtain a throat culture.

the membrane is characteristic or is only suspicious. The department furnishes every health officer with outfits for taking the cultures, and examines the cultures without charge. The examination of cultures sometimes shows the absence of diphtheria from throats in which a membrane is present, and often reveals the germs when no membrane can be seen.

How to Take a Culture.—The outfit for taking a diphtheria culture consists of (1) a sterile cotton swab, and (2) a culture-tube containing a culture-medium of coagulated blood-serum.

When the throat is to be examined, or a culture is to be taken, arrange a light to shine into the throat. Have the child open its mouth wide. Depress its tongue with the handle of a spoon or with a tongue-depressor, in order to get a good view of the tonsils and back part of the throat.

If a child refuses to remain still or to open his mouth, have a strong person hold him in the following manner: Seat the child on the left knee of the person holding him, and throw the right leg over the child's legs. Clasp the left hand around the child's forehead and hold its head firmly against the shoulder. Hold the child's hands firmly with the right hand. The child can now be held firmly in position. If the child will not open its mouth, press a spoon handle between the teeth and into the back of the throat. This will cause a retching or gagging. During the act the chlid will hold its mouth open. The procedure causes no pain or discomfort, and is a far more kind procedure than prolonging the child's baseless fears of an examination.

The method of making a culture from the throat is as follows:

1. Depress the tongue with the left hand.

2. Hold the swab in the right hand and rub it over the membrane, or tonsils, or back of the throat.

3. Hold the culture-tube in the left hand, and remove the plug from its mouth by grasping it with the little finger of the right hand.

4. Rub the swab lightly over the surface of the culture-medium and replace the plug.

5. Throw the swab into a fire, or replace it in its container, if one is provided.

6. Place the tube in the container which is provided with the outfit and mail it to the laboratory.

In order to take a culture from the nose, pass the swab into a nostril horizontally backward along the nasal floor until it touches the posterior wall of the pharynx, and at once withdraw it. Rotating the handle of the swab between the thumb and finger will aid in its passage.

Do not use a culture-tube that is dry or moldy. Be sure that the swab is rubbed over the membrane. Do not allow the swab to touch anything except the throat and the culture-tube. The danger is (1) that it may pick up the ordinary bacteria of the mouth, and (2) it may contaminate other objects with diphtheria germs.

Do not mail the culture-tube in any other container than the one provided by the laboratory, for the postal laws forbid the use of any other container.

Make out a report of the case on a blank that accompanies each outfit, and send it to the laboratory with the specimen.

If the case appears to be diphtheria, do not wait for a report, but begin treatment at once.

When the culture reaches the laboratory, it will be placed in an incubator. The germs grow more rapidly than most other kinds of bacteria, and in from twelve to twenty-four hours the growth will be sufficient for an examination and report. This rapidity of growth causes diphtheria germs to outgrow other bacteria, and the growth that is obtained in positive cases is usually a pure culture of diphtheria germs.

The diseases for which diphtheria is often mistaken are tonsillitis, septic sore throat, and Vincent's angina. No one

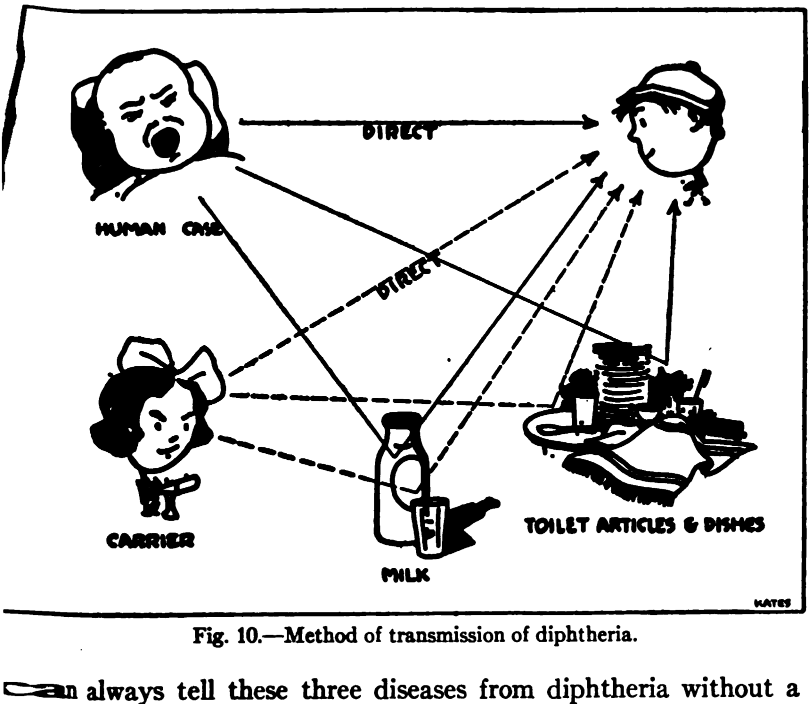

Fig. 10.—Method of transmission of diphtheria.

can always tell these three diseases from diphtheria without a culture.

Manner of Spread.—Almost the only source of diphtheria germs is the human throat. Very rarely diphtheria germs may be found growing in sores on the skin or in the eye. It is barely possible that a cat or other domestic animal may have the disease.

Most cases of diphtheria are acquired by contact with a person who has diphtheria germs in his throat, or with something which has recently touched his mouth or nose, such as a drinking-cup or a towel. Some cases are acquired from milk which contains diphtheria germs, but the germs themselves come from an infected person who handles the milk. If milk is the cause of diphtheria, there is likely to be a number of cases distributed along a milk route. A few diphtheria germs, introduced into milk by a carrier, may multiply to a sufficient number to infect susceptible persons all along a delivery route.

The germs of diphtheria are not long lived, but soon die when they are exposed to the light or to drying, or to the action of bacteria of fermentation and putrefaction, as they are in ordinary cesspools. Diphtheria is not spread by sewer-gas, as was formerly taught.

Isolation.—When a case of diphtheria is reported, the first duty of a health officer is to prevent the disease from spreading to other persons. He will therefore, 1, isolate the case; 2, place a placard on the house stating that there is a contagious disease in the house; and 3, give the people in the house definite instructions regarding (*a*) the method of maintaining the isolation, (*b*) the care of clothing, dishes, and other things in the sick room, and (*c*) the disposal of all excretions from the sick persons. He will also give the parent or nurse a copy of a pamphlet on diphtheria such as that supplied by the New York State Department of Health.

Measures of isolation and quarantine are not strictly legal until the existence of diphtheria has been proved beyond dispute. Yet it would be wrong to delay isolation or quarantine until a report of a culture can be received. A health officer will be upheld by the courts if he begins the isolation or quarantine as soon as he has a strong suspicion that the case is one of diphtheria. Even if the case turns out to be tonsillitis or septic sore throat, the measures for its isolation are justifiable, for both of these diseases are contagious, and are often dangerous to life.

People in a community will sometimes disregard a quarantine from ignorance, or prejudice, or crowded conditions. If a health officer cannot enforce a strict quarantine during an epidemic, the best thing for him to do is to get his board of health to establish an isolation hospital. If the board does this, it must also authorize the health officer to remove to the hospital every case that cannot be properly isolated or treated at home. If this authority is not given, the health officer cannot legally compel a person to go to the hospital.

The end of a period of isolation in diphtheria is determined by the absence of germs from the throat. A throat may appear to be well, and yet it may continue to harbor virulent germs for days and weeks. The rule is not to release a person from isolation until at least two negative cultures have been obtained on successive days. If the germs persist after four weeks, it will be proper for a health officer to ask that a virulence test be made, and if the germs are proved to be non-virulent, he may dismiss the case.

The health officer must give instructions for the disposal of excretions, the cleanliness of the persons in attendance, and of the utensils in use in the rooms.

It is the duty of a health officer to assist in treating cases of diphtheria, even though the burden and responsibility of the treatment is on the family physicians. Every health officer ought to prepare himself to be a specialist in diphtheria, and to place his services freely at the disposal of the physicians.

It is essential that every person who has diphtheria should go to bed and stay there as long as a membrane can be seen in the throat. The toxin of diphtheria is a poison to the heart, and sudden death may occur after an exertion which would ordinarily be harmless.

Difficult breathing in diphtheria usually signifies that the membrane is obstructing the trachea. This condition is now rarely seen, owing to the general use of antitoxin. But a health officer may encounter it at any time in neglected cases. The saving of life may then depend on relieving the obstruction promptly. A former remedy for this condition was to perform the operation of *tracheotomy*, or opening the trachea. This is a simple operation, and requires no special skill, but the opening allows dust to enter the lungs, and thus it often produces pneumonia. It is now performed only in emergency cases when nothing else can be done.

The modern remedy for difficult breathing in diphtheria is *intubation*, or the introduction of a tube into the windpipe. Difficult breathing is slow in its development and there is usually abundant warning of impending danger. A set of intubating instruments costs about $20, and their use requires considerable skill, but no more than a health officer can readily acquire. While intubation may seldom be needed, yet, when obstruction does occur, the operation is life-saving. No other result in the whole range of medicine is so striking and satisfactory as the quiet breathing and calm sleep which follow the intubation of a suffocating child. One health officer in every rural section should be prepared to do intubations for the other health officers and for physicians.

Nature of Immunity.—Immunity to diphtheria is due principally to the presence of antitoxin in the blood. About half of the persons who recover from diphtheria have no antitoxin in their blood. Their immunity is bacteriolytic. Inducing an antitoxin immunity is the only practical means either of curing or of preventing diphtheria in an artificial manner.

Giving Antitoxin.—The principal treatment of diphtheria consists in giving antitoxin. The secret of success consists in giving the antitoxin (1) early in the disease, and (2) in a sufficient amount to overcome the toxins that are present in the blood. The smallest quantity that is usually required is 3000 units, and the largest about 20,000 units.

Antitoxin is given with a hypodermic syringe, and by one of three methods: 1, subcutaneously; 2, intramuscularly; and 3, intravenously.

In the subcutaneous method a fold of skin is pinched up between the thumb and finger. The needle is thrust through the skin and the injection is made under the skin. When the antitoxin is given in this way, it is slowly absorbed into the blood, and from twelve to twenty-four hours are required for it to enter the blood in sufficient quantity to produce its effects.

In the intramuscular method the needle is thrust at right angles to the skin into a muscular part of the body. Antitoxin given in this way reaches the blood in large amounts within three or four hours.

In the intravenous method the needle is thrust into a vein by the following method:

Tie a bandage around the upper arm in order to obstruct the flow of blood and distend a vein at the bend of the elbow. Paint the skin with tincture of iodin in order to sterilize it. Hold the needle parallel with the skin with the slanting side of its tip upward. Thrust it into the vein, remove the bandage, and inject the antitoxin slowly. When the antitoxin is given in this way, it begins to produce its effects within an hour or two.

Timid physicians often give 3000 units subcutaneously and wait twenty-four hours, and if there is no improvement, they repeat the dose. Giving antitoxin in this way is like pouring a little water on a big fire. The proper plan is to give a sufficient quantity in one dose and then stop giving it. When the blood has sufficient antitoxin to neutralize the toxin there is no advantage in giving more.

The doses of antitoxin by the single dose method and the methods of giving it that are advised by the New York Department of Health are as follows:

Case.	Mild. Units.	Moderate. Units.	Severe. Units.	Malignant. Units.
Infant, 10–30 lbs. (under 2 years)	2000–3000	3000– 5,000	5,000–10,000	10,000
Child, 30–90 lbs. (under 15 years)	3000–4000	4000–10,000	10,000–15,000	15,000–20,000
Adult, 90 lbs. and over	3000–5000	5000–10,000	10,000–20,000	20,000–40,000
Method of Administration:	Subcutaneous or intramuscular.	Intramuscular or subcutaneous.	Intravenous or intramuscular.	Intravenous.

The persons to whom antitoxin is dangerous are those who suffer from asthma, and the only form of asthma in which there is danger is that which is produced when a person goes near a horse. This is a rare form, but yet a health officer ought to ask if a person has asthma before he gives antitoxin to him. The bad effects come on suddenly within a few seconds after the injection and may produce death almost instantly. If it is necessary to give antitoxin to a person who has attacks of asthma, give only ½ c.c. of antitoxin and wait an hour. If no bad effects are seen, give the remainder of the dose. The bad effects are not due to the antitoxin, but they are due to the fact that the antitoxin is contained in horse-serum which is a foreign protein. The sickness is a manifestation of anaphylaxis, and comes on in a minute or two after the injection.

Antitoxin sometimes produces an eruption on the skin consisting of red, raised, itching blotches. These effects come on about a week after the antitoxin is given, and are caused by the horse-serum and not by the antitoxin itself. They are harmless and disappear in a few hours or days.

Antitoxin for the Prevention of Diphtheria.—Antitoxin is also given in order to produce a passive immunity to diphtheria in those who are well. The dose for this purpose is 1000 or 1500 units given subcutaneously. When a case of diphtheria occurs in a family, the rule is to immunize the other members of the family. The immunization lasts about a month and then ceases, for the antitoxin that is injected is a foreign protein which is soon thrown off from the body and is not reproduced.

The Schick Test.—The existence of antitoxin in the blood may be determined by the Schick test. This consists of injecting a quantity of diphtheria toxin amounting to one-fiftieth of a fatal dose for a guinea-pig. This quantity of toxin is diluted so that it is contained in a single drop of the injected liquid. The injection is not made under the skin, but into it as near the surface as possible. A successful injection produces a raised white spot which has about the size and appearance of a swollen spot produced by a mosquito bite.

If antitoxin is present in the blood, it will neutralize the injected toxin, and no effects will be visible. But if there is no antitoxin in the blood, the toxin will poison the cells which it touches, and will produce a red spot about the size of a one cent coin which appears on the third or fourth day after the injection. The spot will not be sore, but it will persist for a few days and will then disappear, leaving a transient pigmentation. A positive Schick test, therefore, indicates an absence of antitoxin and a susceptibility to diphtheria. A negative Schick test indicates the presence of antitoxin and an immunity to diphtheria.

About two-thirds of all persons will give a negative Schick reaction, indicating that they naturally have antitoxin in their blood, and are immune to diphtheria. One-twentieth of a unit of antitoxin in each cubic centimeter of blood is sufficient for protection against ordinary infection with diphtheria. Some persons have one or two units of antitoxin in their blood.

The Schick test is of great value in at least three ways:

1. To detect those who are immune and those who are susceptible during an epidemic, especially in an institution. There is no advantage in giving antitoxin to a person who is naturally immune; but a non-immune needs it after exposure to diphtheria.

2. To determine whether or not a nurse or attendant is immune to diphtheria. A non-immune person ought not to be allowed to care for a diphtheria case.

3. To determine immunity in experimental work.

The Schick test shows that 1000 units of antitoxin produce a passive immunity that lasts about thirty days. If another 1000 units are given, the immunity lasts for from seven to ten days only, for the dose partly sensitizes the body to horse-serum, and causes it to throw off the second dose more quickly than it did the first one.

Toxin-antitoxin Immunity.—An active immunity to diphtheria may be induced by the subcutaneous injection of a mixture of toxin and antitoxin. The standard mixture consists of toxin amounting to 200 fatal doses for a guinea-pig, and of antitoxin in sufficient amount to overneutralize the toxin. Three injections are given a week apart. A protective amount of antitoxin appears in the blood in about a month, and persists for years. Over 90 per cent. of persons who have no antitoxin in their blood will produce antitoxin under the stimulus of the toxin-antitoxin mixture.

The toxin-antitoxin method of inducing an immunity to diphtheria is as valuable and practical as the injection of vaccine in the prevention of typhoid fever. A health officer will use it in producing permanent immunity in persons who show a positive reaction to the Schick test.

Carriers.—Diphtheria germs may grow in the throat without producing sickness. They usually disappear from the throat in about two weeks after a person recovers from diphtheria. If they persist for three weeks or more, the person is classed as a carrier.

Carriers harbor the bacilli in situations to which the blood-serum is unable to penetrate. The bacilli have been found among the epithelial cells of the tonsils. They may also grow in the crypts of the tonsils and in folds of the mucous membrane

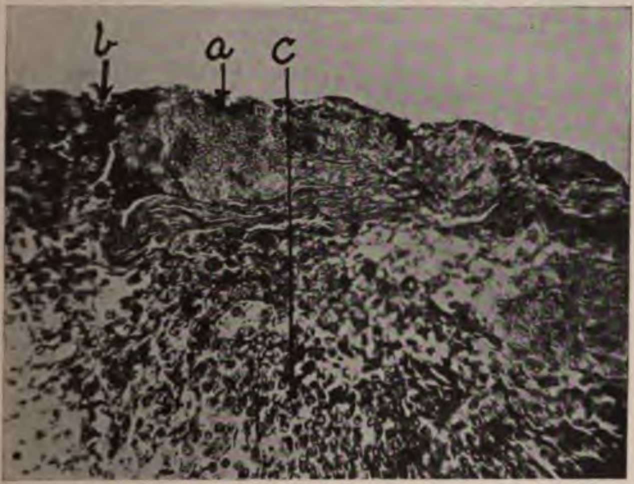

Fig. 11.—Site of diphtheria germs in a carrier (×500). Section of a tonsil showing (*a*) a microscopic center of degenerated epithelium packed with diphtheria bacilli; *b*, normal epithelium; *c*, tonsillar tissue.

of the nose. An abnormal condition of the nose or throat can be seen in nearly every diphtheria carrier, and the germs persist because of the abnormality.

A diphtheria carrier can give the disease to another person. Most cases of diphtheria are caught from unrecognized and unsuspected carriers.

Virulence Test.—Diphtheria bacilli vary in their virulence and in their ability to produce toxin. If a variety has only a slight virulence, it cannot produce the disease in another person, and the carrier is harmless.

A virulence test is performed in the following manner: A culture is taken from a carrier, and the diphtheria germs are isolated from it in a pure culture. A small quantity of the germs are taken and killed and are then injected into the skin of a normal guinea-pig. If the bacilli are virulent, they will produce a red, sore spot in three or four days. The test is like the Schick test on human beings. Laboratories of departments of health are now prepared to make virulence tests on cultures from carriers.

The *control of diphtheria carriers* is one of the most perplexing and aggravating problems with which a health officer has to deal, for healthy carriers do not always understand how they endanger the health of others. A carrier who takes reasonable precautions against transferring excretions of the nose and throat to others may safely go about his work. Child carriers must stay at home and away from other children. If a carrier is reliable, he need not be quarantined, but if he is unreliable and defiant, a health officer's duty is to restrain and quarantine him. If a virulence test shows the bacilli to be non-virulent, a carrier may be discharged from observation.

Treatment of Carriers.—A healthy nose or throat will seldom harbor diphtheria bacilli. The procedures which are of value in ridding a carrier of the bacilli are those which would tend to restore the throat to a normal state if no diphtheria germs were present. Most carriers have enlarged tonsils. The removal of the tonsils and adenoids from the throats of those who have them is almost certain to rid a carrier of the germs. Nearly every diphtheria carrier is immune. If he were not immune he would have the disease in an active form. The administration of antitoxin, therefore, has no effect on the bacilli in their throats.

Epidemiology.—When an epidemic of diphtheria occurs, the duty of the health officer is to make an investigation according to the procedure outlined on page 179. The disease is spread by contact of one individual with another in most cases, but an epidemic may be due to milk. A health officer can soon determine whether or not the epidemic is milk-borne, and if it is, he will close the infected dairy. The principal duty of a health officer is to find the positive cases and also the carriers of diphtheria germs. From 5 to 20 per cent. of all children may be found to be carriers of diphtheria germs while an epidemic is going on. The health officer will find the carriers by means of cultures. If the epidemic is prevalent in a restricted district, he may have to examine each person in the district, but it has usually been found sufficient if he will take cultures only from those who show a redness of the throat. He will also take cultures from school children whose throats are red, but he need exclude only those who have the germs present.

A health officer must be thorough in discovering diphtheria cases and carriers. If he misses a few, the epidemic is likely to continue. If an epidemic of a dozen cases breaks out in a village of 5000 inhabitants, one man might not be able to take all the cultures which are necessary in order to suppress the epidemic quickly. It is the duty of the health officer in such an emergency to ask for help from the state department of health.

Diphtheria in Schools.—When diphtheria occurs among school children, a health officer will be expected to protect the rest of the children. The principal danger will be from carriers. His duty is to take cultures from all children whose throats are red or sore, and to exclude all the carriers that are found. It is also his duty to investigate all cases of sickness among children who are absent from school. If a health officer or medical inspector will examine the school children daily and take cultures from all suspects during an epidemic, there will be no need to close the school.

Diphtheria in Institutions.—When diphtheria occurs in an institution, the precedure for a health officer to follow is:

1. Take cultures from all children who have been associated with the sick.
2. Isolate the sick and the carriers.
3. Do the Schick test on each inmate in order to determine who are immune and who are not.
4. Give all those having a positive Schick reaction an immunizing dose of antitoxin.
5. Secure the removal of tonsils and adenoids from the carriers.

Vincent's angina is a form of sore throat in which there is usually a membrane resembling that of diphtheria. It usually begins as a small, whitish ulcer upon the tonsils or other part of the throat. The ulcer often extends through the crypts of the tonsils and produces an extensive loss of tissue. The disease is to be suspected when a deep ulcer can be seen in the throat or when the throat remains sore and raw after what was called diphtheria. It is caused by a spirochete which occurs in two forms: (1) a large crescent-shaped organism which stains heavily and unevenly; (2) a long, slender spirillum which stains faintly. A diagnosis may be made by taking a specimen of membrane with a swab, making a smear upon a cover-glass, and examining it at once. Large numbers of both organisms will usually be present in a smear from a positive case. A health officer can make a smear from a suspected case and send it to a laboratory for examination.

Vincent's angina is not common, but it sometimes occu
epidemics, and a health officer must keep the disease in r
A case must be controlled in the same manner as one of
theria. Its treatment consists of swabbing the ulcer daily
a 20 to 50 per cent. solution of silver nitrate, and of paintin
throat frequently with weaker solutions. A cure is indi
by a healing of the ulcer and by the absence of the orga
from smears.

CHAPTER XXI

SEPTIC SORE THROAT

Simple Tonsillitis.—Nearly all forms of sore throat and tonsillitis are communicable by contact. If one child in a family has tonsillitis, other children in the family are likely to catch it also. Sore throat and tonsillitis may be caused by any one of a number of different kinds of micro-organisms, but especially by staphylococci or streptococci. The diseases are of great interest to a health officer because they may be the only evident signs of a mild form of communicable disease, such as diphtheria or scarlet fever, which is usually severe and dangerous. The proper attitude for a health officer to take is to consider every case of sore throat and tonsillitis to be catching, and to request that the afflicted person stay at home and keep away from other persons. An ordinary tonsillitis makes persons sick, and if their attention is called to its infectious nature, most people are willing to take precautions in order to prevent the spread of the disease.

The disease that is called simple tonsillitis usually affects only those persons whose tonsils are enlarged and contain cavities or crypts in which disease germs may lodge and grow. The white points seen on the tonsils during acute tonsillitis are the ends of plugs of offensive matter or thick pus which fills the crypts, and which forms an excellent culture-medium for disease germs. This matter, and the germs remaining in the crypts after recovery from an attack of tonsillitis, often constitute a chronic form of infection which is the source of the germs or toxins which cause rheumatism, valvular heart disease, and arthritis deformans.

Septic Sore Throat.—A tonsillitis that is caused by hemolytic streptococci is especially infectious, and frequently occurs in epidemics. It may be spread to a few individuals by contact, but the epidemics of the disease have usually been milk-borne. The disease was first noticed in the United States in Boston in 1911, when over 1000 cases occurred. Since that year many other epidemics have occurred in the United States, and the disease has become one which every health officer must have in mind. The disease is known by the names of septic sore throat, epidemic sore throat, and streptococcus sore throat, each of which is a descriptive term. The disease is caused by a special variety of hemolytic streptococcus which has great virulency, grows readily in milk, and may readily be transferred from milk to the human throat.

The signs of septic sore throat are those of tonsillitis, and usually consist of a chill, sudden fever, pains in the head and back, soreness of the throat and glands of the neck, rapid pulse, and great weakness. A thin membrane may be seen in the throat in about half of the cases, and when it is present, the disease cannot be distinguished from diphtheria without a throat culture. When a culture is taken, it shows an almost pure growth of streptococci.

Septic sore throat may also resemble scarlet fever. Epidemics of the two diseases have existed in the same town at the same time, and cases could then be distinguished only by the absence of the eruption in septic sore throat and its presence in scarlet fever. Streptococci are found in both diseases, and both may be milk-borne.

Septic sore throat is a dangerous disease and the ordinary complications of streptococcus infections are likely to occur in it, particularly rheumatism and inflammation of the valves of the heart. A considerable number of deaths may be expected in a large outbreak.

Many cases of sickness that are called ordinary tonsillitis are due to streptococci, and are actual cases of septic sore throat which are caught by contact with the infectious material from the noses and throats of other cases. The great importance of the disease is that a dairy workman who has it may discharge the germs into milk, and may spread the disease to dozens or hundreds of persons who use the milk. Extensive epidemics of the disease have been reported in recent years, and all have been milk-borne.

An epidemic of septic sore throat usually comprises a considerable number of cases before its nature is suspected. It is usually discovered by the resemblance of some particular case to diphtheria. This case is reported to the health officer, who takes cultures and finds no diphtheria germs, but does find streptococci in almost pure culture. His inquiries then reveal other cases of sore throat, and show that most of the affected persons have used milk from one source.

Origin of an Epidemic.—Streptococci are frequently found in the udders of cows, especially if the udders are inflamed and show signs of disease. But the origin of no epidemic of septic sore throat has been definitely traced to a diseased cow. The streptococci of cow diseases seem to have only a slight virulence for human beings.

Wherever the origin of an epidemic of septic sore throat has been definitely traced, it has been found to be a person with sore throat working in a dairy. The germs may enter the milk directly from the affected person, or they may enter the udder of the cow from the hands of the affected milker, and thus gain access to the milk indirectly. The germs may not produce a soreness of the udder or other evident sign of disease, for the cow is almost immune to human streptococci. Yet the cow may be a carrier of virulent human germs and may discharge them into the milk. When an epidemic is traced to a suspected dairy, a positive diagnosis is made by means of cultures taken from the throats of all the workmen, and of examinations of individual samples of milk taken from each quarter of each cow in the dairy. The carrier, either human or bovine, or both, will be revealed by an almost pure culture of streptococci.

Epidemiology.—When a health officer is confronted with a disease which may be either septic sore throat, or scarlet fever, or simple tonsillitis, or diphtheria, his first duty is to investigate all the cases, following the method described on page 179. An extensive epidemic of either of these four diseases may be milk-borne, and a health officer can readily trace its source by finding that one milk-supply is a common element in most of the cases. The control of the milk-supply will cut off the main source of the infection at once.

A second duty of the health officer is to make an accurate diagnosis in every case, if possible; and in doubtful cases, to isolate the cases until a diagnosis is made.

A third duty of the health officer is to take precautions for the suppression of the epidemic. These measures are—

1. To exclude affected workmen from a dairy.
2. To prohibit the sale of milk from the infected dairy unless it is pasteurized.
3. To maintain an isolation of the known cases in order to prevent infections by contact.
4. To inform the public of the existence and nature of the disease, the means of its spread, and the measures for its control.

The provision that will almost certainly prevent or suppress an outbreak of septic sore throat is the pasteurization of all milk.

The period of exclusion of an infected workman from the dairy is until all signs of inflammation have disappeared from his throat, and cultures from his throat no longer show a preponderance of streptococci.

When the pasteurization of an infected milk-supply is impossible, the sale of raw milk may be permitted under the following conditions:

1. All workmen with sore throats shall be excluded.

2. All cows which show any signs of inflammation of their udders after an examination by a veterinarian shall be excluded from the herd.

3. The pails, bottles, brushes, and all other containers and utensils shall be boiled for half an hour in order to destroy any residual streptococci that remain in them.

Duty of a Health Officer.—The duty of preventing an epidemic of septic sore throat, and of suppressing an epidemic that breaks out, lies with a health officer. The disease is new, and knowledge of it is not yet universal. Milk inspections, the scoring of dairies, and public conferences and lectures on milk, all afford opportunities to educate physicians and the public concerning the infectiousness of colds, sore throats, and tonsillitis, and of the danger from milk that is infected with their germs.

The prevention of an epidemic of septic sore throat consists primarily in excluding all persons who have the disease from working in a dairy, and in the pasteurization of milk. The Sanitary Code of New York State requires that the owner or manager of a dairy shall report to the health officer whenever a person on the premises has a sickness that is presumably communicable, and has no medical attendant. The code further requires the exclusion of such persons from the dairy. A wise interpretation of these provisions is that no one with a sore throat or tonsillitis shall be allowed to work in a dairy.

CHAPTER XXII

SCARLET FEVER

Names.—Scarlet fever takes its name from the redness of the skin, which appears early in the sickness. Many cases are extremely mild and show only a faint redness. Some doctors are unwilling to consider these cases to be true scarlet fever, and so they call them scarlatina, scarlet rash, or roseola, or rose fever, or rose rash. Scarlatina is the scientific name for scarlet fever, and means any case of scarlet fever whether it is mild or severe. The other names are used only to deceive the public. They mean scarlet fever. If there is doubt as to the nature of the disease in any particular case, the patient is entitled to the benefit of the doubt, and to receive the care that is due to a severe scarlet fever case, for a mild case may suddenly become severely sick.

Cause.—Scarlet fever is caused by an unidentified microorganism which is readily transmissible from the sick to other persons. Virulent streptococci are always associated with the special organisms of the disease itself, and are known to be the cause of many of the severe conditions that sometimes arise in the course of the disease. The sickness develops in from three to seven days after exposure to the infection.

Signs.—Scarlet fever begins suddenly, usually with vomiting and a fever. After about twenty-four hours the skin breaks out with a red eruption beginning in the throat and on the chest. The eruption in the throat causes it to be sore and the tongue to be red like a strawberry. The principal diagnostic marks are a sudden onset of fever with vomiting and sore throat, followed in a few hours by a red eruption on the skin. The scarlet fever germs themselves may be so virulent that they produce death. They may produce poisons which often cause kidney diseases. The severe complications of the disease are usually due to streptococci that grow with the special germs of scarlet fever. The streptococci often produce earache, running ears, mastoid disease, enlarged glands, and abscesses of the neck. They often produce a membrane in the throat resembling that in diphtheria and septic sore throat.

The eruption in scarlet fever is due to an inflammation of the skin and to microscopic blisters which form in the deeper layers of the epitheluim and loosen the cells. When recovery takes place, the loosened epithelium peels off, or *desquamates*, in flakes. The peeling usually begins in from fourteen to twenty-one days after the onset of the sickness. It usually commences around the roots of the nails and extends over the whole body, including the palms and soles.

There is no certain test for scarlet fever as there is for diphtheria and other diseases whose germs are known. Many cases are not sick enough to have a physician, and break out so slightly

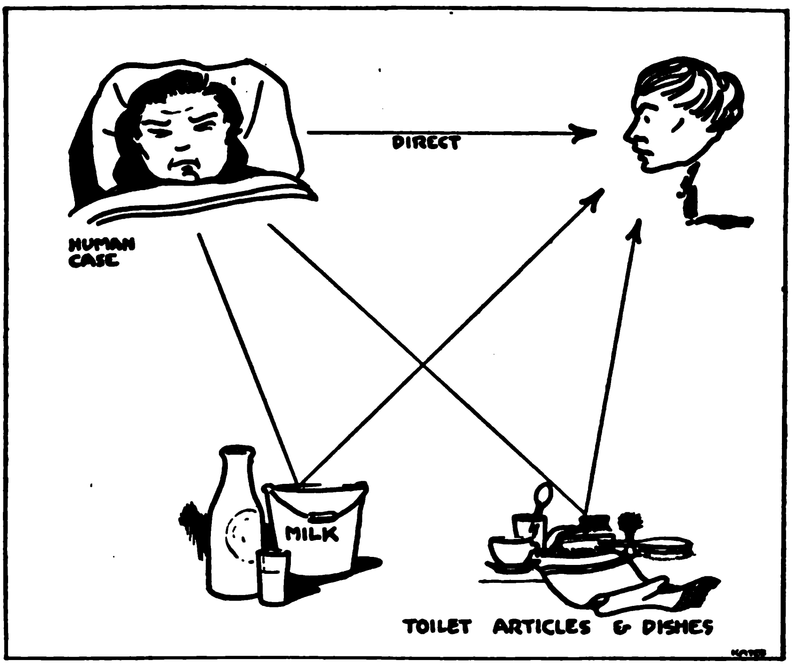

Fig. 12.—Method of transmission of scarlet fever.

that the eruption is not noticed. An almost constant sign is the desquamation of the skin. If a child has a desquamation of the skin two or three weeks after it has had a slight fever, it may be considered to have had scarlet fever.

Method of Transmission.—The living germs of scarlet fever are found in the excretions of the nose and mouth, but they are not found in the skin, even during desquamation. The germs may also be present in discharges from the ear and from abscesses. The germs disappear when the nose and throat become normal and the discharges from the ears and abscesses cease, but they are present as long as the discharges from the nose, throat, ears, or abscesses continue. Many children who have had the disease in an unrecognized form go among other children while they are still carriers of the germs. These carriers are the cause of most of the cases of scarlet fever that are now seen.

Scarlet fever is transmitted by contact with the fresh discharges of the sick or with those of a carrier. The germs produce the disease in from two to seven days after they enter the body. If a child has been exposed to the disease and does not become sick within a week, it may safely mingle with other children. An attack of the disease usually produces an immunity that lasts for life.

Scarlet fever may also be milk-borne by means of germs introduced into the milk by a carrier working in a dairy.

Duty of the Health Officer.—Scarlet fever is a treacherous disease, owing largely to the presence of streptococci which are ready to attack any tissue that has been weakened by the special germ of the scarlet fever. Severe kidney troubles or ear diseases are likely to occur in mild cases which are exposed to the weather, overwork, and overeating. The disease is always a source of danger, and whenever a case occurs, it is the recognized duty of a health officer to take special precautions against its spread. These precautions include: 1, the discovery of cases; 2, isolation; 3, the disposal of excretions; 4, the protection of school children; 5, the treatment of cases; 6, the education of the public.

Discovery of Cases.—When a case of scarlet fever occurs, a health officer knows that it came from a previous case. The old case has usually been a mild one whose nature was not suspected. Children in school are frequently discovered with peeling skins and giving histories of a transient vomiting and sickness two or three weeks previously. These are probably missed scarlet fever cases, and many will be found during an epidemic. They would be discovered between epidemics if the school and health authorities would look for them.

The recognition of scarlet fever is often difficult. Mild cases are often called simple tonsillitis. Scarlet fever often resembles septic sore throat. Experiences with epidemics of septic sore throat seem to indicate that hemolytic streptococci of bovine origin may produce a disease in which there is a skin eruption like that of scarlet fever, but no sore throat.

A skin eruption like that in scarlet fever may be produced by drugs, by antitoxin, by certain foods, and by burns. Harmless skin eruptions, such as unusual forms of hives, often resemble scarlet fever. The public will be fortunate if the health officer enjoys the confidence of the physicians to such an extent that they are willing to report all doubtful cases to him, and to leave the final diagnosis to his judgment. If the health officer is in doubt, his wisest course is to inform the head of the afflicted household of his doubt, and to ask that the suspected person be kept at home and away from the rest of the family; and to wait two or three weeks for the appearance of the desquamation of the skin. If the case is scarlet fever, the desquamation will nearly always appear. It may not be an absolutely sure sign of scarlet fever, but it is the best sign that we have. Extremely severe cases of scarlet fever may resemble smallpox, but the infective nature of these cases is evident, and the health officer will order all precautions to be taken in all of them.

Isolation.—The rule of New York State is that a case shall be isolated for thirty days, or until the nose and throat become normal and there are no more abnormal discharges, such as those from the ear and abscesses. Peeling of the skin may be disregarded, but it would be unwise to frighten the public by allowing a child with evident peeling to mingle with others. There is a tendency among health workers to govern the length of time of isolation by the state of the diseased parts rather than by any fixed or arbitrary length of time.

If a child is properly isolated in one part of a house, grown persons living in the same house may safely continue at their work, provided they do not handle food products. If they handle food, and especially milk, they must not continue at their work unless they stay away from the house.

Children who live in a scarlet fever house must not attend school or mingle with other children. The reason for this rule is the unreliability of children and the ever-present possibility that they may come in contact with the sick person.

Children who live in a house in which there is scarlet fever may be divided into two groups: 1, the immunes, or those who have had the disease; and 2, the non-immunes, or those who have not had it. If the immune children leave the house, they may be released from isolation and quarantine. If the non-immune children leave the house, they must be kept under observation for seven days, in order to be sure that they do not develop the disease. If then they do not come down with the disease, they may be discharged.

Disposal of Excretions.—The infective material in scarlet fever is found in the excretions of the nose and throat, and of the bowels and bladder. The excretions of the nose and throat may safely be received in cloths and papers and burned. The excretions of the bowel and bladder may safely be emptied into a sewer or cesspool, or they may be buried. Those that remain on the face and hands of the patient and on his clothing and bedclothes and on the floors and furniture of the room may be readily killed or removed by the ordinary processes of washing and cleanliness. The germs are not particularly long lived, but they are readliy killed by the same processes by which other disease germs are killed. It was formerly supposed that scarlet fever could be spread by the germs that had survived for months on clothes and playthings. The existence of many unrecognized carriers would account for the cases of the disease which have followed the use of articles which had been handled by scarlet fever patients months previously. Practical experience has abundantly demonstrated that ordinary cleanliness is sufficient to render articles free from scarlet fever germs.

Protection of School Children.—When scarlet fever develops among the children of a school, almost the only danger is that from mild and unrecognized cases. Any child who is likely to spread the disease will give signs which teachers, the school nurses, the medical inspectors, or the health officers can readily recognize if they are on their guard. An inspection of the school children may reveal three suspicious groups: 1, children who are taken suddenly with a mild sickness; 2, children with sore throats; and 3, children whose skins are peeling. These children may possibly have the disease or have had it recently. If they are discovered and excluded, the school may continue its sessions as usual.

Treatment of Cases.—Getting scarlet fever cases well as soon as possible is essential in preventing the spread of the disease. It is the duty of a health officer to know the modern methods of handling scarlet fever, and to place his knowledge at the disposal of family physicians.

Most of the dangerous complications of scarlet fever arise from unclean conditions of the nose and throat. A nose that is stopped up and full of mucus is a culture place for streptococci, and a center from which the streptococci spread to the ears and the tissues of the neck. An efficient method of preventing the complications is that of cleansing the nose with normal salt solution ($\frac{6}{10}$ per cent. of salt in water). The salt solution may be sprayed up the nose, or it may be poured into the nose while the child lies upon its side. The solution may frighten a child at first, but the relief and comfort after its use is so great that children often ask for it. If a child who needs it objects to its use, the kindest procedure is to hold the child firmly and apply the solution thoroughly. It is surprising how quickly and gladly children in contagious disease hospitals submit to having their noses cleansed.

The blood of a person who has recently recovered from scarlet fever contains the antibodies against scarlet fever. This blood has been used with excellent results in the treatment of severe cases of scarlet fever. The method is as follows: Draw from 4 to 8 ounces of blood from the donor's vein with a hypodermic syringe, and inject it at once deep into the muscles of the recipient. The blood is soon absorbed, and the dangers of an intravenous injection are avoided.

Education.—The efficient control of scarlet fever depends on the intelligent co-operation of the public with the health officer. Some of the modern methods of dealing with contagious diseases often seem lax to the public, and the people wonder at the omission of old and discredited procedures. The people will co-operate with the health officer when they become famliiar with the new methods of public health work. Every case of scarlet fever is a center for educating the family and the neighbors. Every case in a school affords an opportunity to explain the new methods of handling contagious diseases. Nothing is gained by secrecy concerning contagious diseases, but a health officer will promote his work by taking advantage of every opportunity to educate the people in all phases of preventive work.

Epidemiology.—When a scarlet fever epidemic breaks out, the health officer or visiting epidemiologist will make an investigation according to the method outlined on page 179. He will obtain information from all the cases, and will analyze it to see if there has been a common milk-supply or other common source of infection. He will also seek to make an accurate diagnosis in every case. It is possible to have an epidemic of scarlet fever intermingled with one of septic sore throat. If both diseases exist side by side, an accurate diagnosis is not necessary, provided all the cases are subjected to the measures of control which are proper in scarlet fever. Both diseases may be spread by personal contact, and by milk, and the same measures of investigation and control apply to each. If an epidemic is milk-borne, the exclusion of the milk from market, or its pasteurization, will control the grosser routes of the spread of infection; but an isolation of the individual cases will be necessary to prevent the development of secondary cases.

Scarlet fever is usually spread by contact, and the chief difficulty in its control is to discover and isolate the individual cases which have not been recognized or treated, but which continue to mingle with other persons. The signs which make a health officer suspicious that a person has had scarlet fever very recently are a peeling of the skin, a redness of the throat, a history of vomiting or other signs of a slight sickness from one to three weeks previously, a history of the exposure of the suspected person to a previous case, and the development of fever in a child who has been exposed to the suspected person. The presence of any of these signs during an epidemic is strongly suggestive of scarlet fever. The control of these cases consists in excluding them from contact with other people.

CHAPTER XXIII

ACUTE RESPIRATORY DISEASES

Entity of Acute Respiratory Diseases.—Nearly all acute respiratory diseases are infectious and communicable. The micro-organisms of the diseases may be classified as follows:

1. The pneumococcus group.
2. The streptococcus group.
3. The influenza bacillus.
4. The Micrococcus catarrhalis.
5. The bacillus of whooping-cough.
6. Various other kinds of bacteria, some of which are unidentified.

The micro-organisms may involve either the nose, or the pharynx, or the larynx, or the trachea, or the bronchi, or the tissues of the lungs, or the pleura; or they may involve all the organs. The resulting illness is caused by a general poisoning of the entire body with the toxins of the bacteria. The sickness is usually named according to the local part which gives the prominent symptoms. A common cold, coryza, pharyngitis, tonsillitis, bronchitis, pneumonia, and pleurisy are names given the sickness according to the anatomic location of the principal site of growth of the bacteria, but they do not indicate the variety of the bacteria.

The severity of an acute respiratory infection depends on two factors: 1, the virulence of the micro-organism, and 2, the immunity or susceptibility of the patient.

The degree of virulence of the bacteria varies within a rather wide range; and the symptoms produced by any of the types of bacteria may be only those of a mild cold or those of a deadly illness. The pneumococcus and streptococcus groups are usually far more virulent than the other forms of bacteria; but the sickness which they produce may be extremely mild. Bacteria from a severe case of illness are likely to produce the same type of disease when they are inoculated into other persons.

Immunity to acute respiratory diseases depends less upon specific antibodies and more upon general health and vigor than does immunity to most other diseases. Many persons are carriers of bacteria which do not enter the tissues of the respiratory organs unless the resistance of the body becomes lowered by exposure to cold and dampness, or by excessive fatigue, or by dissipation, or by some other cause of general weakness.

PNEUMONIA

The general term "pneumonia" is applied to those conditions in which groups of air-cells of the lungs are filled with products of inflammation instead of air. The physical signs and appearance of the affected parts of the lung are those of solid tissues in contrast with those of the air-filled tissue of a normal lung.

The micro-organism which produces pneumonia is usually either the pneumococcus or the streptococcus. The influenza bacillus often causes the disease. Rarely the disease may be caused by other bacteria, such as the Micrococcus catarrhalis and the typhoid bacillis.

Pneumococci are divided into four groups which differ essentially from one another. The type is recognized by means of an agglutination test made with the serum of an animal that has been sensitized with a pure culture of that particular type.

Pneumococci of Type 1 are peculiar in that a curative serum of considerable potency may be produced by their introduction into a lower animal. Those of Type 2 may be used to produce a serum of very slight potency. Those of Type 3 are surrounded with mucous envelopes which cause them to adhere in masses in their cultures. Type 4 embraces a number of other varieties of pneumococci, some of which are extremely virulent, while others have only slight virulence. The identification of the individual strains of Type 4 is not practically applied in the diagnosis and treatment of cases. The number of cases caused by each type is approximately equal, although the proportions vary widely in different localities and epidemics.

Streptococci.—Pneumonia may be produced by two varieties of streptococci, the hemolyticus and the viridans. The hemolytic type is the more common and virulent of the two. Infections with both pneumococci and streptococci often occur.

Types of Pneumonia.—Cases of pneumonia may be divided in a general way into three types: 1, the lobar type, in which a circumscribed area is involved, while the rest of the lung is normal; 2, bronchopneumonia, in which many small patches of lung are involved; and 3, cases associated with fluid in the pleural cavity. There is no clear-cut bacteriologic or clinical distinction between the lobar type, bronchopneumonia, and a severe form of bronchitis. Cases which are diagnosed as bronchitis are often bronchopneumonia; and a bronchopneumonia often becomes å lobar pneumonia by the fusion of the separate patches of affected tissue. The form produced by streptococci is usually a bronchopneumonia at the beginning of the disease. Inflamed areas of tissue located near the surface of the lung frequently cause a pleurisy with the effusion of fluid or an empyema. The infective process usually begins in the bronchi and produces either a bronchitis, a pneumonia, or a pleurisy with effusion according to the anatomic extension of the bacterial growth.

The diagnosis of acute respiratory diseases is based on five methods of examination, as follows:

1. Observation of the clinical symptoms.
2. A physical examination of the lungs.
3. A bacteriologic examination of the inflammatory products.
4. Aspiration of the pleura with a hypodermic needle.
5. An x-ray examination of the lungs.

It is the duty of a physician and health officer to understand the nature of these diagnostic methods, and to apply them to every case if possible.

Bacteriologic Examination.—A determination of the type of bacteria present in an acute respiratory disease is necessary in order (1) to administer serum if pneumococci of Type 1 are found, and (2) to treat the case intelligently. The specific bacteria are found in the sputum, and in the fluid of the pleura when an effusion is present. Fluid aspirated from the lung tissue itself is likely to be sterile. A bacteriologic examination is of special value when it is done early in the disease.

A specimen of sputum must be from the lung itself or from the bronchi. One from the nose or throat may contain the specific organisms, but it is nearly always contaminated with mouth bacteria. The manner of obtaining a specimen is as follows:

1. Sterilize a wide-mouthed bottle and its cover or cork by boiling. A tubercular specimen bottle may be used.

2. Brush the teeth, wash the mouth, and blow the nose of the patient in order to cleanse the parts from loose bacteria which might contaminate the sputum.

3. Collect a lump of expectoration that is raised by coughing.

4. Close the bottle, label it, and send it to the laboratory to be examined as soon as possible.

A standard method of examining a specimen of sputum is as follows:

1. The sputum is washed in normal salt solution in order to remove the mouth bacteria from its surface.

2. About 1 c.c. of the sputum is injected into the peritoneal cavity of a white mouse. The pneumococci thrive, while the other organisms tend to die.

3. The bacteria are removed from the abdomen of the mouse after its death, which usually occurs within thirty-six hours.

4. The bacteria are identified by means of an agglutination test made with the serum of an animal that has been sensitized with a known type of pneumococci.

A more rapid, but somewhat less exact, method of recognizing the type of pneumococci is that known as Avery's, which is as follows:

1. Wash the sputum in three changes of normal salt solution.
2. Emulsify the sputum with a syringe or mortar.
3. Inoculate the sputum into a special culture-medium consisting of 1 per cent. dextrose in broth and 5 per cent. of rabbit's blood.
4. Incubate for five hours.
5. Centrifuge at low speed in order to remove the red corpuscles.
6. Draw off the fluid. Add 1 c.c. of sterile bile to 4 c.c. of the culture liquid in order to dissolve the pneumococci, if any are present. If pneumococci are present, the liquid will become clear.
7. Centrifuge the liquid at high speed in order to remove any solid particles from it.
8. Set up a precipitin test with four tubes. Put 0.5 c.c. of the clear culture liquid into each tube.
   - To tube No. 1 add 0.5 c.c. of immune serum made with pneumococci, Type 1.
   - To tube No. 2 add 0.5 c.c. of immune serum, Type 2.
   - To tube No. 3 add 0.5 c.c. of immune serum, Type 2 diluted 1 to 10.
   - To tube No. 4 add 0.5 c.c. of immune serum, Type 3 diluted 1 to 5.
9. Incubate one hour, and note the results.

The presence of pneumococci is indicated by the dissolving and clearing action of the bile on the culture liquid. Types 1 or 2 or 3 are each indicated by the positive reaction to the precipitin test, while Type 4 is indicated by a negative reaction.

Pneumococci and streptococci will grow well on the ordinary diphtheria culture-tubes which are used by health officers; but the growth is slow, and a diagnosis requires two or three days.

x-Ray.—There is a great difference between the density of normal air-filled lung tissue and that of lung tissue whose air cells are filled with coagulated substances. An *x*-ray photograph will show the extent of the consolidated areas, and will reveal areas which are too small to give evident physical signs. It will also show the outline of the surface of the lung and its relation to the chest walls, and will thereby reveal collections of fluid or air in the pleural cavity. Repeated *x*-ray examinations of the chest, when they can be made, are valuable and certain means of observing the extent and course of a case of pneumonia.

Aspiration.—The presence and nature of fluid in the pleural cavity may be determined by means of a puncture and aspiration. An ordinary pocket hypodermic syringe and needle may be used. The needle is inserted to its full length at the spot where the physical signs indicate fluid, and gentle aspiration is made while the needle is slowly withdrawn. If fluid is present at the spot, it will be indicated by a sudden inrush into the syringe when the point of the needle enters it.

Fluid aspirated from the pleural cavity will usually contain the same variety of bacteria as the sputum; but it may contain streptococci while pneumococci are recovered from the sputum, and in that case the presence of streptococci indicates infection with both kinds of bacteria.

When the fluid of an empyema complicating pneumonia is removed during the early stage of the disease, it is usually clear except for a cloudiness caused by the presence of bacteria. The fluid later may consist of creamy pus. The development of pus in severe cases may be a favorable sign indicating the development of leukocytosis. The appearance of the fluid is a guide to treatment. If the fluid is not pus, the proper procedure is aspiration and removal of the fluid as often as any can be obtained. Resection of a rib and drainage is to be done when pus is fully developed. Excellent results are obtained after the operation by treating the case as an infected wound by the Dakin-Carrel method of irrigation, examining the discharge frequently for bacteria, and closing the wound when very few bacteria are found.

Serum Treatment.—Any variety of pneumococci, when it is injected into a lower animal, may cause the production of an agglutinin which is of value in diagnosis; but only Type 1 pneumococci gives rise to sufficient antibodies to produce a serum that is valuable for treatment. Type 1 serum is of great value in pneumonia caused by Type 1 pneumococci, but it either has no value or is harmful when the disease is caused by other types or by streptococci. It is best not to give the serum until the presence of pneumococci and their type can be determined. The serum is not an antitoxin, but is bactericidal, and acts by digesting the bacteria in the body.

The antipneumococcic serum is given intravenously, in doses of from 8 to 12 ounces, repeated daily for two or three days if necessary. Its effect is to bring on an artificial crisis with a fall of temperature after about twenty-four hours. Since it is horse-serum, there may be a slight danger of producing anaphylaxis with the considerable amount that is required. In order to guard against anaphylaxis, the rule is to give a desensitizing dose of 1 c.c., wait an hour, and then give the rest.

Vaccines.—The immunity following an attack of pneumonia usually lasts for only a short time, but favorable results have followed attempts to produce immunity by means of vaccines composed of Types 1, 2, and 3 of pneumococci. The use of vaccines in the treatment of pneumonia is still in the experimental stage.

Pneumococci in Other Diseases.—Pneumococci are frequently found in the blood of pneumonia patients, and may be carried to other parts of the body, where they may lodge and grow. The principal diseases which may be caused by pneumococci growing outside of the respiratory tract are meningitis, inflammation of the middle ear, pericarditis, and endocarditis. A pneumococcus meningitis is often a complication of pneumonia, and it may also occur without signs of a respiratory disease.

Secondary Pneumonia.—Pneumococci and streptococci frequently invade the lungs and produce pneumonia during the course of other acute infectious diseases, especially influenza, measles, and whooping-cough. Pneumonia follows measles and whooping-cough in cities and institutions more frequently than in country districts, owing to the more frequent opportunities of acquiring a virulent infection under crowded conditions.

WHOOPING-COUGH

Whooping-cough, or pertussis, is caused by an extremely small germ called the Bacillus pertussis. The germs closely resemble influenza bacilli and germs which are naturally found in the saliva. The specific germs of whooping-cough are found in the sputum and in nasal secretions. They are obtained in cultures with difficulty during the first week of the disease, but readily at its height. The blood of about half of the patients after the first week of the disease contains antibodies which will agglutinate pure cultures on the germs; but the recognition of the disease by laboratory methods is uncertain, and the principal reliance in diagnosis must be placed on the clinical signs.

The germs of whooping-cough grow in the nose, throat, and respiratory tubes, and produce an inflammation and the signs of an ordinary cold. The incubation period is from three to eight days. The premonitory symptoms are like those of a simple cold, and last about a week, and then follows a week or more of attacks of the characteristic coughing. The germs are usually produced in the greatest abundance at the beginning of the second week of the disease, and they usually disappear by the end of the third week, although the inflammation and cough may continue much longer. One of the greatest dangers connected with the disease is a pneumonia caused by a secondary infection with pneumococci, streptococci, influenza bacilli, and other virulent micro-organisms.

Prevention.—Whooping-cough is spread by contact and by droplet infection. A person who has the disease may expel droplets of infected saliva and mucus to a distance of 4 or 5 feet during the violent coughing spells. The prevention of the disease consists in keeping the sick at least 5 feet away from the non-immunes. There is only a slight chance of infection after a patient has been isolated three weeks. The disease is not extremely infectious, and less than a third of exposed children catch it. The complete prevention depends upon the recognition of all cases before the whooping stage, for the bacilli are expelled for days before the whooping begins. When whooping-cough is epidemic, it is necessary to isolate every child with a cough or apparent cold in the head. One plan is to allow an affected child its freedom provided it wears a yellow band as a distinctive sign of its infection.

Vaccine Treatment.—The injection of whooping-cough germs into lower animals causes them to form protective antibodies against the germs. This principle has been applied in giving subcutaneous injections of pure cultures of the germs for the prevention of whooping-cough and for the cure of the disease. The vaccine is of great value as a preventive. When a case develops in a family of children, preventive doses will probably protect the others from taking the disease. The vaccine is of less value after the disease has begun to show evident signs, and of little value if its administration is begun after severe symptoms have developed. The doses recommended by the New York State Department of Health for prevention are three injections three days apart, containing, for children, 500,000,000 bacilli for the first dose, 1,000,000,000 for the second, and 2,000,000,000 for the third; and for adults 1,000,000,000, 2,000,000,000, and 3,000,000,000. The curative doses for children under one year are 250,000,000, 500,000,000, 1,000,000,000, 1,500,000,000, and 2,000,000,000. For patients over one year the doses are 500,000,000, 1,000,000,000, 2,000,000,000, and again 2,000,000,000. Very little soreness or other reaction is usually produced by the injections.

INFLUENZA

Influenza and the grip are terms that are applied loosely to any form of acute respiratory disease that is not evidently pneumonia, but they properly refer only to the sickness that is produced by the influenza bacillus. The bacilli of influenza will grow on an ordinary culture-medium if it contains hemoglobin. They are readily killed by drying, but may remain alive in dust that rises from freshly dried sputum. They are spread by the contact of one person with another, especially by means of droplet infection.

The various strains of influenza bacilli differ in their virulence. Non-virulent strains are wide-spread and may often be found in the throats of healthy persons. A virulent strain may suddenly arise and produce a worldwide epidemic, as in 1889 and 1918.

Influenza itself is not a particularly dangerous disease, but it renders a patient extremely susceptible to pneumonia. Pneumococci and streptococci are likely to grow in the lungs of those who are weakened by influenza. Death from influenza is usually caused by pneumonia germs which grow along with the special bacteria of influenza. When an epidemic of influenza occurs, about one-fifth of the cases usually develop pneumonia, and about one-fifth of the pneumonia cases die.

The susceptibility to influenza is greatest during early adult life. One factor which accounts for the prevalence of the disease in army camps is that soldiers are at the most susceptible age to catch influenza.

A Cold.—A common cold is a name that is applied to almost any mild infection of any part of the respiratory tract, especially the nose or throat. Pneumococci and streptococci have frequently been identified as the cause of rhinitis, pharyngitis, and tonsillitis. Cases of pneumonia are often preceded by obstinate pneumococci colds, and the organisms extend from the nose to the lungs when the general health and resistance of the body become lowered.

Micrococci catarrhalis and diphtheria bacilli are also frequently identified as the cause of rhinitis or coryza. The nasal secretions in many mild cases of acute colds are found to be sterile within a day or two after their onset, and this fact suggests that some colds may be caused by a filterable virus of mild virulency.

Research into the bacteriology of common colds is one of the greatest needs in public health. Two practical points for a health officer to consider are (1) a common cold is an infectious disease, and (2) affected persons are carriers of disease germs which are likely to be virulent pneumococci, streptococci, diphtheria bacilli, or other variety of virulent micro-organism.

A mild case of whooping-cough is often mistaken for a common cold. A case of measles resembles a common cold during three or four days previous to the appearance of the skin eruption.

Carriers.—Pneumococci may often be found in the noses and throats of healthy persons, but they usually belong to Type 4, and are not virulent. Persons who come in close contact with a case of pneumonia frequently harbor pneumococci of the same type as those of the patient, but the organisms tend to disappear in a few days or weeks unless their supply is renewed by repeated contacts with an actual case of sickness. Non-virulent pneumococci also tend to disappear, but they are often renewed by contact with other persons. Small groups of persons who are absent from inhabited regions for long periods, as, for example, sailors on long voyages, and explorers in Arctic regions, usually become free from pneumococci and other bacteria of acute respiratory diseases, and do not contract pneumonia or colds even when they are exposed to cold, dampness, fatigue, and other conditions which often lead to respiratory diseases in peopled regions. It may be considered that nearly every person in a city or village is a carrier of pneumococci, and that the bacilli may

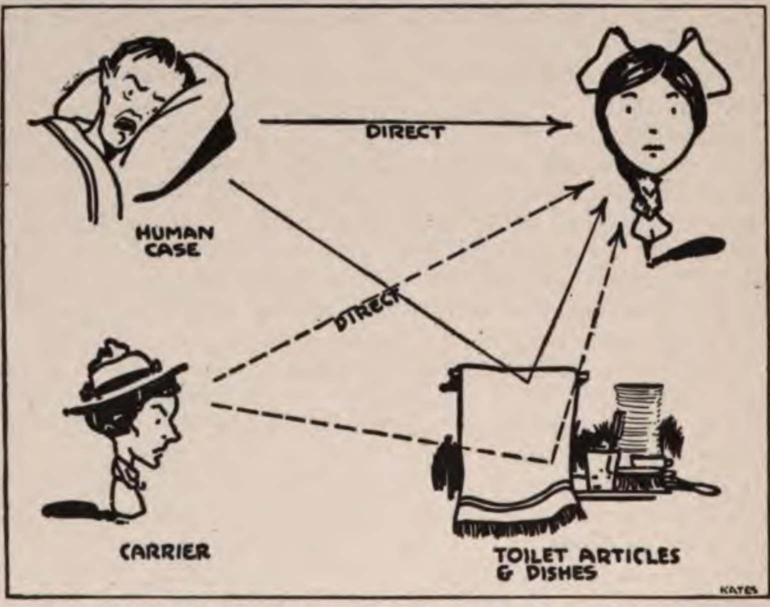

Fig. 13.—Method of transmission of acute respiratory diseases.

invade the tissues and grow when the general health and vigor of the body become impaired.

Epidemiology.—Acute respiratory diseases, including colds, influenza, and pneumonia, are alike, in that they are all highly infectious, and that the infectious material is found in the excretions of the nose and throat. Each is caught from an affected person in the same way that measles or smallpox is caught. A disease often goes through a whole family when one member becomes sick. Wives catch it from their husbands, parents from their children, and nurses from their patients. An acute respiratory disease may develop within two days after the bacilli are taken into the body. That the incubation period is short is shown by:

1. The development of the disease after a known infection, such as a patient coughing into the doctor's face during a throat examination.
2. The sudden development of many cases among a group of workmen or soldiers who are exposed to a known case.

The principal things which contain the bacilli of acute respiratory diseases are:

1. Droplets expelled by violent expiratory acts, such as coughing, sneezing, loud talking, and hard laughter (page 170).
2. Hands soiled with the excretions of the nose and throat.
3. Dishes and toilet articles which have been used by patients or carriers.
4. Dust rising from freshly dried sputum.

When these things are controlled, the diseases are not likely to spread.

The principal means by which the germs of acute respiratory diseases are spread are:

1. Contact with a case.
2. Crowding.
3. Spitting.
4. Poor ventilation.
5. Uncleanliness.

The principal means of infection by contact are:

1. Droplet infection.
2. Hands soiled with the excretions of the nose and throat either directly or through dust.
3. Dishes, toilet articles, and bed-clothing soiled by the patient or carrier.

Crowding increases the chances of infection by—

1. Bringing people close together.
2. Increasing the number of sick persons and carriers with whom each person comes in contact.

3. Increasing the amount of infectious material in a given space.

Spitting on floors is a common means of spreading respiratory diseases, for dust from freshly dried sputum may contain living bacilli. One's hands soiled with the dust of dried sputum may carry the bacteria to the nose or mouth.

Poor ventilation promotes the accumulation of infectious dust, especially in rooms in which persons spit on the floors. Droplets of excretions from coughing or sneezing also become dried and add to the amount of infectious material in the dust of crowded meeting places, especially when ventilation is poor.

Uncleanliness in any respect, especially of the hands, promotes the chances of infection with the bacteria of colds and other acute respiratory diseases.

The resistance of the body to the growth of the bacteria of respiratory diseases depends on—

1. Specific immunity.
2. Bodily vigor.
3. Fatigue or other temporary weakness.

There are many varieties and strains of the bacteria of respiratory diseases, and no one is either susceptible or immune to all of them. Probably one-third or one-half of the people are immune to the kind that is the cause of any given epidemic. Bodily vigor and physical endurance are usually associated with a high degree of immunity to respiratory diseases; but exposure to cold, fatigue, dissipation, or other conditions which temporarily weaken the body lessens the immunity and increases the susceptibility to infection. The period of incubation is so short that a respiratory disease may develop before the body has time to recover its strength. This fact accounts for the frequent development of pneumonia in those who are strong and vigorous.

The evident effects of cold, fatigue, and dissipation on the feelings and actions have led to the popular belief that they are the essential or principal factors in the cause of colds and pneumonia. They are only passive causes; the active cause is always an infection with the specific germs of the disease.

Duties of a Health Officer.—The cause of an acute respiratory disease is a human case or a carrier; and the measures for its control are similar to those for the prevention of measles or smallpox. The duties of a health officer in regard to acute respiratory diseases are:

1. The discovery of cases.
2. The isolation of affected persons.
3. The control of the routes of infection.

4. Measures for increasing immunity.
5. Educational measures.

Reporting Cases.—Acute respiratory diseases are about as contagious as measles, and a health officer cannot control them unless he knows where cases are. The reporting of all cases of pneumonia and influenza by physicians is necessary, and is required by many health departments and boards of health.

A health officer may have to search for cases, especially in a school or an institution. Taking the temperatures of all exposed persons daily may be necessary in order to detect the first signs of the onset of the disease.

Isolation of known cases of acute respiratory diseases is as necessary as isolation for diphtheria. A health officer's duty is plain in fully developed pneumonia, but there is no definite standard by which he can judge the milder cases. A number of different germs may cause any type of acute respiratory disease, and it is not always possible to detect the specific germ in a given case. It is the duty of a health officer to inform the members of an affected family of the infectious nature of the sickness and to advise them in the methods of preventing the disease from spreading.

A person sick with an acute respiratory disease gives off virulent disease germs in the sputum and other discharges from the throat and nose. The measures for preventing the spread of the germs are:

1. Collecting and destroying the sputum.
2. Cleanliness of the patient, the sick room, and everything in the room.
3. Precautions by the attendants to avoid taking the germs from the patient by droplet infection, and soiled hands. Special precautions are: (*a*) wearing face protectors or masks, and (*b*) washing the hands immediately after handling the patient or soiled articles.
4. Disinfecting the dishes, toilet articles, and bed-clothing with boiling water.
5. Final disinfection of the room and its contents by means of cleanliness, fresh air, and sunshine. The germs are readily killed by the ordinary means used in house cleaning.

The length of time for continuing the isolation of a case cannot usually be determined from a culture from the nose or throat. A practical rule is to continue the isolation until the lungs, nose, and throat are in a normal condition.

It is a necessary rule that every person with a cold or cough shall be excluded from schools, churches, theaters, and other meeting places. An acute respiratory disease is in its most infective stage during the first hours of its onset. There is no means of determining whether a mild fever with nose or throat signs is only a slight cold, or is the beginning of a deadly pneumonia. A wise rule is that the patient shall remain in isolation at home until the nature of the sickness can be determined.

Control of the Routes of Infection.—The public measures which a health officer can take to control the spread of acute respiratory diseases are:

1. The adoption and enforcement of rules and regulations regarding spitting.

2. Requiring every person to cover the nose and mouth when coughing or sneezing. The departments of health of the city

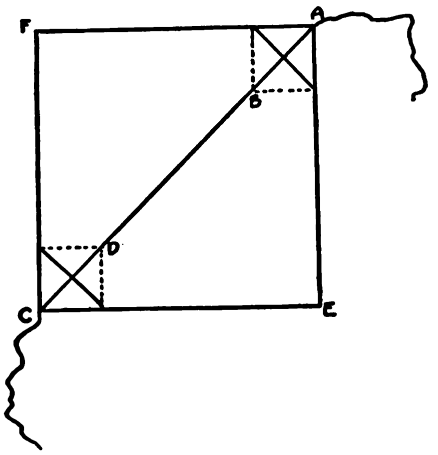

Diagram of a face mask made from a paper napkin.

and state of New York make it a misdemeanor for any one to cough or sneeze in public without covering the nose or mouth.

3. Closing schools, churches, theaters, and other meeting places. This is a measure of last resort to be used when there are no public health nurses or other agencies to supervise those who attend the meeting places.

4. Control of the hours of opening factories, theaters, and other public meeting places in order to avoid crowding on railroads and street cars.

5. Enforcing cleanliness of streets, railroad stations, cars, factories, and public meeting places.

6. Measures to prevent the spread of infection in crowded sleeping quarters, such as providing at least 3 feet of space be-

tween beds; placing screens or hanging sheets between the beds; and facing the heads of sleepers in opposite directions so that the head of one person is opposite the feet of the next.

7. Provision for treating and curing persons who have any of the diseases or a chronic cold.

Face Masks.—The great value of face masks is to prevent the expulsion of infective droplets by the sick or carriers. They prevent the entrance of moist droplets, but they are of little value against dust. They may be harmful when they are soiled and contain dried sputum. Two layers of muslin are as efficient as ten of coarse gauze in preventing the expulsion of droplets. An efficient face mask that is recommended by the New York State Department of Health may be improvised by folding a paper napkin according to the diagram on page 248.

Fold *A* upon *B*, and *C* upon *D*. Lay a tape across from *A* to *C*. Fold *E* upon *F*. Tie the string around the head above the ears.

Increasing Immunity.—Measures to increase immunity include:

1. The control of conditions of working, feeding, exercise, fatigue, ventilation, recreation, and exposure to excessive dampness and coldness.

2. The control of other diseases, such as measles and whooping-cough, which often lead to pneumonia.

3. The use of vaccines.

Extensive experiments have been made to determine the value of vaccines in preventing acute respiratory diseases. Streptococci do not induce immunity to pneumonia.

Types 1, 2, and 3 pneumococci will induce a high degree of immunity to those types, but not to Type 4 or to other organisms of pneumonia.

Influenza bacilli may induce an immunity to the strains that were used in making the vaccine.

Education of the Public.—The preventive measures which can be carried out by health boards, health officers, public health nurses, physicians, and other persons in authority are only about 50 per cent. efficient in themselves on account of the great number of mild cases or carriers which do not come to the attention of the officials. The control of acute respiratory diseases in a community requires the intelligent co-operation of all the people. This co-operation will not be secured unless the people understand the elementary principles of the causes of the diseases and the methods of their spread. The ways by which the diseases are spread are numerous, and a lengthy set of rules would be required in order to block all the routes of infection.

But, fortunately, the foundation principles are few and simple and can readily be grasped by an ordinary person.

Intestinal diseases have become rare because the people are fairly well educated regarding the dangers from the excretions of the bowel and bladder, and use a considerable degree of care in preventing the spread of the excretions from one person to another. But the people are not yet educated regarding the danger from spit and phlegm, and do not keep in mind the methods by which the excretions of the nose and throat are spread. Three essential things which every person should know about colds, influenza, pneumonia, and other acute infectious diseases are:

1. They are caught from other persons who have the disease.
2. They are spread by means of spit and phlegm.
3. The essential preventive measures are included in the rules of good manners and politeness.

The following catechism[1] may be used in teaching the people regarding the prevention of acute respiratory diseases:

Q. What are some forms of colds?

A. 1. A common "cold in the head."
2. Influenza or "grip."
3. Pneumonia.

Q. What is the cause of a cold?

A. Disease germs which can be seen and measured. There are several kinds of germs, some of which are more poisonous than others; but the most poisonous may produce only a mild cold in a strong person.

Q. Where do the germs grow?

A. In the noses and throats of persons.

Q. Who are likely to have the germs?

A. Four classes of persons:
1. The sick, even the mildest cases.
2. Those about to be sick.
3. Those who have been sick and have recently got well.
4. Carriers, or those in whose mouths or noses the germs grow without producing sickness. The germs in carriers do not grow in the flesh, but on the surface of the lining of the mouth and nose, and in the spit and mucus.

Q. From what source does a person get the germs?

A. From some one who has the germs in the nose or mouth.

Q. How are the germs given off from the body?

A. With anything that comes from the nose or mouth, such as saliva, spit, phlegm, or liquid from the nose.

[1] Published by authority of the Surgeon-General of the Army.

Q. Where are living disease germs likely to be found outside of the body?

A. On anything which a person soils with saliva, spit, or phlegm. For example, they are found on a floor on which a person with a cold has spit, and on a towel on which he has wiped his face, and on a pillow on which he has slept. Any dirt that comes from a person with a cold may contain the disease germs.

Q. What are the principal means by which the germs are naturally killed?

A. Sunlight, drying, and cleanliness.

Q. How long will the germs of colds live outside of the body?

A. Hours and days in places which are dark, damp, and dirty; only an hour or two or a few minutes in places which are sunny, dry, and clean.

Q. When will the germs of colds be found on floors, bedding, dishes, and other things?

A. When these things are dirty and damp. The germs cannot live on things which are clean and dry, and have lain in the sunlight.

Q. Why are dishes and table utensils likely to spread colds?

A. Because they are soiled with saliva and spit when a person eats from them. If they are washed in *boiling* water the germs on them will be killed. This is the reason for boiling the dishes after they have been washed.

Q. When will the air contain the germs of colds?

A. 1. When dust floats in it.
2. When an affected person blows germs into it. The outdoor air is nearly always free from disease germs.

Q. What kind of dust contains living germs of colds?

A. That rising from floors and things which are soiled with spit and phlegm. The living germs will be found in the air of rooms in which persons spit on the floor.

Q. When will the air near a diseased person contain disease germs?

A. When he blows tiny drops of spit and phlegm into the air. He will blow them out when he sneezes, coughs, laughs hard, or talks loud.

Q. How far will the germs float in the air?

A. Only 2 or 3 feet, for the drops soon fall to the ground. You are safe if you are 2 or 3 feet from a diseased person.

Q. What are the most common means of spreading disease germs?

A. 1. By means of droplets of spit and phlegm.
2. By means of soiled toilet articles.
3. By means of soiled hands.

Q. What are the principal means of keeping disease germs from spreading?

A. 1. Quarantine or isolation.
   2. Care by each person himself.
   3. Cleanliness.

Q. Why are sick persons quarantined or isolated?

A. To keep them, and everything that they have used, away from other persons.

Q. Why may the quarantine or isolation of known cases fail to stop a disease?

A. Because a physician may not see the cases until a few hours after the disease begins; and because many persons do not call a physician when they are only slightly sick.

Q. What is the danger from those who have only slight colds?

A. A cold may be caused by the same germs that will produce a deadly pneumonia in the next person.

Q. What can each person do to keep from catching cold?

A. 1. Keep away from crowds.
   2. Keep your face 2 or 3 feet away from the face of another person.
   3. Cover your mouth and nose when you cough or sneeze.
   4. Do not sneeze or cough or talk loud into the face of another person.
   5. Use clean towels and other toilet articles. Do not use any which have been used by another person. Wear a nose and mouth protector. Many other rules could be made, but you must think for yourself and use common sense. The rules of good manners and politeness will protect you from colds and influenza.

Q. What parts of the body must you keep clean in order to keep from catching cold?

A. The hands, the mouth, and the nose.

Q. Why must the hands be washed?

A. 1. Disease germs may stick to them when you touch your nose or mouth.
   2. If they are dirty, you may carry disease germs into your mouth when you eat. Be sure to wash your hands before you eat or handle food.

Q. Why is cleanliness of the mouth and nose necessary?

A. 1. To remove the germs which may be growing there.
   2. To remove disease germs before they have time to grow.

Q. How can you cleanse your mouth?

A. Brush the teeth morning and night. Rub the toothbrush over the top of the tongue and the roof of the mouth. These parts become as dirty as the teeth.

Q. How can you cleanse your nose?

A. By blowing it. Close one nostril and blow through the other. Do this with each nostril. Do not try to blow both nostrils at the same time.

Q. What is the cause of "mouth-breathing"?

A. The nose is stopped up.

Q. What harm comes from mouth-breathing?

A. One harmful result is that disease germs may be held in the nose and cannot be blown out. If you cannot blow air through a nostril, that nostril is stopped up with flesh or bone. Go to your physician and let him treat you so that you can breathe through your nose.

CHAPTER XXIV

INFECTIONS OF THE DIGESTIVE ORGANS

Typhoid-colon Group.—Acute diarrheas may be due to three causes: 1, Irritating substances, such as green fruit or spoiled food, in the intestine; 2, toxins or other products of decomposition; and 3, poisonous bacteria growing in the intestine. All three causes may operate together.

The intestine is a natural culture-tube in which countless bacteria grow. The majority of those which flourish in the intestine form a closely related group, consisting of the colon, typhoid, paratyphoid, and dysentery bacilli, of which there are many subspecies.

The colon bacilli naturally inhabit the intestine and do not usually do harm. Some of the colon group are beneficial, for they produce lactic acid and have a marked effect in restraining the growth of the organisms of disease and fermentation. But sometimes the colon bacilli invade the tissues and produce sickness. These virulent forms of the colon group may be bacilli which are naturally found in the intestine, and which are able to grow on account of a loss of immunity by the body, or they may be new and virulent strains introduced from outside the body. The typhoid, paratyphoid, and dysentery members of the group are harmful to the body, although certain persons may have an immunity to them just as they have to ordinary colon bacilli. The typhoid bacillus is the best known and most common of the harmful members of the group.

TYPHOID BACILLI

The micro-organism of typhoid fever is called the typhoid bacillus. It has numerous flagellæ, and is in constant motion during life. The characteristic lesions of typhoid fever are swellings and ulcerations of the lymphoid tissue of the intestine. The bacilli are plentiful in the blood during the first week of the disease, and through it they reach every part of the body. They have been found growing in lesions in the lungs, central nervous system, bones, liver, spleen, and other parts of the body. They are constantly found in the contents of the intestine, and in about half of the cases in the urine also. The fever and prostration of the disease are due partly to poisons developed by the germs in the blood and tissues, partly to poisons absorbed from the intestines, and partly to streptococci, colon bacilli, and other bacteria which may grow with the specific typhoid bacilli of the disease.

Typhoid bacilli may be found in anything that is soiled or contaminated with the discharges of a typhoid patient. They may remain alive in sewage, water, milk and other foods, and on the hands of nurses who care for the patients. A person catches typhoid fever by swallowing something which has been

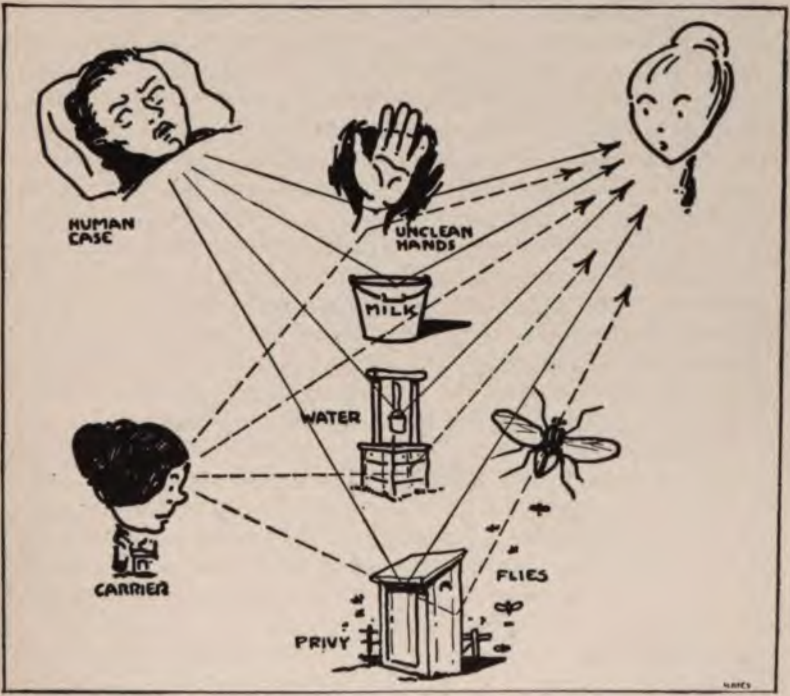

Fig. 14.—Method of transmission of typhoid fever.

contaminated with the excretions of those afflicted with the disease or who are carriers of the germs.

Susceptibility.—The susceptibility of persons to typhoid infection varies greatly. Gastric juice of good quality has great power to digest the bacilli which are swallowed, and a healthy epithelial lining of the intestine has a considerable resistance against them, but if a person has a gastric indigestion or an intestinal disturbance, the typhoid bacilli may gain lodgment in the intestine and may produce the disease. A water-borne outbreak of typhoid is often preceded by the development of many cases of simple diarrhea. These cases may come from two causes. When typhoid bacilli enter the water, the bacteria of diarrhea and other common intestinal disturbances enter it also, and the two sources of infection may exist together. Also many dead bacilli and products of their action may enter the body and produce a simple poisoning or toxemia. Both of these conditions produce a susceptibility to typhoid bacilli, and may be secondary factors in producing typhoid.

Recognition of Typhoid Fever.—Typhoid fever produces a fever whose onset is slow and insidious. There are usually vague and indefinite pains in the abdomen, and a disturbance of the intestine. A slow, persistent course of these three symptoms is suggestive of typhoid fever. The disease in a mild form, or walking typhoid, is often unrecognized for days and weeks, for the signs are those of an ordinary intestinal disturbance. If the symptoms persist for a few days, even in a mild form, without positive signs of some other disease to account for them, it is the duty of the physician or health officer to take the necessary steps to make a positive diagnosis, and to begin the protective and preventive measures against the spread of the disease. Three positive diagnostic signs are the presence of the bacilli in the blood, the agglutination of a pure culture of typhoid germs by the blood-serum of the suspected person, and the presence of typhoid bacilli in the intestinal excretions.

Blood-culture.—A culture made from the blood will usually reveal the bacilli during the first week of the disease. The bacilli may disappear during the second week. The culture is made by obtaining a fresh supply of the proper culture-medium from a laboratory and inoculating it with blood drawn from a vein with a sterile syringe. If the culture-medium is not at hand, the blood may be inoculated into about ten times its bulk of sterilized distilled water and taken to the laboratory as quickly as possible. The bacilli which develop may be recognized by means of agglutination tests made with a serum containing typhoid antibodies.

The *Widal reaction*, or the test for agglutinating antibodies in the blood-serum of suspected cases, is a simple and reliable laboratory test for typhoid fever. The method of performing it is described on page 147. A positive reaction appearing promptly in a serum dilution of 1 : 40 indicates typhoid fever. The antibodies usually begin to appear in the blood during the second week of the sickness, but they may be delayed until the third or fourth week, and in rare cases they may not be present at all. They usually persist for years after recovery from typhoid, and are present after vaccination with typhoid bacilli. They are usually present in the blood of carriers of typhoid bacilli.

A Widal reaction will be given by those who have been vaccinated with typhoid bacilli. Always inquire whether or not the person from whom a specimen is taken has received typhoid vaccine.

The agglutination test may be made with fresh blood-serum, or with serum from a blister, or with dried blood. It is the duty of every health officer to know how to take samples of blood for a Widal test. The method of taking a sample of dried blood is as follows:

1. Use alcohol and sterilize (*a*) the back of the finger just behind the nail; (*b*) a needle (Hagedorn); (*c*) a microscope slide.
2. Prick the sterilized flesh with a quick stab of the needle and press out a drop of blood.
3. Apply the slide to the blood, making two or three spots.
4. Allow the specimen to dry, wrap it in a clean paper, and send it to a laboratory for examination.

Typhoid Carriers.—The bacilli which cause typhoid fever grow in the blood during the incubation period and early stage of the sickness, and may not be found in the intestinal excretions until the second week of the disease or later. Great numbers may usually be found in the excretions after the first week. They usually diminish in number during the stage of convalescence, and are entirely gone by the time the patient has recovered; but they persist in about 1 per cent. of cases. They may continue to grow in the gall-bladder and bile-ducts and in other parts of the intestine. A person in whom they persist is called a typhoid carrier, and is a source of danger to other persons. The most practical means of detecting a typhoid carrier is by finding the typhoid bacilli in the intestinal excretions. Typhoid bacilli are also sometimes found in the urine of carriers.

Examination of Intestinal Excretions.—The typhoid bacilli in intestinal excretions are always mixed with colon bacilli and other bacteria. The detection of typhoid bacilli depends on their enrichment by their growth on a medium unfavorable to the associated organisms (page 136). The method is as follows:

1. Prepare a lactose-agar medium to which a minute quantity of the dye, brilliant green, is added, and pour it into Petri dishes.
2. Rub a small quantity of intestinal excretions with about fifteen times its volume of water and let it stand for half an hour.
3. Take a loopful of the surface layer of the liquid and streak it over the surface of the medium and incubate it for about twelve hours.
4. Choose a typical colony and test its agglutination with typhoid serum.

While typhoid bacilli may exist for days in infected water and food, their cultivation is difficult and uncertain a few hours after the intestinal discharges have left the body, for colon bacilli and other intestinal organisms tend to multiply and overgrow them. It is necessary that the fresh excretions be used for a test. A health officer may take a specimen from the fresh excretions with a sterile swab of cotton, enclose it in a sterile test-tube, and send it to a laboratory as quickly as possible. The New York State Department of Health supplies health officers with mailing outfits for taking samples for typhoid culture tests.

Typhoid Vaccination.—When a vaccine of killed typhoid bacilli is injected into the body, it produces antibodies which consist of agglutinins and also of substances which protect the body against living typhoid bacilli. The protection afforded by the vaccination has been tested on a large scale in the American Army, and its effectiveness proved. It is not an absolute protection, but it will protect against an amount of infection which a person is likely to take into the body. The protection lasts for at least two or three years.

Vaccination done after a person has been infected with typhoid bacilli hastens the onset of the sickness and the development of the disease, but it shortens the course of the fever. It is of little or no value in the treatment of the fever.

Typhoid vaccine is given subcutaneously into the arm over the insertion of the deltoid muscle. Three doses are given a week apart, the first of 500,000,000, the second and third of 1,000,000,000 bacteria. A single dose confers very little immunity, and many of the cases of typhoid after vaccination have followed insufficient amounts. The injections produce a soreness at the site of injection, and a slight fever and feeling of sickness. The Department of Health of New York State supplies health officers with the material for typhoid vaccinations.

A practical and efficient form of material for antityphoid inoculation is that known as lipo vaccine, in which the bacteria are suspended in oil instead of water. The three doses may be given at once, for the oil retards their absorption.

Disinfection of Excretions.—The routes by which typhoid bacilli usually leave the body are the intestine and bladder, and millions of the bacteria are found in the excretions of these two organs in typhoid cases and carriers. The disinfection of these two excretions is one of the great problems in sanitation. One method of disinfection is by means of heat. Various devices have been invented for boiling the excretions without producing odors. They are successful in camps and hospitals where experts are in attendance, but they are impractical for an ordinary health officer.

Chemicals are frequently used for disinfecting typhoid excretions. Unslaked lime is often used, but its action depends upon the heat that is generated by the slaking and not upon any special disinfecting quality of the lime itself. Two difficulties with disinfectants are the penetration of masses which are jelly-like or solid, and the length of time required for the destruction of the bacilli. They are about 80 per cent. efficient, and a health officer cannot rely on them alone. The method of disinfection recommended by the New York State Department of Health is as follows:

Prepare a solution of chlorid of lime by adding ½ pound to 1 gallon of water. Pour about a pint of the solution into the vessel in which the excretions are to be received. Pour over them an amount of the solution equal to twice the volume of the excretions. Stir the contents of the vessel and allow them to stand for an hour before emptying them.

The final disposal of excretions is of the utmost importance even when disinfectants are used. If the plumbing of a house is connected with a public sewer, the discharges may be emptied into it, for the final destruction of typhoid bacilli is supposed to be done at the disposal plant. If the house plumbing is connected with a private cesspool which is in good order, the excretions may be emptied into the toilet receptacle. The excretions may be safely emptied into an outdoor toilet only when its receptacle is water-tight and fly-proof. The most practical method of their disposal in the country is by burial in the soil. Provide a deep hole at least 2 feet square, and cover each collection of excretions at once with at least 6 inches of soil. Use the hole until it is half filled, and then dig another one. If the ground is frozen, the health officer must devise some method of preventing the excretions from being washed away during the spring thaws.

Management of a Case.—When a case of typhoid fever develops, the first duty of the health officer is to shut off all the avenues by which the disease spreads. The infective material is not air-borne, nor spread by droplets of saliva or nasal mucus, nor by ordinary dust from dried material. A strict isolation or quarantine is therefore unnecessary. Since the typhoid bacilli are contained in the excretions of the intestine and bladder, the precautions are directed against the routes by which excretions may be carried from the patient to other persons even in minute amounts. The protective measures which a health officer must take are as follows:

1. Exclude all persons, except the necessary attendants, from close contact with the patient. A near friend or relative who calls may sit beside the patient if the bed is covered with a clean sheet and the visitor does not touch the patient.

2. Secure an intelligent and capable nurse who will observe the necessary precautions. There is great danger of spreading infection if a mother cares for a case and at the same time does the cooking and household work for her family. It will pay a community to hire a competent nurse at public expense if the family cannot afford to employ one.

3. Provide a disinfecting solution, at public expense if necessary, and give instructions to the nurse and other attendants that they shall keep a bowl of it ready at all times, and shall wash their hands immediately after doing anything to the patient or handling the bed, or soiled clothes, or excretions. Warn the attendants against putting their soiled hands to their mouths.

4. Exclude flies from the room and from contact with the excretions or soiled clothes and dishes of the patient.

5. Pay special attention to the disinfection and disposal of excretions, and to the cleansing of the vessels in which they are handled. A health officer must make a personal inspection of the place in which the excretions are finally emptied, and give detailed orders for their disposal.

6. Boil all used dishes before they are washed. Provide a wash-boiler for receiving soiled clothes, towels, and other articles that are used by the patient, and boil them before they are laundered. If they are kept protected, and are boiled, there will be no need for soaking them in a disinfecting solution.

7. Inquire into the occupations in which the well members of the family are engaged, and exclude them from handling food so long as they live at home or come in contact with the patient. A milkman must leave the house, and keep all the dairy utensils away from it. The New York Sanitary Code, Chapter 2, Regulations 37-39, has detailed directions regarding handling foods by persons who may come in contact with cases of typhoid and other communicable diseases.

Epidemiology.—A health officer has not completed his duty when he has instituted the measures for the control of a case of typhoid fever. The case originated from another, and it is the duty of the health officer to find the original one and to break up the route over which the bacilli traveled to reach the patient. If he can find either the original case or the route of transmission of the disease, he will usually be about 90 per cent. successful in controling the spread of the disease. If he can find both the original case and the route of its transmission, he can score 100 per cent. of success. He will conduct the investigation along the lines indicated on page 179.

When a health officer starts to investigate an outbreak of typhoid fever, the first thing for him to do is to obtain a history of each case with special reference to the dates of onset of the sickness, and to what each patient was doing during the time when he became infected. The date of onset is usually given as that on which the patient took to bed, but there have usually been indefinite pains and other signs of sickness which the patient or members of the family can recall. The date of onset of the sickness may usually be considered to be the date on which the first definite signs were noticed. The date on which infection occurred is the important date which a health officer seeks. It will usually be a week or ten days previous to the date of onset, but it may be only four or five days, or as much as three weeks.

The health officer will make diligent inquiry concerning the actions of the patient about the time when infection could have occurred. He will have in mind the four great public routes—water, milk, food, and flies—over which the infectious material may have been carried to the patient from a distant, unknown case, and also the private route of direct contact with a nearby known case. The investigation in a typhoid fever epidemic will be more complicated than that in any other disease, for the possible sources of infection are many. The patients themselves are often unable to recall clearly where they have been, what they have eaten, and whom they have met.

If there are a number of cases, an analysis of the data will reveal the elements which are common to many or all of the cases. Dates of onset near together would indicate a common source of infection, such as a banquet, picnic, excursion, or a flooding of the public water-works. An interval of a week or so between two series of cases would point to a spread of infection from the original cases to secondary ones.

Water as a source of infection would be indicated by a distribution of the cases over the whole area supplied by the water, and would be confirmed or disproved by an analysis of the water and an inspection of the water-shed.

Infection through milk would be indicated by the distribution of the cases along a particular milk route, and a health officer would follow up the clue by an investigation of the workmen in the dairies and on the farms from which the milk is obtained.

The transmission of typhoid by food would be indicated by a common source of food, such as a banquet or a particular restaurant. The source of the bacilli will usually be found to be a carrier who has recently started work. The possibility of infected oysters must also be remembered.

Another source of food infection is green foods which are eaten raw, such as celery and lettuce. The infection may come from sewage or house slops used in watering the garden, or from an infected brook or drain in which the vegetables were washed. These sources are improbable, and yet the disease now spreads principally by unusual and unsuspected routes, for the usual routes are watched and guarded.

The occurrence of cases in summer and early fall among those who live amid unsanitary surroundings would point to flies as the source of infection. Confirmatory evidence would be the presence of flies and of open privies, and further evidence would be the occurrence of cases of persistent intestinal disorders in the neighborhood.

The detection of the great routes of transmission of typhoid fever, and the discovery of cases who are sick in bed, are comparatively easy, but it takes persistent effort to discover carriers. A carrier may have had only a mild sickness many years previously, and may be inclined to conceal the fact, or may have forgotten it. A typhoid carrier may be recognized by the Widal test and by an examination of the intestinal discharges. Nearly all carriers give a positive Widal reaction, for they are immune to typhoid bacilli.

If a health officer suspects a person to be a typhoid carrier, his first procedure will be to take a sample of blood. If the Widal test is positive, his next step will be to take a specimen of the intestinal discharges. He has no direct power to compel a healthy person to provide a specimen for examination, but he can use indirect means to secure it. Most persons will yield to explanation and persuasion, or their employers will compel them to yield. Making routine examinations of the blood and of the discharges of suspected persons has enabled the New York State Department of Health to do brilliant work in discovering carriers who have been the innocent causes of the continual existence of typhoid fever in their neighborhoods for years.

When a health officer has discovered a typhoid carrier, the great problem is what to do with the person. The measures which the health officer may take are:

1. Exclude the carrier from occupations in which food is handled.

2. Teach the carrier personal cleanliness and the proper disposal of his excretions.

3. Advise the carrier to undergo an operation for the removal of the gall-bladder. This operation is effective in about half of the cases.

4. Advise the carrier to take the typhoid vaccination repeatedly with the object of inducing a higher degree of immunity which will overcome the germs.

PARATYPHOID FEVER

Bacteriologic studies have shown that there are bacilli which closely resemble those of typhoid fever, and which produce a disease which can scarcely be distinguished from typhoid, but which differ from typhoid bacilli almost as much as from colon bacilli. These bacilli are called paratyphoid bacilli. Their distinct identity is shown by their peculiar growths on culture-media, their failure to agglutinate with higher dilutions of typhoid serum, and the failure of typhoid vaccination to protect against infection with them.

Paratyphoid fever occurs either in isolated cases or in epidemics. It is spread in the same manner as typhoid, and the same procedures are used for its detection and prevention. There may be healthy carriers of paratyphoid bacilli, and a vaccine of the killed bacilli is efficient as a preventive against the disease. A health officer must always have the disease in mind in making a diagnosis of a case that is suspected to be typhoid, and in doubtful cases it is his duty to request that an agglutination test be made with paratyphoid serum as well as with that of typhoid.

Paratyphoid bacilli are themselves divided into two groups, A and B, which may be detected by their cultural and agglutination characteristics. Paratyphoid bacilli A usually produce a severe form of disease whose symptoms and course resembles those of a well-marked case of typhoid fever. Paratyphoid bacilli B usually produces a mild type of sickness which resembles an acute gastro-intestinal disturbance, and which lasts only a few days. The duties of a health officer in paratyphoid fever are the same as those in typhoid. Inoculations of killed bacilli are effective in producing immunity. The triple vaccine used in the American Army consists of typhoid bacilli, paratyphoid A, and paratyphoid B.

Paratyphoid Bacilli and Food Poisoning.—Some bacilli of the paratyphoid group may grow in cattle and produce a septicemia. The bacilli will grow readily in the meat of diseased cattle. They may be transferred from one piece of meat to another by contact. The bacilli produce toxins which are not destroyed by the heat of ordinary cooking. When a person eats meat that is infected with paratyphoid bacilli, the effects will depend largely on whether the bacilli are alive or dead. If they are alive, they may produce a paratyphoid fever. If the bacilli are killed by cooking, their toxins may remain active and produce an acute gastro-intestinal disturbance which usually comes on within from half an hour to twelve hours, depending on the rapidity of absorption of the poisons.

Most cases of so-called ptomain poisoning are caused by infection with paratyphoid bacilli. When a health officer hears of a number of cases of food poisoning, the proper course for him to take is:

1. Secure some of the food and send it to a laboratory as soon as possible for examination.
2. Secure samples of the intestinal excretions of the patients and send them to the laboratory to be examined for paratyphoid bacilli and other organisms.
3. Take precautions against the spread of the disease until a positive diagnosis is made.
4. After a week or two secure a sample of blood of the patients for agglutination tests.

BACILLARY DYSENTERY

Dysentery is a name applied to any disease in which the mucous membrane of the large intestine is inflamed or gangrenous. It may be recognized by a diarrhea with frequent discharges of mucus and blood. An acute form which sometimes occurs in epidemics is caused by a specific bacterium, the dysentery bacillus, which belongs to the typhoid-colon group. It resembles the typhoid bacillus in its manner of growth and production of agglutinins. It is found in the intestinal excretions, and may be recognized by the same methods of culture and agglutination by which the typhoid bacillus is isolated and identified. A diagnosis is made by agglutination tests and by a bacteriologic examination of the intestinal excretions. There may be mild, unrecognized cases of the disease and healthy carriers of the bacilli. A curative serum may be made for some forms of the disease. Dysentery spreads in the same manner, and may be controlled by the same methods as typhoid fever. A health officer will investigate an epidemic in the same manner that he would a typhoid outbreak, and will follow the same methods of control.

There are several varieties of the dysentery bacillus just as there are of the paratyphoid bacillus. They may be recognized by cultural and agglutination tests. Two types which are well known are those of Shiga and of Flexner. An extensive epidemic of the disease that occurred in New York State in 1916 was caused by the Flexner type of bacillus, and was started by mild cases and carriers. A curative serum was used with prompt success in treating the cases.

It is probable that unrecognized cases of bacillary dysentery occur every year. A health officer must keep the disease in mind and ask for the assistance of the State Department of Health when he suspects its presence.

A vaccine composed of killed dysentery bacilli produces immunity to the disease. A curative serum of great value is also produced, and is potent against the type of bacilli that was used in producing the serum, and less potent against other types. Uniformly satisfactory results are attained only when the serum suitable to the type of dysentery is used, as in pneumonia.

Amebic Dysentery.—A form of dysentery that occurs in the tropics is caused by an ameba. It has no relation to the epidemic form that occurs in temperate regions.

Common Forms of Dysentery.—The mild forms of dysentery, called summer complaints, are caused by bacilli belonging to the typhoid-colon group, and are analogous to the colds which affect the respiratory organs. They are infectious and every case probably develops after swallowing the bacilli from a previous case. It is probable that a great diminution in the number of babies who suffer with the disease would follow an isolation of every baby that has the disease, its protection from flies, the disinfection of its excretions, and the cleansing and disinfection of its body after every bowel movement. The public needs education regarding the infectiousness of ordinary forms of diarrhea and dysentery just as it does regarding the infectiousness of a common cold.

CHOLERA

Cholera Vibrio.—Cholera is caused by a curved bacterium called the cholera vibrio or spirillum. It has no relation to the typhoid-colon group of bacilli. It may be recognized by its curved form and rapid motion. It grows in the lining of the intestine, and destroys the epithelium of the mucous membrane. The severe symptoms are caused by an absorption of the poisons through the raw surface. The signs of the disease are those of a severe diarrhea with great weakness. The bacteria are given off with the intestinal discharges, and their entrance into another person is by way of the mouth. The routes by which they are spread are infected water and food, and by contact. There are healthy carriers, but they may suddenly develop the disease when they overeat or otherwise abuse their stomachs. Those who recover from the disease may remain carriers for a month or two, but there are no chronic carriers as in typhoid fever.

Cholera was formerly a common disease in Europe and America, but sanitation and the protection of water-supplies have made it a rare disease in most civilized lands. But cases often reach New York City, and any health officer may suddenly be confronted with the disease.

Examination for Vibrios.—A diagnosis of cholera is made by finding its vibrios in the intestinal discharges. They grow readily in a medium which is so strongly alkaline that it restrains the growth of other intestinal organisms. A liquid alkaline medium of peptone or egg-water is inoculated with discharges from the suspected person. If cholera vibrios are present, they will grow on the surface of the medium. They are identified by agglutination tests. When cholera appears among a number of persons who are closely associated, as on shipboard, there are usually a number of healthy carriers, and the only way to detect them is to examine the intestinal discharges of every person.

A cholera vaccine is used for preventive inoculation, and a serum for treatment, but with varying success.

If a health officer suspects a case to be cholera, it is his duty to quarantine the person and request prompt assistance from the State Department of Health.

CHAPTER XXV

INFECTIONS OF THE CENTRAL NERVOUS SYSTEM

INFECTIONS of the brain and spinal cord may occur with a number of different kinds of bacteria, among which are streptococci, pneumococci, tubercle bacilli, and influenza bacilli; but the diseases caused by these germs do not occur in epidemics. Two diseases which do occur in epidemics are epidemic cerebrospinal meningitis and anterior poliomyelitis.

EPIDEMIC CEREBROSPINAL MENINGITIS

Epidemic meningitis is an inflammation of the brain and spinal cord. Pus is formed in the meninges, and the spinal

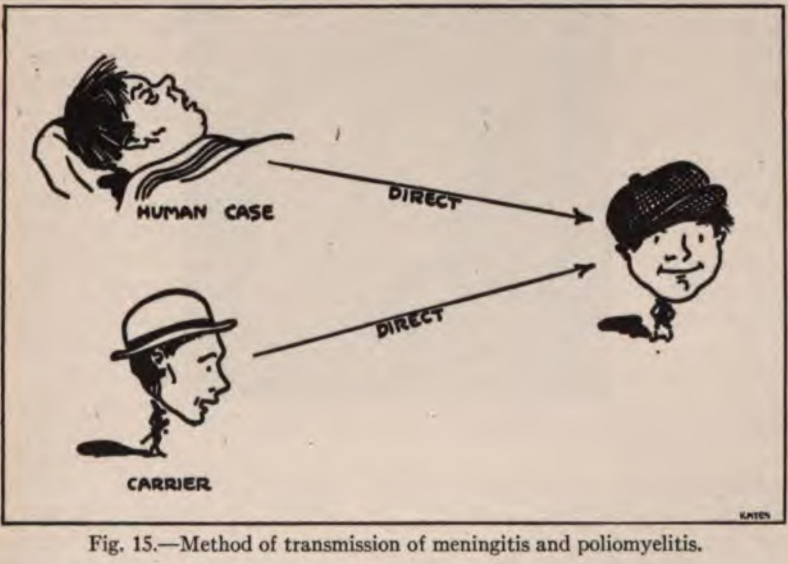

Fig. 15.—Method of transmission of meningitis and poliomyelitis.

fluid is cloudy and increased in amount. The disease is caused by a specific bacterium called the *Meningococcus intracellularis*. The cocci are found in the spinal fluid, the nasal secretions, and the urine. They also exist in the blood during the first week or two of the disease. Healthy carriers have the cocci in the nose and pharynx. The disease is spread by contact through the transference of nasal secretions. Scattered cases are frequent and epidemics of the disease sometimes develop.

While the principal seat of a meningococcic infection is usually the spinal cord, there may also be a general infection of the blood. There are also cases of a general infection or septicemia due to meningococci in the blood with few or none of the cocci in the spinal cord.

Recognition.—All forms of meningitis give general signs of irritation of the brain and spinal cord. There are fever, irritability, twitchings of the muscles, rigidity of the neck and back, and often convulsions. These signs indicate meningitis in some

Fig. 16.—Method of holding a child for spinal puncture.

form, and it is the duty of the health officer to determine whether or not an infectious type of the disease is present. A skin eruption may be present, and from this fact the disease is sometimes called spotted fever. Symptoms resembling those of epidemic meningitis may be present in meningismus, which is an irritation of the brain and spinal cord occurring during the course of any disease, especially pneumonia. The same symptoms may occur in poliomyelitis, tubercular meningitis, and meningitis caused by other organisms, such as pneumococci. A diagnosis between these conditions cannot always be made by the clinical symptoms. The only certain method of recognizing the diseases is by means of a spinal puncture and the examination of the fluid that is drawn.

Meningitis may also be caused by the organism of mumps. This form may be recognized by the presence of the signs of mumps and the absence of bacteria in the spinal fluid.

Spinal Puncture.—This is a surgical operation, and is to be done with all the precautions of surgical antisepsis. The operation is not difficult for anyone who is expert in minor surgery. No anesthetic is required. The best position for the patient is lying upon the side with the body bent forward as much as possible in order to open the spaces between the vertebræ. If the patient is a child, an assistant lays it across his lap upon its side with its face looking backward, grasps its neck and shoulders with one hand and the knees with the other, and forcibly flexes its whole body. The puncture is made just below the lower end of the spinal cord. A hypodermic needle may be used, but the best instrument is a long, slim trocar or needle made especially for the purpose. The point of entrance of the needle is immediately below the spine of the vertebra that is nearest a line connecting the crests of the ilium. The skin is sterilized with iodin, and the needle is thrust forward and slightly upward to a depth of from 1 to 3 inches, according to the age and development of the patient. Entrance into the spinal canal is indicated by a sudden loss of the feeling of resistance and by a flow of spinal liquid. The spinal fluid will run out drop by drop from a normal cord, but in a stream if it is under pressure. About a teaspoonful will flow normally, but 1 or 2 ounces may flow if disease is present. A sample is caught in a sterile bottle and sent to a laboratory for examination. The fluid may sometimes be bloody on account of puncturing a vein.

Examination of the Spinal Fluid.—An examination of a spinal fluid consists of a cell count, a bacteriologic test, and a chemical analysis. The cell count and chemical analysis have little value when the fluid is bloody.

The cells in a spinal fluid consist of leukocytes or white blood-cells. They are counted by means of an ordinary blood-counting apparatus. A normal spinal fluid usually contains from 10 to 20 cells per cubic millimeter, and is clear and colorless.

The bacteria in a spinal fluid are determined by a direct examination of the fluid and by cultures. Finding a specific organism, such as the meningococcus or streptococcus, fixes the diagnosis.

The usual chemical analysis of a spinal fluid are those for albumin, for globulin, and for the reduction of Fehling's solution. Albumin or globulin, in the absence of blood in the spinal fluid, indicates inflammation. The absence of the reduction of Fehling's solution points strongly to tuberculous meningitis.

The spinal fluid in epidemic meningitis contains so many cells that it is cloudy, and may properly be called pus. If a spinal fluid is cloudy, the disease is much more likely to be epidemic meningitis than any other disease. A stained microscopic specimen of fluid from a case will show the characteristic cocci of the disease. If Gram-negative diplococci are found in a cloudy fluid, the disease may be considered to be epidemic cerebrospinal meningitis, for the other bacteria which produce a cloudy fluid, especially streptococci and pneumococci, are Gram-positive.

Serum Treatment.—Killed meningococci injected into horses give rise to an abundance of antibodies which act directly upon meningococci with which they come in contact. The serum of the injected horses is successfully used in the treatment of epidemic meningitis in human beings. A spinal puncture is made, and the serum is slowly injected in an amount slightly less than the quantity of the fluid that is withdrawn. The amount is usually from 15 to 30 c.c. in an adult. Usually six doses are given on successive days. It is well to have the serum ready and to inject it at the time of making the first diagnostic puncture if the fluid is cloudy. The State Department of Health of New York State supplies antimeningitis serum to health officers free of charge. There are several subvarieties of meningococci; and a serum is potent against only those varieties with which it was produced. There is no practical method of determining the type of meningococci present in a case in time to be of value in choosing the proper serum. The serum supplied by the New York State Department of Health is made from several of the most common varieties. Since meningococci may be present in the blood, it is a standard procedure to give the antimeningococcic serum intravenously as well as intraspinally.

Management of a Case.—Epidemic meningitis spreads by contact with the excretions of the nose and mouth, and the principal precautions are directed against those excretions. Isolation, cleanliness, and the destruction of the excretions are necessary in every case. The precautions are about the same as in diphtheria (see page 216).

Epidemiology.—Epidemic meningitis is a reportable disease in New York and many other states. It is the duty of a physician to report every case that shows signs of meningitis, and to take advantage of the means for diagnosis and treatment that the health officer has at his command. The recognition of cases is essential in the control or prevention of an epidemic of the disease. There are often from five to ten carriers to every known case. The carrier problem in meningitis is about the same that it is in diphtheria.

Carriers are detected by means of cultures taken from the nasopharynx. The bacilli die quickly when they are chilled or dried, and so the culture-media must be inoculated at the time that the culture is taken. Curve the end of a sterile swab upward, pass it behind the soft palate, and rotate it against the back of the pharynx. Remove it and rub it lightly over the surface of the culture-media in a Petri dish. Keep the dish warm by means of a bottle of warm water carried in the container, and take it to the laboratory as soon as possible. Taking a culture and inoculating the culture-media require some skill, which a health officer can readily acquire by observing an experienced operator. The rule is to isolate a carrier until two negative cultures have been obtanied on successive days.

Tubercular Meningitis.—A meningitis due to tubercle bacilli frequently occurs. It has a gradual onset with an irregular fever, and projectile vomiting is usually present. The patient falls into a coma from which it is aroused only with great difficulty; the spinal fluid is clear but increased in amount; the cell count is increased; and the case slowly progresses to death.

Meningitis Due to Other Causes.—A meningitis due to streptococci, pneumococci, and other organisms gives signs and symptoms similar to those of epidemic meningitis. Frequently a middle-ear disease or an injury may produce the infection. The diagnosis is made by finding the specific bacteria in the spinal fluid.

Differential Diagnosis.—When symptoms arise suggesting an infection of the central nervous system, the health officer must bear in mind the various conditions and diseases that may produce them. He must consider the typical signs of the various diseases, and balance them with the findings of the examination of the spinal fluid. A correct diagnosis is difficult in isolated cases, and a health officer is justified in asking for expert assistance in doubtful cases.

POLIOMYELITIS

Nature of the Disease.—Anterior poliomyelitis, or infantile paralysis, is caused by a virus which will pass through a porcelain filter. It may be grown in culture-media, and when it is so grown, extremely small cocci like streptococci may be seen;

but the visible forms have not been positively identified as larger forms of the invisible germs.

Poliomyelitis germs produce a general poisoning, or toxemia, of the whole body, as is shown by a fever and general sickness. There is also a local effect on the central nervous system depending on the amount and virulence of the toxins. A mild poisoning may give only slight signs of irritation of the brain and spinal cord which soon pass off. A poisoning that is more severe or long continued may produce a weakness of the cells of the central nervous system, especially of groups of motor cells in the spinal cord, and is shown by a loss of reflexes, and by paralysis which may be transient or permanent, according to the degree of the injury to the nerve-cells. The degree of sickness may vary from a slight, unnoticed fever to a paralysis of all the muscles of the body, and death.

The poliomyelitis virus is contained in the substance of the spinal cord and in the excretions of the nose. Poliomyelitis may be readily transmitted to monkeys by spraying the infective material into the animal's nose; less readily by injecting it into the spinal canal; and only with difficulty by its injection into the blood. The course of the disease in monkeys is almost exactly similar to that in human beings. The fact that poliomyelitis may exist in a mild form of what appears to be a simple fever has been established by animal experimentation.

Poliomyelitis has frequently occurred in mild epidemics in which the death-rate was only 2 or 3 per cent.; but in 1916 an epidemic spread from New York City as a center, involved about 20,000 cases, and had a death-rate of about 25 per cent. This is an example of an old disease suddenly developing a virulence and infectiousness that had never before been observed. Every health officer must keep the possibility of the disease in mind hereafter.

Recognition.—Poliomyelitis produces a fever which usually has a sudden onset, often with vomiting. After a day or two there is a remission of the fever, soon followed by its return. This remission and return of the fever without definite signs of other sickness is a fairly constant and reliable symptom of poliomyelitis.

Poliomyelitis usually causes a headache and backache and a tenderness of the muscles. The pain and tenderness are marked in the nerves as they pass out from the spinal cord, and in order to avoid pressure on them the patient instinctively holds the head and spine bent backward and resists attempts to bend them forward. Kernig's sign is resistance to straightening the knee when the leg is flexed on the abdomen, and is due to the tenderness of the spinal nerves. An evident distress on bending the neck and body forward is a sign that is strongly suggestive of poliomyelitis. If it is entirely absent, the case is probably not poliomyelitis.

The muscular reflex of the knee is often impaired in poliomyelitis, although it may be increased during the period of irritation which precedes paralysis.

A paralysis of any part of an arm or leg or the face following a fever is suggestive of poliomyelitis. The paralysis may be only slight and may be evident only when the patient cries or throws its limbs about. It does not exist in many cases which are undoubtedly poliomyelitis. A paralysis of an arm or leg is often preceded by a twitching of the muscles of the part, and if it is observed, paralysis may be expected.

Spinal Puncture.—Changes in the spinal fluid are nearly always found in poliomyelitis. It is the duty of the physician and health officer to have a spinal puncture done and an examination of the fluid made whenever the two signs of the typical course of a fever and the tenderness and rigidity of the neck are present; but if the two signs are accompanied by a paralysis, a spinal puncture may not be necessary for a diagnosis. A persistent loss of the knee reflex usually indicates paralysis.

The spinal fluid in poliomyelitis is increased in amount, is clear and colorless, and the number of its cells is increased. If 50 cells per cubic millimeter are found, the case may be considered to be poliomyelitis, provided there are no evident signs of other spinal cord disease, such as tetanus. The number of cells may run into the hundreds and thousands.

Groups of Cases.—There are three broad groups of poliomyelitis cases which a health officer must keep in mind. The first group consists of those which show a typical paralysis. These cases are plain and evident, and were the only ones that were formerly recognized.

The second group of cases is composed of those in which the disease seems to be seated in the brain, and the symptoms are those of meningitis. These cases were formerly called meningitis, and many cases are still mistaken for that disease.

The cases belonging to the third group are those in which there is no paralysis or other severe symptom. These are often called abortive cases. They were formerly entirely unrecognized and unsuspected; but a typical onset and course of the fever and a stiffness of the neck are present in these cases, and the disease may be recognized by a careful observation.

Skin Rash.—An eruption of the skin sometimes occurs during poliomyelitis, and may be mistaken for measles or scarlet fever. It may be in small patches or may cover extensive areas. Health officers who are ignorant of the possibility of the eruption are needlessly alarmed when they see it.

Serum Treatment.—Persons who have had poliomyelitis are immune to the disease during the rest of their lives, and their blood-serum may contain protective antibodies. The Departments of Health of the City and State of New York advise the use of human immune serum in the treatment of cases if it can be obtained. The serum is given in the same manner and quantity as meningitis serum.

Epidemiology.—Susceptibility to the virus of poliomyelitis is not great, and the disease was not recognized as communicable until experiments on monkeys in 1911 proved its infectiousness. During the 1916 epidemic an exposure to previously known cases could be traced about as frequently as in an epidemic of scarlet fever. Poliomyelitis spreads by means of the excretions of the nose and throat. The period of incubation seems to be about one week. There are healthy carriers of the germs, but patients who have recovered from the disease seem to become free from the germs within a month or six weeks after the beginning of the sickness.

The control of poliomyelitis requires a strict quarantine of the sick persons and their premises for at least three weeks from the onset of the fever, the disinfection and proper disposal of all excretions, and the exclusion of flies from the sick room. If the disease is epidemic, the board of health may require the isolation and medical supervision of all children under sixteen years of age coming from the infected districts, and may forbid all gatherings of children. If the epidemic involves more than one state, the United States Public Health Service may institute a medical supervision of all children traveling from one state to another. These measures may seem harsh and crude, but they are justified until we have more exact knowledge of the virus and of the manner of its spread.

A great difficulty in poliomyelitis prevention is the detection of cases. It is a reportable disease in most states, but many physicians fail to recognize the disease or to suspect it unless paralysis is present. If a diagnosis is in doubt, it is the duty of the health officer to ask for the assistance of the State Department of Health. A poliomyelitis epidemic is a severe test of a health officer's diagnostic acumen and of his ability to secure the co-operation of physicians.

After-care of Paralyzed Cases.—After an epidemic of poliomyelitis has passed, there will be a number of cases of paralysis which will require treatment for months and years. Good results that were formerly supposed to be impossible may be obtained by training the affected muscles. One procedure that is of great value in every case is complete rest of the affected muscle. This advice is directly opposite to that formerly given —to exercise the paralyzed part as much as possible. Exercise stretches and tires the muscles beyond recovery, but the rest treatment allows the muscles and the nerve-cells to regain their nutrition and strength. For example, a child with paralyzed muscles of the calf of the leg is kept off its feet for weeks. Its leg is exercised for only a moment on each day at first, and the exercises are increased as strength returns. The treatment is

Fig. 17.—Testing muscular strength at a poliomyelitis after-care clinic.

slow and tedious, but the results in most cases are useful muscles and ability to use the limbs.

The Departments of Health of Vermont and New York conduct clinics and supervise the after-care of cases in their homes. The procedure with each case at a clinic is as follows:

1. Test each group of muscles and make an accurate estimate of the strength of each group.

2. Prescribe the exact method and amount of rest, massage, and exercise which is required. This prescription is as definite as a prescription for a medicine to be taken for rheumatism.

3. Advise the family physician regarding the plaster casts and braces that are needed, and take exact measurements for the braces.

Public health nurses visit the cases in their homes and instruct the mothers in the proper methods of carrying out the treatment. The after-care must be continued for months or years.

TETANUS

The Bacilli.—Tetanus, or lockjaw, is caused by a bacterium which often grows in the intestines of horses. The bacilli are found in the soil of streets and cultivated fields which contain the excretions of the animals. It probably does not multiply in the soil, but it exists in the form of spores which are not easily killed. The spores enter the human body by means of wounds which are contaminated with soil. The bacilli are anaërobic, and cannot grow except in the absence of oxygen; but they are likely to grow in wounds into which oxygen cannot penetrate,

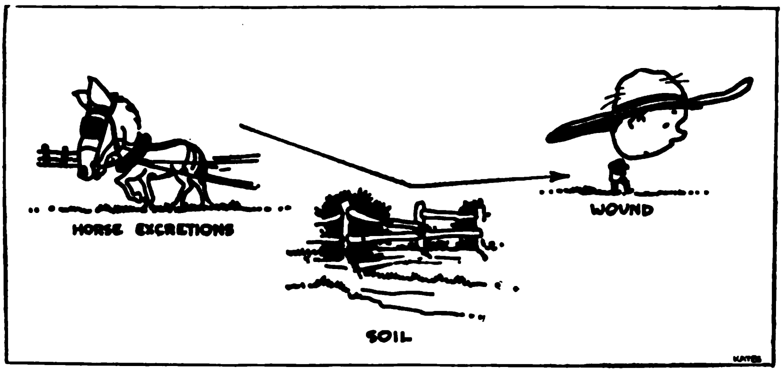

Fig. 18.—Method of transmission of tetanus.

such as puncture wounds made by stepping on nails and those made by fireworks. The period of incubation of tetanus is usually from one to two weeks. The toxin of tetanus travels from the site of growth of the germs through the nerves and enters the nerve-cells of the spinal cord and irritates them, producing contractions of the muscles and convulsions. A diagnosis of tetanus is made by a stiffness of the neck and an inability to open the mouth. A chill and fever usually accompany the stiffness, and there is usually a history of a wound or a severe bruising, or a burn.

Antitoxin.—The injection of tetanus bacilli into horses causes them to form an antitoxin which is used for the prevention and treatment of tetanus in human beings. It is manufactured in the same manner as diphtheria antitoxin. The preventive dose for an adult person is 1000 or 1500 units given subcutaneously as soon as possible after a contaminated wound is received, and repeated in two weeks if the wound has not healed at that time.

The curative dose of tetanus antitoxin is from 10,000 to 20,000 units given intraspinally in the same manner that meningitis serum is given. If the antitoxin is given intravenously or subcutaneously, it travels to the spinal cord too slowly to be of much benefit, but if it is introduced directly into the spinal canal, it will reach the toxin in the nerve-cells within a short time. If antitoxin is given intraspinally in the first day or two after the first symptoms of tetanus, nearly all the patients will recover. It is also of great value when it is given later in the disease. It is necessary to treat the original wound and to remove all foreign substances which contaminate it.

The New York State Department of Health distributes tetanus antitoxin to health officers in both preventive and curative doses, and advises that it be used for immunization after every suspicious wound.

A health officer need not isolate a case of tetanus or disinfect the excretions of the patient. The prevention of the disease consists in treating all wounds according to the rules of antiseptic surgery, and in giving immunizing doses of antitoxin to all who have wounds in which the tetanus germs are likely to grow.

RABIES

The Virus.—Rabies, or hydrophobia, is an infectious disease which is now rarely seen in human beings, although it frequently

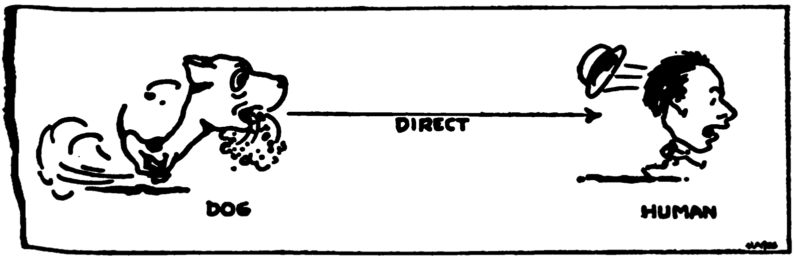

Fig. 19.—Method of transmission of rabies.

occurs in dogs and cats. It is caused by a filterable virus which is found in the central nervous system and in the saliva of affected dogs and cats, and is introduced into the human body by means of wounds made with the teeth of rabid animals. The incubation period of the disease is extremely variable, but in human beings it is from two weeks to six months. The symptoms of the sickness in human beings are spasms and convulsions beginning in the muscles of swallowing. After the disease has developed, it always ends in the death of the patient.

Recognition.—Rabies is a common disease of dogs in some parts of the United States, and any health officer may suddenly be called to deal with an affected animal. The disease may be suspected when a dog or cat is sick and shows unusual irritability. A rabid dog or cat is likely to attack and infect other animals that approach it. If a dog or cat shows suspicious symptoms, confine it in a quiet place where it cannot bite another animal or a person. If it has rabies, it will die within a very few days. If it recovers, it has not had rabies. If the animal dies or is killed, cut off the head, preserve it on ice, and send it to a laboratory for an examination of the brain in order to make the diagnosis certain.

Negri Bodies.—A diagnosis of rabies may be made by finding Negri bodies in the brain cells. A small piece of gray matter is crushed upon a microscopic slide and stained. The Negri bodies appear as spheres approximately the size of red blood-cells located in the nerve-cells. If suspicious bodies are seen, animal inoculation tests with the brain tissue will produce the disease when the animal has rabies.

The nature of the Negri bodies is in doubt. They may be the specific organisms of the disease, or bodies produced by a poisoning of the nerve-cells.

Preventive Inoculations.—The subcutaneous injection of the virus of rabies from a rabbit into a human being produces an immunity which lasts for a few months. The injections are used in order to prevent the development of rabies in a person who has been bitten by a rabid dog. They constitute the Pasteur preventive treatment. The material used is the spinal cord of a rabbit that is paralyzed with rabies. The cord is removed and hung in a bottle over sticks of caustic potash. The dose is about 2 cm. of a cord emulsified with glycerin. The first injection is made from a cord that has been hung for eight days, during which time its virus has become weakened and nearly killed. The time during which the cords are hung is progressively lessened until an emulsum of an almost fresh cord is used. The whole series of injections cover a period of three weeks.

The material for the injections may be obtained by mail daily from the United States Public Health Service in Washington. The Departments of Health of New York State and the city of New York also supply the material through the health officers, all of whom are expected to know where to obtain the virus, and to use it on every person who has been bitten by a rabid animal.

When a person is bitten, the virus grows and spreads slowly. It may be killed by cauterizing the wound to its bottom with strong nitric acid. Other preventive measures against rabies are the muzzling of dogs on highways and catching and killing all stray dogs and cats. A dog-catcher is an important official on the staff of every board of health. If a dog is supposed to have been bitten, the proper measure to take is to confine the animal for three weeks, or the period of incubation in a bitten animal. If it does not develop the disease within that time, it probably has escaped infection.

The power of capturing and controlling rabid animals in New York State is vested in the Commissioner of Agriculture. He may institute a quarantine of a particular district and may empower the sheriff to execute his orders (Agricultural Law, Sec. 96).

CHAPTER XXVI

VENEREAL DISEASES

A Public Health Problem.—The two diseases that are usually classed as venereal are gonorrhea and syphilis. A third one of less importance is chancroid. Their specific micro-organisms are given off from open lesions upon the skin or the mucous membranes. Each disease is produced by the entrance of discharges from an infected person directly into an open wound upon the skin or mucous membrane, or through the mucous membrane at an orifice of the body.

There has been a popular belief that a venereal disease is of merely temporary importance, and concerns only the person who is infected. There is often little discomfort or gross evidence of sickness. The severer symptoms often subside promptly, and the patient may be able to mingle with society without exciting suspicion. But the specific germs often remain in unhealed and unnoticed lesions, and are transmitted to innocent persons, especially to a wife by an uncured husband. The germs that remain in the body may produce severe forms of diseases months or years after apparent recovery. Many cases of rheumatism and bone disease, a quarter of all cases of insanity, many severe gynecologic conditions, and all cases of locomotor ataxia and paresis are late manifestations of uncured venereal disease. Grave effects are left in probably 10 per cent. of all cases. Venereal diseases are plagues which rank with tuberculosis in their prevalence and in their evil effects on individuals and society. They are both curable and preventable, and their control is a public health problem which concerns every health officer and physician.

Chancroid is an ulceration caused by bacterial infection. It is usually located upon an external sexual organ, but it may occur upon any other part of the body. It may cause enlargements and abscesses of the neighboring lymph-nodes. Its affects are usually local, and resemble those of a streptococcus infection. It is important to a health officer chiefly because it may resemble a syphilitic sore. A diagnosis may be made by examining the scraping from the ulcer with a microscope. If the sore is syphilitic, the characteristic spirilli of syphilis may be found.

Gonorrhea is caused by a diplococcus called the gonococcus or the Micrococcus gonorrhœæ. The germs nearly always enter the body through the genito-urinary tract or the eye. The incubation period is usually about four days, but it varies from one up to eight days. The bacteria grow among the epithelial cells of the mucous membrane at the point of entrance, and produce an acute inflammation with a discharge of pus. They may destroy the epithelium and produce ulcerations which lead to strictures or blindness on healing. The germs may remain alive and dormant in the unhealed ulcers, and may regain their original virulency when they are transferred to another person. Those in whom evidences of the disease remain are usually carriers of virulent germs.

Gonococci may enter the blood-stream and produce septicemia, or endocarditis, or an inflammation of the joints which may persist for weeks. They may enter the peritoneum and produce peritonitis or abscesses. Many cases of peritonitis in married women are caused by gonococci which are derived from the uncured disease of their husbands. The disease is the cause of most cases of sterility by closing either the spermatic tubes in the male or the fallopian tubes in the female. Gonorrheal ophthalmia is the principal cause of blindness in children. The crippling effects of the chronic forms of the disease and the damaging results of the acute forms are more common than are popularly supposed, for physicians often conceal the true nature of the disease by calling it rheumatism, or heart disease, or peritonitis, or by giving it some other general term which describes the symptoms regardless of their cause.

A diagnosis of gonorrhea is made, first, by finding gonococci in the pus or discharges from the surface of the body, and second, by complement-fixation tests upon the blood.

A search for gonococci is a standard procedure both for diagnosis and also for ascertaining when a cure is complete. Gonorrhea is similar to diphtheria in that it is often mild, and that its virulent germs frequently persist without causing discomfort or inconvenience. An up-to-date physician will make use of laboratory tests in all cases in which gonorrhea may be suspected. The departments of health of some of the states and cities supply the slides, mailing cases, and blank forms for information, and make the examinations free.

A specimen for making a laboratory diagnosis of gonorrhea is prepared by collecting some of the discharge with a small swab or a wire loop, smearing it in a thin film on a microscope slide, and letting it dry. If there is little or no discharge in a male, some may be obtained by massaging the deep urethra or prostate gland or by injecting a weak solution of nitrate of silver which will irritate the mucous membrane and set up a discharge. Two samples are usually taken from a female, one from the vaginal wall and one from the cervical canal. A specimen taken within twelve hours after an antiseptic douche is likely to be free from gonococci, but if no antiseptics have been used within twenty-four hours, gonococci may nearly always be found if any are present in the tissues.

A specimen is stained with the Gram stain, and examined with a $\frac{1}{12}$ oil-immersion objective. Typical gonococci appear as Gram-negative diplococci within pus-cells. The location of the germs within a pus-cell is determined by raising and lowering the objective while observing the cell. The measure of the thickness of a pus-cell is two or three times that of the depth of focus of a $\frac{1}{12}$ oil-immersion lens. If the objective is focussed on the upper surface of a cell, and is slowly lowered, the diplococci within the cell first come into clear view and then the lower surface of the cell may be seen.

A complement-fixation test is valuable in determining the nature of the disease in gonorrhea of the joints or internal organs. A specimen of blood is taken in the same manner as one for the Wassermann reaction (page 150). The test is usually positive in gonorrheal rheumatism and other conditions in which the micro-organisms exist in the blood; but it is negative in the acute forms of disease in which the germs do not enter the blood. The test is especially valuable in determining the nature of obscure forms of inflammation of the joints.

Ophthalmia neonatorum, or gonorrheal inflammation of the eyes, may occur in newborn children as a result of infection from mothers who either have gonorrhea or are carriers of the gonococci. It also occasionally occurs in adults by the transference of infected pus to the eyes by means of soiled fingers, and by towels and other toilet articles. The disease is an intense inflammation of the conjunctiva, with much pus and swelling of the eyelids. A similar condition may be caused by virulent streptococci derived from mothers who do not observe cleanliness. A diagnosis is made by a microscopic examination of the pus. The condition is dangerous to sight, and requires skilful treatment. It may be prevented in babies by putting 1 drop of a 1 per cent. solution of nitrate of silver into each eye of a baby immediately after its birth.

Gonorrheal infection of the eyes is so likely to occur that the New York State Department of Health supplies outfits of nitrate of silver solution for giving the preventive treatment to every newborn child. The department requires that every birth certificate shall contain a statement of the means used for preventing the development of the disease; and if none are used, the reason for omitting them must be stated. It also requires that every case of ophthalmia neonatorum shall be reported to the health officer.

Syphilis is apparently either a new disease which appeared about the close of the fifteenth century, or an old one which suddenly acquired an intense virulency similar to that of poliomyelitis in 1916. Its severe nature is indicated by its name, pox, or great pox, by which it was distinguished from the less virulent disease, smallpox. Its virulency is probably as great as ever, but severe acute cases are now comparatively rare owing to the common use of the specific drugs—mercury, arsenic, and the iodids—in the treatment of the disease. Chronic forms of the disease, such as arterial degeneration, locomotor ataxia, and paresis, which were not formerly ascribed to syphilis, are now recognized as late manifestations of the disease, especially in persons in whom its early stages were mild and unrecognized.

Syphilis is caused by a micro-organism, the Spirochæta pallida, which may be classed as an intermediate form between the bacteria and the protozoa. It appears like the worm of a corkscrew having from three to twenty well-marked turns. The spirochetes multiply at their point of entrance into the body, which is usually upon a genito-urinary organ, although it may be upon any other part. The period of incubation is about three weeks. The first evidence of the disease is an open sore, called the primary lesion or chancre, which appears at the point of infection, and heals spontaneously after a few weeks.

The spirochetes begin to enter the blood-stream as soon as the primary sore is developed, and in about six weeks they produce an eruption, called the secondary lesion, upon the skin and mucous membranes. This period of the disease corresponds to that of the eruption in smallpox, and is accompanied by fever, pain, and evident sickness. This is the stage in which infection is usually spread, for the spirochetes are contained in the eruptive spots, and are given off when the spots become abraded or ulcerated. Patches on the mucous membranes and moist surfaces of the skin are particularly infective.

The spirochetes may remain alive in a localized part of the body after the acute symptoms have subsided, and after years of dormancy they may produce chronic symptoms in almost any organ, especially in the arteries, bones, and nervous system. The late manifestations of the disease are called tertiary lesions. It was formerly supposed that the disease was not infective during this stage, but the living spirochetes can often be found in the lesions of tertiary syphilis, and may be given off if there are open lesions upon the surface.

An exact diagnosis of syphilis may be made by either of two laboratory methods, first, by finding the characteristic spirochetes, and second, by a complement-fixation or Wassermann test. The spirochetes are usually present in the serum that exudes from the primary sore, and if they are found, the diagnosis is made with certainty. A satisfactory method of obtaining a specimen from a primary sore for diagnosis is as follows:

1. Wash the sore with clean, sterile water, and dry it with sterile gauze.
2. Curet the edge until blood begins to appear.
3. Wipe the sore with sterile gauze until clear serum oozes from it.
4. Take a drop of this serum upon a microscope slide for examination.

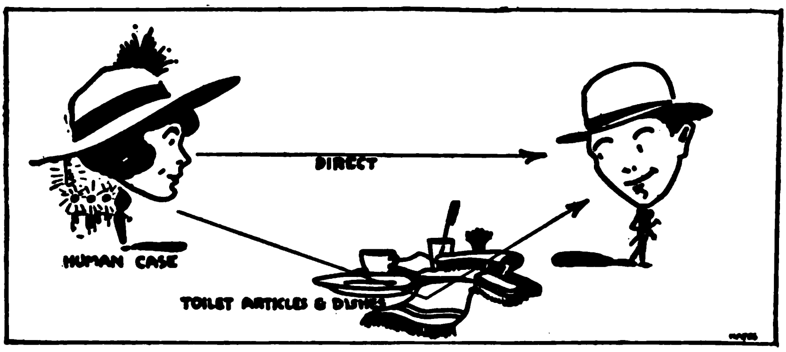

Fig. 20.—Method of transmission of venereal diseases.

A specimen of serum must be examined fresh with a dark-field illumination. The organisms are as large as the larger bacteria, and fresh specimens show a twisting motion.

The spirochetes may also be found among the tissues beneath the primary sore. A small amount of tissue may be taken from the edge of the sore, preserved in a 2 per cent. solution of formalin, and sent to a laboratory to be sectioned, stained, and examined.

The complement-fixation or Wassermann test is described in the chapter on Immunity (page 150).

Transmission of Venereal Diseases.—The venereal diseases are similar in the methods of their transmission and control. A considerable number of cases of venereal diseases are spread by ordinary contact with infected persons. This is true in both gonorrhea and syphilis. Epidemics of gonorrhea occur in children's hospitals and orphanages, and are difficult to prevent or to suppress. Persons affected with active syphilis frequently spread the disease by kissing, towels, and other direct means of transferring the germs. But transmission of venereal diseases usually occur by sexual contact between persons of opposite sexes. An epidemic of the diseases usually comes from a very few local sources, that is, from one or a few infected females. Males are not the cause of an outbreak, for each infected male seldom puts himself in a situation to spread the disease extensively. An epidemic is caused by an infected female, for she often comes in infectious contact with many males. There is a close analogy to the development of an epidemic of typhoid or diphtheria. A number of cases of venereal disease, or of typhoid fever, or of diphtheria, points to a limited virulent source of infection, and its suppression will control a very large proportion of all cases—say at least three-fourths. The main part of the problem of preventing venereal diseases is practically to discover and eliminate infected prostitutes. The prevention of the infection of prostitutes by discovering and treating infected males is also necessary.

Control.—The control of venereal diseases has been considered to be impossible, owing largely to the fact that a large number of men and women voluntarily and deliberately expose themselves to infection. The former attitude of the public toward the diseases was that of secrecy. Each case was regarded as a private matter, and the continual existence of a grave epidemic of preventable disease was ignored. But from the time when venereal diseases have been recognized as public health problems, great progress in their control has been made. A similar development from secrecy to open discussion and control has taken place in the attitude of the public toward tuberculosis. Experience shows that venereal diseases may be discussed in the same open manner as tuberculosis or any other public health matter. Effective measures for preventing venereal diseases have been introduced into the American Army, with the result that they are rare among the troops in many large camps. These experiences clearly indicate the lines of work which promise success among the civilian population.

The measures for the control of venereal diseases may be divided into four groups: 1, medical; 2, legal; 3, educational; 4, social. A health officer is directly interested in the medical means of control, and to a great extent also in the legal and educational means. He is indirectly interested in the social and moral measures for the control of venereal diseases.

Medical Measures.—There are two essential medical measures for controlling any infectious disease: 1, the discovery of cases, and 2, their treatment to remove the sources of infection. A responsibility rests upon health officers and physicians to make an accurate diagnosis of cases of venereal diseases, to give efficient treatment to every case, and to educate the patients in the means of preventing the spread of the diseases to others. A laboratory diagnosis is as important in venereal diseases as in diphtheria. An examination of specimens from every case is necessary for diagnosis and in order to determine whether or not the disease is cured. Physicians must be educated to use the laboratory, and the public must be educated to demand its use.

The departments of health of the larger cities are establishing clinics and hospitals for the treatment of venereal diseases. They have a great value in educating physicians to use the modern methods of treatment, and in causing patients to shun quack doctors and to seek scientific treatment.

Medical measures for preventing the development of a venereal disease after an exposure to possible infection are used in the American Army and Navy, but they have not come into general use among civilians. The wisdom and propriety of their use have been questioned on moral grounds, but from a public health point of view any medical means of preventing the diseases are proper. If a person exposed to a venereal disease seeks prophylactic treatment, there is no valid reason for denying him its benefits. The method used in the Army and Navy is as follows:

1. Wash the parts with soap and an antiseptic solution.
2. Inject a 2 per cent. solution of protargol into the urethra.
3. Apply calomel ointment to the organs.

The procedure is usually successful when used soon after exposure, and its value is lessened in proportion to the time during which the germs have grown in the body.

Legal Measures.—The laws of customs of American people require patients who are afflicted with communicable diseases to submit to inconveniences and restrictions in order to prevent the spread of the diseases to others. The ideal requirements in venereal diseases are that every patient shall submit to efficient treatment, and shall not expose another person to the danger of infection. These measures are observed in the Army and Navy, and a beginning has been made looking toward their ultimate adoption among civilians. In 1917 and 1918 New York State adopted four measures for controlling patients suffering with venereal diseases. First, the Council of the State Department of Health put chancroid, gonorrhea, and syphillis on the list of diseases which are subject to supervision and control. The effect is that a careless venereal patient, like a careless consumptive, may be subjected to the control of the health officer under Section 25 of the Public Health Law, which reads as follows: "Every local board of health and every health officer shall guard against the introduction of such infectious and contagious or communicable diseases as are designated in the sanitary code, by the exercise of proper and vigilant medical inspection and control of all persons and things infected with or exposed to such diseases, and provide suitable means for the treatment and care of sick persons who cannot otherwise be provided for." Under this section of the law a health officer may exclude a venereal case from occupations involving close contact with children and other persons.

Second, the State Department of Health amended the State Sanitary Code so that Regulation 29a of Chapter II reads as follows: "It will be the duty of every physician when first attending a person affected with chancroid, gonorrhea, or syphilis to furnish said person with a circular of information issued or approved by the State Commissioner of Health, and to instruct such person as to the precautions to be taken in order to prevent the communication of the disease to others." This regulation will stimulate physicians to give efficient treatment and advice to their venereal cases, and to see that they are cured. It will doubtless soon lead to the adoption of regulations requiring that venereal diseases shall be reported to the health officer.

Third, the Legislature of New York State amended the domestic relations law so as to require every applicant for a marriage license to subscribe to the following statement: "I have not to my knowledge been infected with any venereal disease, or if I have been so infected within five years, I have had a laboratory test within that period which shows that I am now free from infection from any such disease." This brings the question of venereal disease home to every young man and woman who expects to be married. The observance of the law does not seem to cause embarrassment or objection to those applying for marriage licenses.

Fourth, the Legislature added subdivisions to Section 343 of the Public Health Law, authorizing boards of health and health officers to examine and control any person whom they have good reason to suspect to be likely to spread a venereal disease. This law subjects a careless person suffering with a venereal disease to the same kind of control that would be applied to a person who has diphtheria or smallpox.

Education.—The conditions regarding the control of venereal diseases are now about the same that they were regarding tuberculosis during the early days of the antituberculosis movement. Further progress will depend largely on the education of physicians, patients, and the public, as in the control of tuberculosis.

Every health officer is expected to become familiar with modern methods of diagnosis and treatment of venereal diseases, and to recommend them to the physicians in his jurisdiction. He is expected to have supplies of diagnostic outfits and educational literature if they are furnished by his state department of health or other agency.

When patients afflicted with venereal diseases receive the benefits of scientific treatment and the advice required by the sanitary code of the New York State Department of Health, they become centers for spreading the knowledge to others and of influencing others to seek adequate treatment. The education of patients is a valuable means of reaching the public.

The education of the public regarding venereal diseases is conducted along two lines, first, concerning the diseases themselves, and second, regarding sex matters in general. It is the work primarily of social workers and teachers, but a health officer can be of great assistance to them.

The very great value of moral teaching must also be recognized. An appeal to the moral nature is one of the most compelling forces for controlling the passions and animal inclinations of men and women.

Social Measures.—Social and community measures are also necessary for controlling venereal diseases. One measure is provision for proper amusement and recreation for young people. If thoughts of animal passions and feelings are to be controlled, they must be displaced by higher thoughts and feelings.

The prevention of venereal diseases is closely connected with the problem of alcoholic liquors. Temperance measures are among the most necessary and efficient means of suppressing venereal diseases, and of dealing with many problems concerning sexual relations.

Measures for the control and suppression of prostitution are also necessary. Experience has shown that the regulation of prostitution is a failure in preventing venereal diseases. Prostitution is the greatest factor in spreading venereal diseases, and the moral sense of the American people will not allow its legalization and supervision. Its suppression is a necessary public health measure.

Summary.—The various protective measures against attacks of venereal diseases may be represented by circles of outposts surrounding each individual. These circles from without inward are:

1. Social and moral forces, and the standards of civilized society.
2. Education regarding sex matters and sex diseases.
3. Wholesome recreation and mental occupations.
4. Legal control of prostitutes.
5. The treatment and cure of cases.
6. Prophylactic treatment for those who, in spite of other measures, persist in exposing themselves to infection.

CHAPTER XXVII

TUBERCULOSIS

The Problem.—Tuberculosis constitutes one of the biggest and most neglected of all the problems with which a health officer has to deal. Although tuberculosis was one of the first diseases in which the specific germs were discovered, bacteriologists have not been able to develop direct methods of its

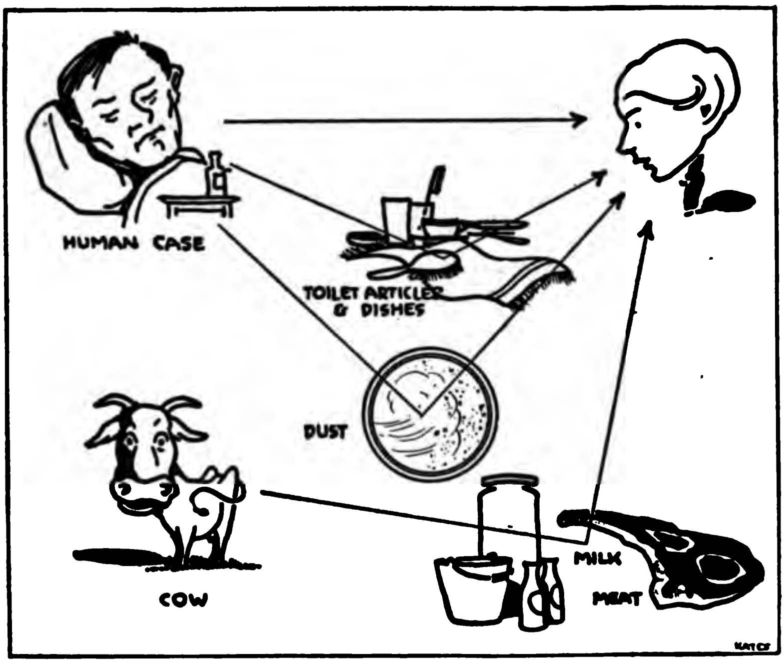

Fig. 21.—Method of transmission of tuberculosis.

treatment or prevention similar to those used in diphtheria and smallpox. The management of the tuberculosis problem is a severe test of a health officer's activity, judgment, and influence, for the treatment and prevention of the disease involves doing a long series of commonplace acts by the patient, his family, his physician, and often by social organizations. We now possess sufficient knowledge of the disease to control it if the health officer in each community will be a leader, and will organize the forces for its treatment and suppression.

The Bacteria.—Tuberculosis is caused by a small rod-shaped bacillus which may grow in almost any part of the body, but the health officer is especially interested in pulmonary tuberculosis or consumption, which is produced by the growth of the bacilli in the lungs. The bacilli may be readily grown in cultures, but they make an extremely slow growth, and in a month their development is usually no greater than that of diphtheria germs in a day. The slow development accounts in part for the insidiousness of the disease, and for the many and varied forms which the disease often assumes.

Tuberculosis germs do not multiply under ordinary conditions after they have been expelled from the body. Sunlight is especially harmful to them. They may survive drying for some days, and may be found in the dust of extremely dirty, dark rooms; and they may also be found in the dust of streets into which they have been expelled by careless spitters. They will survive for days in dark, damp places when they are protected from the sunlight by coverings of dirt, and they are frequently found in house dust which has recently been raised from dirt and filth containing the germs.

The large number of tuberculosis cases in every community makes it probable that tuberculosis germs are widely distributed, and that some have entered the body of every person through the nose with dust, or through the mouth with food. Whether or not the germs produce the disease will depend principally on the degree of immunity of the person. The lungs of over half of all people show slight evidences of the growth of tuberculosis germs in them, but it may be that these germs act like a vaccine and protect the person against further infection. The prevalence of the scars left by healed tuberculosis has given rise to the statement that everybody has tuberculosis, but this is not true if by tuberculosis we mean a disease in which there is evident sickness. But these old scars are of great importance, for a few tubercle germs may remain alive in them for years, and when the body becomes weakened from any cause, they may multiply and produce extensive disease.

When the germs of tuberculosis enter the body either through the nose or by way of the stomach, they usually find their way to the lungs, and there give rise to white bodies about the size of pin heads, called tubercles, in which the tuberculosis germs are found. The germs and their poisons also cause the neighboring lymph-glands to become enlarged. The tubercles and the enlarged glands are the first gross effects that are produced by the germs.

Other germs, such as streptococci, may also enter the body and grow along with the tubercle germs. Many of the effects of severe cases of tuberculosis are due to the other germs which are associated with the tubercle bacilli.

Examination for Tubercle Bacilli.—The recognition of pulmonary tuberculosis is made with certainty by finding tubercle bacilli in the sputum. Their slowness of growth makes it impracticable to use cultures, and so the sputum is examined directly. The tubercle germs in it are recognized by their peculiarities of staining. They belong to the acid-fast group, meaning that they retain their stain when they are acted on by acids which will remove the stains of most other kinds of bacteria. About 3 per cent. of the substance of tubercle bacilli consists of wax which hinders the entrance of the stains into the bacilli, and afterward protects the stains in the bacilli from decolorizing agents. The wax also tends to prevent the bacilli from drying, and thus it prolongs their life outside the body.

The method of preparing a sample of sputum for examination is as follows:

1. Spread a small bit of thick sputum upon a microscope slide and fix it by heat.
2. Apply carbolfuchsin as a stain for about five minutes.
3. Wash off the stain and apply a 3 per cent. solution of hydrochloric acid in alcohol in order to remove the carbolfuchsin from all the germs except the tubercle germs.
4. Stain the specimen with methylene-blue, which will color all the parts of the specimen except the tubercle germs, which remain red.

The recognition of tubercle germs would be easy if their numbers could be multiplied readily by cultures, but only a few are usually found in a specimen of sputum, and it may be necessary to examine many fields under the microscope before a single bacillus is found, and to spend an hour in the examination of a single specimen in order to make sure that it contains no tubercle germs.

There are several methods of concentrating the germs in a specimen in order to increase the probabilities of finding them there. One is as follows:

1. Mix the sputum with antiformin, and let it stand for fifteen minutes in an incubator in order to liquefy the sputum.
2. Centrifuge the mixture and examine the sediment for the bacilli.

Many state departments of health supply health officers with outfits for collecting and mailing specimens of sputum for examination. The specimen must actually come from the bronchi in order to be of use, and not be merely a collection of saliva and nasal mucus. If a health officer receives a report that no tubercle bacilli were found, he is not to conclude that the person does not have tuberculosis. The health officer may not have sent a specimen from the lungs, or the patient may not have been giving off bacilli at the time of the examination. Still, the examination of sputum is the most reliable and ready means of diagnosis which a health officer has.

Errors in diagnosis are sometimes made by mistaking other acid-fast bacteria for the tubercle bacilli. An acid-fast bacillus similar to tubercle bacilli grows on hay, and is found in the intestines of cows and often in milk. Another acid-fast bacillus is often found contaminating specimens of urine, and leads to erroneous deductions regarding tuberculosis of the kidneys. These acid-fast bacilli do not grow readily in inoculated animals, and they may be excluded by animal inoculation tests.

Animal Inoculation Test.—If a specimen contains so few germs that they cannot be found in a stained specimen, or if there is a possibility of the contamination of a specimen by other acid-fast bacilli, the tubercle germs may be identified by their growth after inoculation into young guinea-pigs. These animals are extremely susceptible to tubercle bacilli. An inoculation of the suspected material is made into the thigh subcutaneously or intramuscularly. If the tubercle bacilli are present, the first effect will be the enlargment of the lymph-glands of the groin in about three weeks, and is usually followed by the death of the animal in four or five weeks. When the animal is examined, a pure culture of the tubercle bacilli will be found in the glands, and the characteristic lesions of tuberculosis will be found in the abdominal organs. The animal inoculation test is delicate and certain, but it requires three or four weeks to make.

Susceptibility and Immunity.—Nearly every person is susceptible to tuberculosis germs, but there must be some form of immunity to account for recovery from the disease. The injection of tuberculosis germs produces agglutinins and lysins in the body, but in such an irregular manner that they cannot be utilized for diagnosis or treatment. The immunity to tuberculosis does not seem to depend upon the production of an antitoxin or other antibody, but upon the resistance of the individual cells of the body. If the body is weakened by any cause, such as overwork or alcohol, the resistance of all the cells of the body is lowered to such a degree that tuberculosis germs may readily grow and produce disease. Innumerable attempts have been made to produce artificial immunity by the injection of tuberculosis germs or their poisons. The results of these experiments seem to indicate that, while a person has a few germs actively growing in his body, he is protected against the growth of more germs which may enter it. But, on the other hand, if a person has the germs already growing in the body, anything which lowers the general health of the body tends to allow these germs to grow and spread, and produce the disease in a severe form.

Immunity to tuberculosis depends mainly on vigorous health. If a person is sick with tuberculosis, his recovery depends principally on doing those ordinary, every-day things which tend to make a well person strong and vigorous. There is no antitoxin, or serum, or drug which has an appreciable effect in producing immunity to tuberculosis.

Tuberculin.—Tubercular diseases may often be recognized by what is called the ***tuberculin reaction.*** Tuberculin is the liquid in which tuberculosis germs have grown. Another form of tuberculin is the dried germs dissolved in water. Neither contains living germs. When tuberculin is injected into a normal person, it produces no effect, but a very small amount causes fever in a person who has tuberculosis. This test is used in various forms, but the most common is that of von Pirquet. The test is performed as follows: Scratch the superficial layers of epidermis from two areas of skin upon the forearm, each about the size of an "o" of ordinary newspaper print. Apply a drop of tuberculin to one area and leave the other untouched for comparison. If a person has tuberculosis, a red area about the size of a dime will develop around the spot touched with tuberculin, while the other spot will remain normal. The von Pirquet test is valuable for detecting tuberculosis in babies, but the test is so sensitive that it produces red areas on the skins of many grown persons who have no evident signs of tuberculosis, although it is probable that they have the scars of small tubercular lesions which have healed. A practical application of tuberculin tests is made in the detection of tuberculosis in cattle (page 353).

Many experiments have been made in treating tuberculosis with injections of tuberculin with the intention of producing immunity to the disease. But the process is difficult and dangerous and has not been satisfactorily developed. The body seems to respond only to the degree of producing conditions resembling an anaphylaxis which does not go on to the production of sufficient antibodies to have a beneficial effect.

Types of Tubercle Germs.—Four main types of tuberculosis are well recognized: 1, human, affecting persons; 2, bovine, affecting horned cattle; 3, avian, affecting birds; 4, a group affecting cold-blooded animals. Human beings are susceptible to the bovine type of tuberculosis. Although this was long disputed, the explanation is that grown persons are almost entirely immune to the bovine type, but children are somewhat susceptible. About 10 per cent. of all child deaths from consumption are caused by the bovine type of tubercle bacilli. The chief situations in which the bovine type of tubercle bacilli occur are the glands of the neck and of the abdomen. These situations are what one would expect from the fact that the bovine type is usually caught by drinking milk from tubercular animals.

A diagnosis may be made between the human and the bovine type of tubercle bacilli by injecting the suspected bacilli into a rabbit. This animal is extremely susceptible to bovine tuberculosis, and much less so to the human type. If the germs that are injected are of the bovine type, the rabbit will have tuberculosis of practically all the internal organs, while if it is of the human type, only the lungs or the liver or both will be affected.

Prevalence of Tuberculosis.—Health officers frequently give the excuse for doing little tuberculosis work that there are very few cases in their jurisdiction. Tuberculosis is epidemic everywhere. About one-tenth of all deaths are due to it, and the number of living cases in a community is about five times the number of annual deaths from tuberculosis. Every health officer has cases within his jurisdiction, and it is his duty to search them out and to make an earnest attempt to suppress the epidemic. A health officer has three duties to perform: first, to record the cases as in epidemics of other communicable diseases; second, to protect the public from further spread of the disease; and third, to see that the cases receive the proper treatment.

Records.—The laws of the state of New York require physicians to report all their cases of tuberculosis to the local health officers, but the health officers often get few reports, especially in the rural communities. Most of the cases employ no physician regularly, but go from doctor to doctor. Many doctors do not recognize the disease until the victims are dying. The present condition in regard to reporting tuberculosis is like that of diagnosing diphtheria in only those cases which show marked signs of croup. Reporting tuberculosis is a new procedure, and the law has required that the reports be kept secret. But this feeling of secrecy is passing away with the demonstration that reporting cases leads to helping the victims and often to restoring them to health.

There has been a strong public fear of tuberculosis cases, and the victims often conceal their illness for fear that they will lose their positions or their social standing, or that tuberculosis always means sure death. But there is a stage when tuberculosis is not a loathsome disease, when it can scarcely be recognized by an ordinary person, when there is little danger of giving it to another person, and when it can be readily cured. The problem before the health officer is to get the cases in this early stage, and to prevent the disease from going on to advanced forms. This work is a test of the efficiency of a health officer. If he is active and has public health work at heart, he will seek to get physicians to report cases, and will also go out and seek the cases himself. He will follow up rumors and reports from schools, social organizations, charitable societies, and churches, and will endeavor to co-ordinate the forces for the control of the disease.

Recognition of Cases.—One great difficulty with which a health officer has to deal is a failure of the public and physicians to recognize cases of tuberculosis in the curable stage. The health officer will recognize the cases by three methods: first, by a history of the cases; second, by a sputum examination; and third, by a physical examination of the lungs.

Most cases of tuberculosis begin like a prolonged cold, and the victims feel tired all the time, as if they were overworked. If there are signs of a persistant cold with some cough and loss of weight and strength, there are good grounds for at least suspecting tuberculosis, and for seeking examinations of the sputum and chest to determine the presence or absence of the disease.

The presence of tuberculosis is positively determined by finding tubercle germs in the sputum. The departments of health of some of the states and of the larger cities examine specimens free of cost, and supply health officers with containers for sending specimens to a laboratory. It is the duty of the health officer and the physicians to make use of the facilities for sputum examination. Finding tubercle germs fixes the diagnosis of tuberculosis, but failure to find them does not exclude the disease (page 293).

Physical Examination.—An expert health officer or physician should be able to recognize tuberculosis by the physical signs of the lungs before tubercle bacilli appear in the sputum. The two physical signs which almost positively indicate tuberculosis are an afternoon fever without an apparent cause and the presence of slight lung signs, especially a few râles, in any part of the lungs. These râles will be heard at the base almost as frequently as at the apex. A valuable sign which is almost constantly found is a few râles heard at the beginning of an inspiration which is taken after a person has coughed at the end of expiration. Many physicians are not familiar with these slight signs of the disease. It is the duty of the health officer to study to make himself an expert in these physical signs, to teach them to the physicians within his jurisdiction, and to get their co-operation in the examination of the cases. This requires tact and enthusiasm on the part of the health officer; but he cannot do effective tuberculosis work unless he is deeply interested in the subject and is willing to study and work.

An x-ray examination of the lungs will reveal spots of consolidation and is a valuable means of detecting the disease in small areas both in the beginning of the disease and after they have healed.

Experience in the army has demonstrated that when men live under crowded conditions, a low grade, chronic infection with streptococci frequently occurs in the lung, and produces an area of inflammation which gives the symptoms and physical signs of tuberculosis. These cases have no tubercle bacilli in their sputum. They nearly always recover under treatment with fresh air, good food, and rest.

Protection of the Public.—Tuberculosis does not come from a cold, or overwork, or exposure, but it is a communicable disease, and is caught from some person or animal that has it. A person who has the disease gives off the germs with the sputum; and the prevention of the spread of the disease consists of taking care of the sputum of the cases. The patient is to expectorate into a cup or a napkin, and the sputum is to be burned or buried. The patient is to avoid spitting on floors of public places or in any place from which the germs may escape. He is to avoid kissing other persons or doing anything by which his sputum may be spread. His dishes, knives and forks, towels, and other eating utensils are to be cleansed in hot water. If a patient does these things, he will not be likely to give the disease to other persons.

Tuberculosis patients may be divided into two classes: those who have tubercle bacilli in their sputum and those who do not have it. Tubercle bacilli do not appear in the sputum until the tissues of the lungs begin to break down. The incipient cases are not likely to have tubercle bacilli in their sputum, and may go in public places without danger to other persons. The degree of danger in each case of tuberculosis must be judged by itself. The elements to be considered in judging the danger from a case of tuberculosis are: first, the number of germs in the sputum; second, the reliability and intelligence of the patient in regard to caring for his sputum; and third, his ability, physically and financially, to carry out the instructions of the physicians and health officer. An intelligent patient in moderate circumstances who is conscientious can readily take care of himself and his sputum in such a way that he may mingle with other persons without danger of spreading the disease. On the other hand, a patient is a menace to the public if he is unreliable or stupid, or is so weakened by the disease that he is unable to procure the necessities of life.

The protective measures which a health officer may adopt are: first, to provide sputum cups, paper napkins, and other utensils which a patient needs in caring for his sputum; second, to see that a patient receives proper treatment; third, to secure his removal to a hospital if one is available; and fourth, to instruct the patient and his family, and to maintain an oversight over him. The health officer or his helpers will need to make many visits to a patient. Perfunctory oversight will accomplish nothing, and no measures will do much good unless the health officer succeeds in obtaining the co-operation of the patients and their families.

Treatment.—It is the duty of a health officer to secure treatment for cases of tuberculosis not only for the benefit of the patients themselves, but for the protection of the members of their families and of the public. The old idea of treatment of tuberculosis was that a change of climate was necessary. Cases from mountainous regions were sent to the sea-shore and those from the sea-shore were sent to the mountains. We now know that climate and change of air are minor considerations in producing the cure. A patient can get well in his own home town as quickly and completely as he can in a distant land.

An experimental method of treatment is the use of vaccines with the expectation of producing an immunity to the disease. The sickness and fever in many cases of tuberculosis are due not so much to the tubercle germs as to streptococci and other germs which are associated with the tubercle germs. Vaccines sometimes have effects in destroying the associated germs, and the body thus relieved of its burden may be better able to overcome the tubercle germs. Vaccines for the destruction of tubercle germs themselves have not produced cures (page 293).

All manner of drugs and special foods and applications have been tried, and all have been found wanting.

The three essential things in the cure of tuberculosis are fresh air, nourishing food, and rest. These are extremely simple things, and because they are so simple they are often difficult to obtain. It does no good for a health officer to prescribe fresh air when a large family is housed in crowded quarters without heat and with insufficient clothing, or when the family does not possess the means for buying food, or when the sick person must work to maintain himself and his family. The rich man who has a cough and is overworked gets relief by taking a vacation; but a poor person must stay at home and make use of the meager facilities which he has. It is the duty of the health officer to see that the means of treatment are provided. This is largely a social problem, and requires the co-operation of the churches for the comfort and solace which they afford; of charitable societies for their supplies of food and clothing; and of reform leagues for laws to compel municipalities to provide the means for the care of the cases. If a health officer is unable to obtain all the things which are necessary for the treatment of a tuberculosis case at once, he can at least agitate the subject and talk about it persistently until he rouses the public and officials to provide the means for treatment.

The health officer will naturally divide cases of tuberculosis into three classes: first, the incipient class, or those in which no germs are found in the sputum, and which have only mild, beginning symptoms. These cases will get well, and may be safely treated at their home, and may continue at work.

The second class of cases are those who are giving off germs with their sputum, but who will get well if they take great care of themselves. Some of these cases may be safely treated at home, but others will require considerable assistance and possibly expert care in a hospital.

The third class of cases are those who are advanced so far that they cannot get well. If they are poor and remain at home, they often give the disease to other members of the family. These cases require treatment in hospitals not merely for their own comfort, but for the protection of their own families and the public. Every advanced case passes through the stages of incipiency and moderate advancement, and it is the duty of the health officer to offer the means for the detection and care of these cases in the early stages of the disease.

The health officer cannot attend to all the cases alone. He must have the co-operation of many assistants, and his success will depend upon his ability to secure their services.

An assistant which is almost absolutely necessary for a health officer to carry out tuberculosis work is a public health nurse. Her duty is to visit the homes of the patients and to instruct them in their breathing, eating, and rest, and to do simple nursing for them if it is necessary. She will also keep track of their needs, and will see that the proper officers supply them.

A tuberculosis sanatorium is also almost indispensable in combating tuberculosis. A hospital is not merely a place where patients receive treatment. Its chief value is that it is a school of instruction where the curable cases can go and learn to breathe, eat, and rest. It is also an isolation place where advanced cases can receive care and where they will not be a menace to the community.

A great problem in tuberculosis work is how the health officer is to enable recovered persons to live as they should after they leave the hospital. If they have to work hard for their living, or to provide for the necessities for a large family, they will soon relapse and be sick with the disease again. It is the duty of public officials to provide the means by which these persons may be relieved of the greater burdens of life.

CHAPTER XXVIII

INSECT-BORNE DISEASES

MALARIA

MALARIA is a communicable disease whose control and prevention is a public health problem. It is caused by a protozoön, formerly called the Plasmodium malariæ, but now the Hæmamœba malariæ. The organisms grow in the blood and destroy the red blood-cells. They multiply in human blood by segmenting or dividing every forty-eight or seventy-two hours, according to the type of the disease. A chill and fever follow each segmentation.

Fig. 22.—Method of transmission of malaria and yellow fever.

The parasites of malaria may be transferred from a malarial patient to another person by the transfusion of blood, but the ordinary method of their transference is by means of blood-sucking mosquitoes. When the organisms are taken into a mosquito, they undergo a sexual development and multiplication. They are then found in the salivary glands of the mosquito, and are injected into the persons whom the insect bites. The affected mosquito itself does not seem to be harmed by the malarial parasite, but it may live for weeks, and may bite and infect many persons. The organisms appear in the salivary glands in from seven to ten days after a mosquito has bitten a malarial patient. When a well person is inoculated by an infected mosquito, he will have his first chill in from one to three weeks. It therefore takes from two to four weeks for a secondary case of malaria to develop from a primary case.

The Mosquito.—The only mosquitoes that carry malaria germs are those belonging to the genus Anopheles. The two common species that produce malaria in the United States are the Anopheles quadrimaculatus and the Anopheles punctipennis. A ready means of recognizing an anopheles mosquito is that it rests with its body at nearly right angles to the surface on which it alights, while other mosquitoes rest with their bodies parallel to the surface. The anopheles mosquito is a night flier, and this peculiarity accounts for the old observation that the outdoor night air in the neighborhood of marshes was unhealthful and produced malaria.

Diagnosis.—Physicians often make a diagnosis of malaria in order to account for any slight chill or fever whose cause is obscure. These physicians often give a reputation for malaria to districts in which not an anopheles mosquito can be found. An accurate diagnosis of malaria can be made only by examining the blood and finding the malaria organism.

Control and Prevention.—Every person who has malaria is a breeder of malarial organisms. Some persons have chronic malaria and are carriers of the organisms for years. A health officer would naturally consider some plan of keeping mosquitoes away from every malarial case, or every case away from mosquitoes, but there seems to be no practical way of enforcing the plan or of compelling the chronic carriers to rid themselves of the organisms.

Anopheles mosquitoes do not fly far or high. Locating dwellings on high land affords some protection against malaria. Remaining indoors behind screened windows at night gives almost complete protection, for the anopheles mosquitoes are active only at night.

An attack of malaria does not produce immunity, but it rather gives a greater susceptibility to another infection. A considerable degree of immunity is produced by the use of quinin, but only so long as the drug is used.

The most practical measure of protection against malaria is the destruction of anopheles mosquitoes in their breeding-places. A health officer is justified in conducting an extensive anti-mosquito campaign on the ground of the prevention or suppression of malaria.

YELLOW FEVER

The Virus.—Yellow fever is caused by a virus which is in the blood during the first three days of the fever. The disease may be transmitted by the inoculation of blood, but the only way in which the disease naturally spreads is by the bite of a mosquito called the Aëdes calopus, formerly called the Stegomyia calopus. A mosquito cannot transmit the disease until twelve days after it has bitten a yellow fever patient, but it afterward carries the yellow fever organisms as long as it lives. The disease develops five days after a person has been bitten by an infected mosquito.

The Mosquito.—The Aëdes calopus mosquito is small and brilliantly marked with silver. It breeds in small collections of water around houses, and is not found more than a quarter of a mile from human dwellings. It is a weak insect, and does not fly to a distance of many yards. It is killed by a freezing temperature, and this accounts for the fact that an epidemic of the disease ceases at once after the first frost.

Control and Prevention.—The measures for the control and prevention of yellow fever are directed against mosquitoes. Quarantine or isolation is unnecessary except to prevent mosquitoes from approaching the patient. A mosquito screen over each patient will effectually prevent the spread of the disease. This measure cannot always be carried out owing to the existence of extremely mild cases of the disease which are not discovered.

The destruction of all mosquito breeding-places in a yellow fever district effectually suppresses an epidemic and prevents the development of the disease in an uninfected district. Anti-mosquito work is one of the most essential of all the duties which a health officer performs in a tropical climate.

TYPHUS FEVER

Typhus fever was formerly confused with typhoid fever, but its onset is rapid, and an abundant red, macular eruption

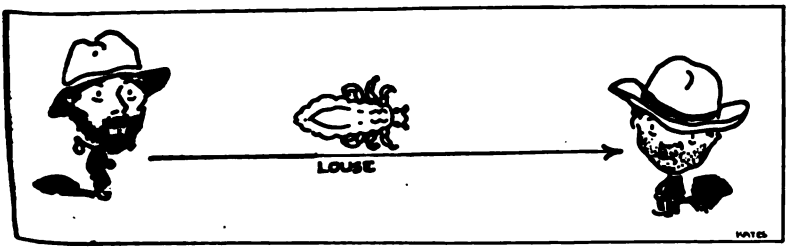

Fig. 23.—Method of transmission of typhus fever.

appears from the third to the fifth day. The eruption gave the disease one of its names—spotted fever. The fever runs for about two weeks, and falls suddenly if recovery takes place.

The disease is caused by a bacillus which is transmitted from person to person by the bite of infected body lice and head lice. It was formerly common, but a health officer will probably seldom or never see a case. The illness called Brill's disease is a mild form of typhus fever which is occasionally recognized in cities. The preventive measures against typhus fever are directed almost solely against lice on human beings. Their extermination will prevent typhus fever as effectually as the extermination of mosquitoes will prevent malaria.

PLAGUE

Plague is a highly infectious disease which is caused by a bacterium called the Bacillus pestis. There are three main

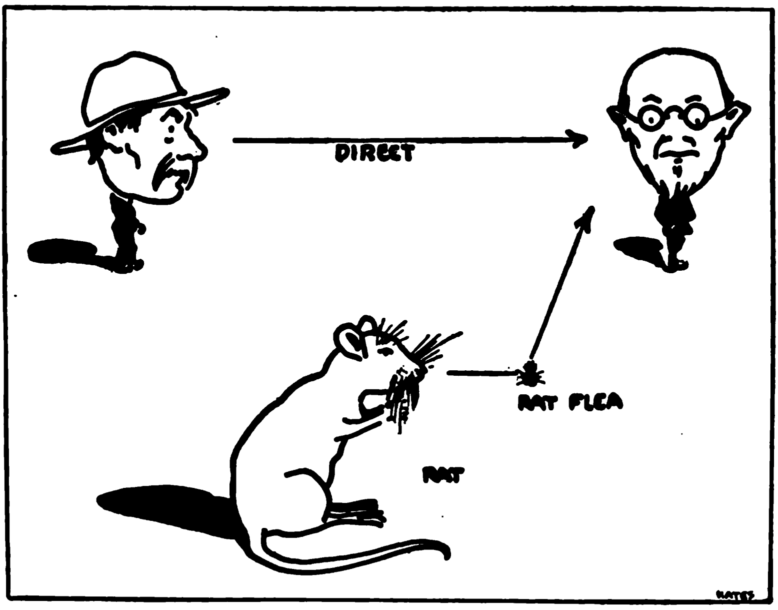

Fig. 24.—Method of transmission of plague.

forms of the disease: 1, the bubonic, in which there are enlargements of the lymph-glands, often with suppuration; 2, a septicemia; and 3, the pneumonic form, which affects the lungs. The bubonic and septicemic forms are not usually directly transmitted from person to person by contact, for the germs are not excreted from the body; but the bacilli are found in the sputum of patients who have the pneumonic form, and the disease may then be transmitted directly from one person to another. The usual method of transmitting the disease is by means of fleas that have bitten infected persons or rats. The disease affects rats, squirrels, and other rodents, and the bacilli are usually spread by fleas from the rats that have died from the disease.

The prevention and eradication of plague depends upon a quarantine of all cases, and the extermination of rats, ground squirrels, and other animals that are infected. The disease is prevalent in southern Asia. It frequently appears in the United States, and may suddenly spread among rats at any time unless they are kept under control.

CHAPTER XXIX

MISCELLANEOUS DISEASES

EYE INFECTIONS

Ophthalmia Neonatorum.—A health officer often has to deal with infectious diseases of the eye, and two of them, ophthalmia neonatorum and trachoma, are reportable in New York State. Ophthalmia neonatorum, or inflammation of the eyes of newborn children, is caused by an infection which enters the eyes at birth, and is derived from the mother. It is a severe inflammation of the eyeball and lids, with much swelling and production of pus. It often produces ulcers on the cornea which leave white, opaque spots on healing. It is the cause of over one-half of all cases of blindness. The disease is caused by two kinds of infection, that by gonococci and that by streptococci. The two forms are very much alike, and can be told apart with certainty only by an identification of the germs in the pus. Both forms are dangerous, but the streptococcus form usually runs a shorter course and its effects are less severe than the other.

Ophthalmia neonatorum may readily be prevented. Its prevention consists in cleanliness during birth, and in treating the eyes of the child immediately after birth with a 1 per cent. solution of nitrate of silver dropped upon the cornea while the lids are held open. The Department of Health of New York State supplies physicians and midwives with outfits of the silver nitrate solution, and the birth report has a blank space on which the physician or midwife is required to report whether or not any treatment was applied, and if none was given, the reason why it was not must be stated.

Pink-eye.—Children often have an acute infection of the conjunctiva called pink-eye, or acute contagious conjunctivitis. It produces soreness and redness which lasts a week or two, and leaves no permanent injury. The disease is contagious, and is usually caused by a bacillus, called the Koch-Weeks bacillus, which resembles that of influenza. The disease is spread by the direct transference of secretions from an affected eye to the eye of another person, usually by handkerchiefs, towels, or fingers. Its prevention consists in keeping every affected child away from others, and in each child using its own handkerchiefs and towels and avoiding those used by other persons.

Granulated Lids.—There is a common eye condition in which the conjunctiva appears granular, as if it were sprinkled with sand. The granules vary in size from those which are just visible to those as large as small pin-heads. They give rise to itching and smarting, and to sensations that sand is in the eye. The feelings are due largely to the friction of the granules upon the sensitive cornea. The danger of the condition depends upon the extent and nature of the trouble.

Trachoma.—One form of granulated lids is infectious, and is called *trachoma*. There is doubt regarding its bacteriology, but a bacillus like that of influenza is usually associated with it. The disease is spread by contact with excretions from the eye of an affected person. It runs a short course, and tends to increase in severity and not to disappear. The granulations extend themselves deep into the conjunctiva and cause a destruction of the tissues. The conjunctiva heals by the formation of new connective tissue or scar tissue, which contracts and draws the lids out of shape. The granulations scrape against the cornea and produce soreness and ulcerations. Trachoma is dangerous to sight, and if it is neglected, it often leads to blindness.

Severe cases of trachoma can be cured only by removing the diseased tissue by a surgical operation; but the mild cases may be cured by treating them daily with drops of 1 : 2000 solution of bichlorid of mercury in water. The exact strength of the solution may be varied, but it must be sufficiently strong to produce a smarting sensation lasting about five minutes. If the drops are applied regularly, the secretions of the eye do not seem to be infectious, and the affected person need not be placed under restrictions or excluded from school.

Follicular Conjunctivitis.—There is a non-infectious form of granulated lids, called *follicular conjunctivitis*, which resembles a mild form of trachoma, and can scarcely be distinguished from it. The medical examination of school children reveals many cases of granulated lids whose nature cannot be determined with certainty. Eye specialists agree that there is a disease, follicular conjunctivitis, which is not contagious, and another disease, trachoma, which is contagious. They usually agree in the diagnosis of well-marked cases, but they often disagree over cases that are mild. A health officer is frequently in doubt as to his duty in excluding affected children from school and in requiring their treatment. The experts fortunately agree that the bichlorid drops will cure follicular conjunctivitis as well as trachoma. The health officer may, therefore, not press the question of naming the disease so long as the bichlorid treatment of the affected children is carried out.

HOOKWORM DISEASE

The Parasite.—Hookworm disease is caused by worms about ½ inch in length which attach themselves to the wall of the intestine, suck blood from the mucous membrane, and probably inject a poison into the system. The worms produce eggs which leave the body with the intestinal excretions and hatch in the soil. The young worms enter the body through the skin, usually between the toes, and finally reach the intestine, where they attach themselves. The young worms may also reach the intestine by means of drinking-water. The spread of the disease is due principally to the lack of privies in some sections of the United States, and to the resulting pollution of the soil with human excretions.

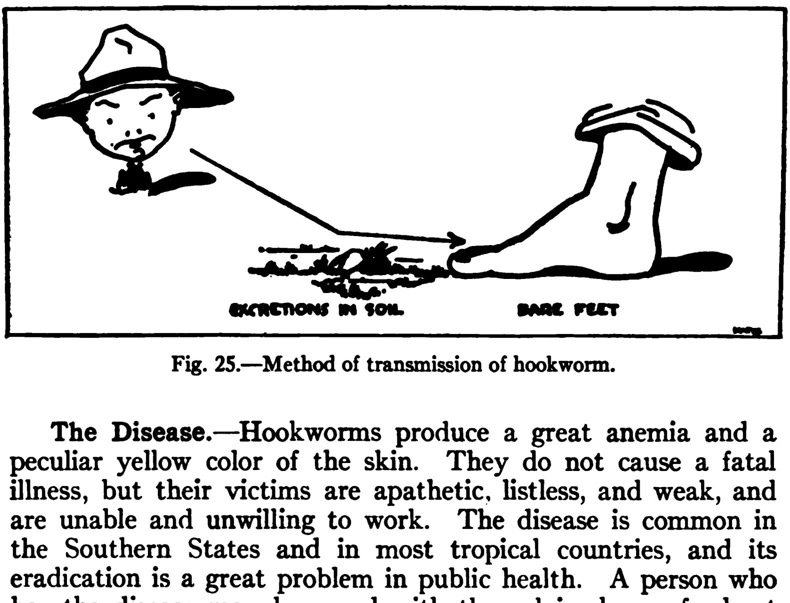

Fig. 25.—Method of transmission of hookworm.

The Disease.—Hookworms produce a great anemia and a peculiar yellow color of the skin. They do not cause a fatal illness, but their victims are apathetic, listless, and weak, and are unable and unwilling to work. The disease is common in the Southern States and in most tropical countries, and its eradication is a great problem in public health. A person who has the disease may be cured with thymol in doses of about 20 grains, taken while fasting and after a dose of Epsom salts.

Hookworm disease is spread by means of the intestinal discharges. The means of prevention are:

1. Provision for privies in order to prevent the pollution of the soil with human excretions containing the eggs.
2. Wearing shoes in order to protect the skin against the entrance of the worms.
3. Cleanliness of the hands in order to avoid transferring the worms to the mouth.

4. Boiling drinking-water in order to kill the worms that may be in it.

5. The adoption of general sanitary measures.

The prevention of hookworm disease is largely an economic and social problem, and involves the expenditure of money and effort in the disposal of intestinal excretions, and the adoption of higher standards of social life.

TAPEWORM

A tapeworm consists of a head and a long series of broad, flat segments. The head is about the size of a very small pea,

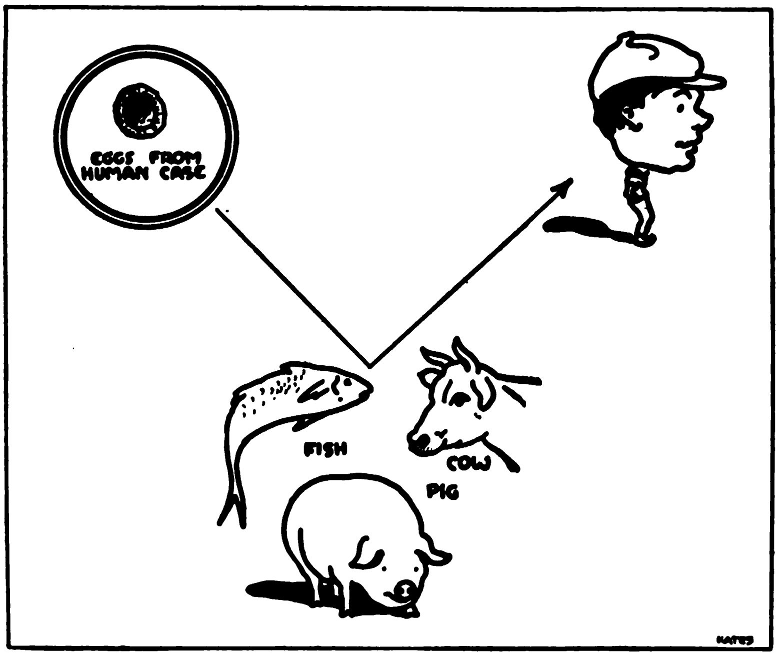

Fig. 26.—Method of transmission of tapeworm.

and is fixed to the mucous membrane of the intestine. Its only action is to develop the segments. Each mature segment is about ½ inch square. It produces fertile eggs which are expelled from the human body with the intestinal excretions. When the eggs are eaten by swine, cattle, or fish, they develop into new heads which pass into the blood-stream and lodge in the muscles. A head develops a new tapeworm in the body of a person who eats the meat.

The prevention of tapeworm consists in three measures:

1. The cure of the affected person.
2. The disposal of human excretions in such a way that swine, cattle, or fish cannot have access to them.
3. Cooking meat and fish, or thoroughly salting or smoking that which is to be eaten raw.

Tapeworm is not classed as a serious disease, and it is seldom brought to the official notice of a health officer. The possibility of infecting food animals is an argument for the proper disposal of human excretions.

GLANDERS

Glanders is a disease of the horse, and is occasionally communicated to stablemen. It is caused by a bacterium called the Bacillus mallei. The disease exists as nodules and ulcers either in the nose or upon the skin. The existence of the disease may be suspected from a history of the contact of the patient with diseased animals. It may be confirmed from a culture which may be taken on a diphtheria culture-tube, and by animal inoculations.

The disease in horses may be detected by the mallein test, which is similar to the tuberculin test. It consists of a rise in temperature following an injection of killed bacilli.

The control of glanders in New York State is vested in the Commissioner of Agriculture, and a health officer may call on the Agricultural Department for assistance when the disease is suspected in horses.

ANTHRAX

Anthrax was the first disease in which a specific microorganism was demonstrated. The bacilli were seen in the blood

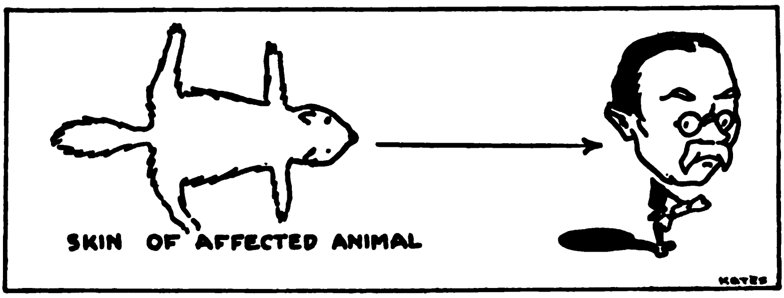

Fig. 27.—Method of transmission of anthrax.

in 1849, and were obtained in pure cultures in 1877. The disease affects cattle, and is occasionally communicated to persons who handle the skins of affected animals. The bacilli form spores which may remain alive for years. The symptoms of the disease are indicated by its old name, malignant pustule. It begins as a vesicle, or pustule, in a hard, swollen area of skin which is usually located on the hand or face at the site of inoculation. The vesicle or pustule soon dries, leaving a black, necrotic area. The bacilli appear in the blood late in the disease, but they may usually be detected in a culture from the pustule. A health officer may make a culture upon a diphtheria culture-tube, and send it to a laboratory for examination; or the pustule may be cut out and sent to a laboratory. The disease may usually be detected within a day or two by inoculation of the suspected material or its culture into mice.

Anthrax may produce a disease of the lungs and intestine, but in this form it usually goes unrecognized and unsuspected unless cultures of the excretions are taken.

The treatment of anthrax consists in the cauterization or excision of the original pustule as early and completely as possible. The measures for the prevention and spread of the disease are the isolation of the patient, strict antiseptic precautions, and the sterilization or efficient disposal of all discharges and excretions. A curative serum has been used with success.

TRICHINOSIS

Trichinosis is a disease of human beings and of hogs, rats, mice, dogs, and other animals. Human beings catch the disease by eating the flesh of infected hogs. The organism of the disease is a worm which is barely visible to the naked eye. The miniature worms are found coiled in the muscles where they give rise to tenderness and soreness which may be mistaken for signs of rheumatism.

When a person or animal eats the infected muscles, the miniature worms are set free. They quickly reach their full size and produce young, which enter the blood-stream and thus reach the muscles. Only a week or two may elapse between the time of eating the infected meat and the development of symptoms. If only a few worms reach the muscles, there may be no noticeable symptoms; but if there are many, they may produce death. The prominent symptoms are fever and muscular pain, and the disease is often mistaken for rheumatism or typhoid fever. The prevention of the disease in man consists in thoroughly cooking all hog flesh that is eaten.

Hogs and rats catch trichinosis by eating offal from slaughter-houses and butcher shops, and from meats discarded from kitchens. Hogs could readily be kept free from the disease if

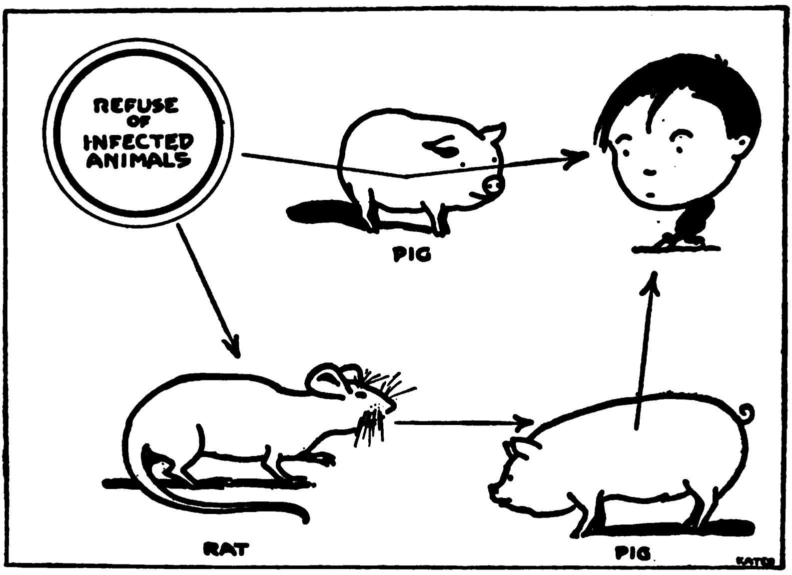

Fig. 28.—Method of transmission of trichinosis.

rats did not bring it to them. The spread of the disease by rats is a great argument for their extermination.

LEPROSY

Leprosy is caused by an acid-fast bacillus which resembles the tubercle bacillus. It produces two forms of disease. An anesthetic form affects the nerves and produces areas which are at first painful and later anesthetic. The skin over the areas is usually white. The other form of leprosy consists of skin tubercles which often ulcerate and cause a loss of the fingers and toes. The bacilli of leprosy are given off with the excretions of the nose and of the ulcers. The disease is only mildly contagious in the United States. Its prevention consists in the isolation of the cases.

CHAPTER XXX

MENTAL DEFECTS

The care and control of those who are mentally deficient is within the scope of the activities of a health officer. Mental defects concern public health officials for the following reasons:

1. The various defects are disease units; they are classified and defined; and their cause and development may be predicted with a considerable degree of precision.
2. Many of the defects are transmissible from one person to another.
3. They are, to a great extent, preventable and curable.
4. They are frequently the result of communicable diseases, such as syphilis or tuberculosis.
5. They are often the result of social and economic conditions, especially those leading to overwork, malnutrition, and disease.
6. They are frequently the underlying causes which result in disease, prostitution, disorder, poverty, and crime.

The plea that an offender is only half-witted is no longer a valid excuse for tolerating unsanitary conditions, disorder, and crime in a community. It is a public duty of officials to prevent or remedy mental defects, and to control those who are unwilling or unable to control themselves or those under their charge. The recognition of permanent mental defects and the control of the mentally deficient are largely medical problems, and dealing with them is one of the duties of a health officer in his capacity as the medical adviser of his municipality. The mental defects with which a health officer has to deal vary from violent insanity to mild degrees of mental insufficiency.

Number of Cases.—Cases of mental disorder are more numerous than they are popularly supposed to be. New York State supports about 40,000 inmates in hospitals for the insane, and there are as many more in the incipient and convalescent stages of insanity. A careful survey of an average county of 115,000 inhabitants revealed 1500 persons whose mental abnormalities were sufficiently marked to bring them in official contact with public officers. It is a conservative estimate that at least 1 per cent. of the population require public care and control, and are a burden upon society on account of mental abnormalities and deficiencies.

Causes.—The principal causes of mental defects are:

1. Heredity.
2. Environment.
3. Physical disease.
4. Drugs.
5. Mental strains.

Heredity.—Mental traits, like physical characteristics, are transmissible. Children tend to resemble their parents both mentally and physically. The science of eugenics is concerned principally with the relation of the laws of heredity to the improvement of the mental and physical condition of the human race.

A fundamental principle in heredity and eugenics is that the peculiar traits which distinguish individuals may be analyzed into units which are inherited independently of one another. Examples of physical unit characters which are inherited are the color of the eyes, the shape of the nose, the complexion, tallness, and immunity or susceptibility to diphtheria. Examples of mental unit characters which are inherited are musical tastes, mathematic ability, quickness of temper, emotional control, deaf-mutism, imbecility, and Huntington's chorea.

Each person embodies a complex collection of unit characteristics. The mental and physical nature of an individual is a compound of many units which often overlie and obscure one another. A trait may apparently be absent when it is dominated by another trait. If, for example, a person inherits both quickness of temper and emotional control, the quickness of temper may not be apparent to an observer. The detection and determination of all the unit characters of an individual are difficult unless a complete ancestral history of all the parents and grandparents for many generations is available.

Mendel's Law.—When both parents possess a particular unit character, all their children will inherit it; and if these children marry persons having the character, all their descendants will have it, and we say that the strain of blood is pure. When only one parent has a unit character, the children will be of mixed blood, and when they intermarry, one-quarter of their descendants will have the unit character in full degree; one-quarter will lack it entirely; and two-quarters will be of mixed blood. A statement of the proportions in which descendants of mixed blood show unit characters is called *Mendel's law.*

An illustration of Mendel's law is the proportion of black to white chickens that may be expected when a white chicken is crossed with a black one, and succeeding generations are intercrossed. Since black is due to a pigment and white to its absence, chickens of mixed blood will be black and indistinguishable from the blacks of pure blood. The possible combinations of black and white in a pair of chickens which have both black and white strains in them is shown by the following diagram:

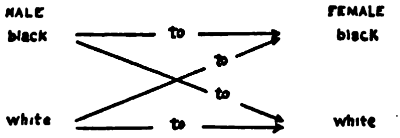

Diagram illustrating the hereditary transmission of color in fowls.

Each male and female contains a unit character of white and one of black. If the white character of one parent unites with the white of the other, the offspring will be a pure strain of white with no trace of black.

If the black character unites with the black, the offspring will be pure black.

There are two chances that the black of one will unite with the white of the other, and the offspring be of mixed strains. The result is that one-quarter of the chickens will be of a pure strain of black, one-quarter of a pure strain of white, and two-quarters of a mixed strain of black. Experience demonstrates that the law usually holds good.

Mendel's law explains the occurrence of abnormal mental conditions among the descendants of parents having a strain of mental abnormality. The possible combinations of normal and abnormal elements is shown by the following diagram:

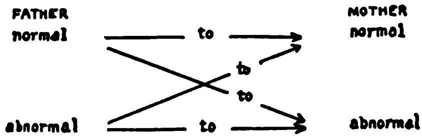

Diagram illustrating the hereditary transmission of mental traits.

When persons with a strain of mental abnormality marry others with a similar strain, the result will be that one-quarter of the descendants will be normal without a trace of abnormality; one-quarter will be abnormal to a great degree, and two-quarters will show lesser degrees of abnormality.

The operation of Mendel's law in the inheritance of mental traits is as certain and exact as it is in chicken breeding. This law of heredity justifies strong measures for the control of marriage among defectives, and the prevention of procreation among those who are mentally deficient. It is also a source of encouragement, for there is an inheritance of mental traits which are normal and desirable as well as of those which are abnormal and undesirable. It furthermore accounts for the fact that one member of a family may be normal and highly intelligent and have brothers and sisters who are abnormal or feeble-minded.

Environment.—Hereditary traits are implanted and fixed in the germ cell of an individual at the time of conception, but the development of the traits is affected to a profound degree by environment and training. It is often a question whether a trait is the result of heredity or of environment. Proper environment and training may cause the development of normal traits when hereditary influences tend to the development of traits which are abnormal and undesirable. An efficient teacher must consider both the history of the parents and also the child's home-life and surroundings. Hereditary and congenital weakness or abnormality may be so great that no amount of care and training will bring the individual up to a normal standard; and, on the other hand, hereditary strength of mentality and character may be so great that an individual may develop normally amid surroundings and influences that are evil and weakening to both mind and body.

Two fundamental principles in the prevention of mental abnormalities and weaknesses are: 1, the protection of the abnormal person from influences which tend to arouse or produce the abnormal state of mind; and 2, training to develop the mind along normal lines. Nearly every person who is feeble-minded or abnormal is normal in many respects. Most inmates of institutions for the insane and feeble-minded may lead normal lives so long as they remain under the influence and protection of the institution or of a competent person outside of it.

Physical Disease.—A mental abnormality or defect may be the direct result of a physical disease or defect. The delirium of an acute fever is the result of poisons developed in the body. Syphilis is frequently the cause of insanity and of congenital feeble-mindedness.

Feeble-mindedness in the blind or deaf is often the direct result of eye or ear defects dating from infancy. These persons may be feeble-minded merely because they are unable to receive normal mental impressions. Their minds develop normally when they are taught to receive mental impressions through the senses which are normal.

The most frequent causes of blindness and deafness are infectious diseases, such as scarlet fever, measles, and syphilis, which are directly under the control of the health officer. The care of the blind and deaf children is a phase of the child welfare and school inspection work of the health officer.

Drugs.—Insanity, feeble-mindedness, and abnormal mental states may be the result of poisoning by drugs, especially morphin, cocain, and alcohol, when they are used habitually. Other habit-forming drugs are chloroform, headache cures, such as phenacetin, aspirin, and bromocaffein, and hypnotics, such as choral, sulfonal, and paraldehyd. The detection, control, and treatment of drug habitués is within the scope of the activities of a health officer, especially in a rural district.

Mental Strains.—There are varying degrees of temper of mind as there are of steel. Some minds are unable to withstand a prolonged strain or severe shock, while others can endure the most severe strains and shocks, as in violent and prolonged bombardments. Fine mental temper and control may be hereditary, or a considerable degree may be acquired by training.

The common forms of mental strains, such as financial worries, overwork, and loss of friends, usually produce the premonitory symptom of inability to sleep. Some persons become dull and sleepy when they endure mental strains; and they recover their normal state of mind after sleep. Mental strains cause other persons to become excited and sleepless, and it is these who break down under mental stress.

Mental strains often result from the concentration of the mind upon a single object day after day. The best mental relaxation comes from a complete change of work, even though the second line of thought requires as much mental effort as the first. There is a very great health value in a favorite sport, or amusement, or hobby. A health officer can do excellent public health service by promoting organized games and sports in a community.

Classification of Abnormal Mental States.—The standard of the classification of mental abnormalities may be either medical or sociologic. The medical list of abnormalities is lengthy and complicated. A health officer is expected to make only a general diagnosis and to classify the case in a proper medical group in order to place the patient in the proper institution, or to secure the proper supervision and control over the case. Four groups of abnormalities which are of special interest to a health officer are:

1. The psychoses, or what are popularly called insanities. Cases in this group are treated in special hospitals and institutions for the insane.

2. Simple dementia of old age. The cases of this group may properly be sent to almshouses or be treated in their homes.

3. Disorders due to drug habits. Greater provision is necessary for the control and care of drug habitués.

4. Feeble-mindedness. Cases of mental deficiency are sent to special institutions and reformatories, and are often improperly sent to jail. The prevention of the condition is within the scope of infant welfare work and the medical inspection of school children.

A health officer will frequently use a sociologic classification based on the relation of the patients to their families and to society. A practical classification is that of the British Royal Commission on the care and control of the feeble-minded, and is as follows:

1. Persons of unsound mind. These are persons who require care and control owing to a disorder of the mind, and are consequently incapable of managing themselves or their affairs. This class comprises those who are popularly called the insane or lunatics; but it excludes those in the following classes.

2. Persons mentally infirm. These are persons who through old age or the decay of their faculties are incapable of managing themselves or their families.

3. Idiots. These are persons who are so deeply defective in mind from birth or from an early age that they are unable to guard themselves from common physical dangers. Their mentality is that of helpless infants.

4. Imbeciles. These are persons who are capable of guarding themselves from common physical dangers, but are incapable of earning their own living by reason of mental defects existing from birth or from an early age.

5. Feeble-minded. These are persons who may be capable of earning a living under favorable circumstances, but on account of mental defects existing from birth or from an early age they are incapable of competing on equal terms with their normal fellows, or of managing themselves or their affairs with ordinary prudence. This class includes the morons, or those whose mentality is above that of an imbecile, but below that of a normal person of low intelligence.

6. Moral imbeciles. These are persons who from an early age display some mental defect coupled with strong vicious or criminal propensities on which punishment has little or no deterrent effect.

7. Epileptics who are also mentally defective.

8. Inebriates and drug habitués, who are also mentally defective.

9. The deaf and dumb or blind who are also mentally defective.

All classes of cases of mental disorder frequently come to the attention of the health officer. He has official duties to perform in relation to the insane and the feeble-minded, and is indirectly interested in the other classes of cases. The aged, the mentally infirm, idiots, and imbeciles obviously require care which is usually given by guardians and overseers of the poor. The moral imbeciles come under the control of police officers. Arrangements for the care of epileptics, inebriates, the deaf and dumb, and the blind are usually made through charitable and philanthropic workers.

Evidences of Mental Abnormality.—Cases of mental disorder and feeble-mindedness usually come to the attention of the health officer on account of conduct which would be considered disorderly or foolish if it were the act of a normal person. There is often difficulty in determining the motive for an action and its interpretation when the person performing it is apparently normal and yet obstinately independent and disregardful of public sentiment.

Some of the gross evidences of abnormality are as follows:

Retardation at school.
Truancy, unruliness, cruelty, etc.
Sex immorality.
Disorderly conduct.
Criminal tendency.
Vagrancy.
Dependency.
Inebriety.
Drug habits.
Domestic maladjustment.
Incompetency, especially among housewives.
Improper guardianship of children.
Unsanitary conditions at home.

The classes of persons in which a health officer may expect to find numerous cases of mental disorder and feeble-mindedness are as follows:

1. Those under arrest.
2. Backward children in school.
3. Persons known to be public nuisances.
4. Hermits.
5. Drunkards.
6. Prostitutes.

A health officer usually learns of the probable existence of mental abnormality from the following groups of persons:

1. Teachers.
2. Neighbors who are annoyed by the affected persons.
3. Overseers of the poor.
4. Ministers and church workers.
5. Workers in charitable and philanthropic societies.
6. Physicians who seek assistance in sending cases to institutions.

The Insane.—Insanity is the principal mental disorder with which a health officer has to deal. One of his duties is to secure the proper control and care of insane persons whose guardians are unable or unwilling to care for them at home. Treatment in special hospitals is recognized as the best means of caring for the insane, and as the only practical means in most cases. Many insane persons accept hospital treatment voluntarily when the nature and curability of their disorder is explained to them. Most cases of insanity, like those of tuberculosis, recover or are arrested in development when they receive proper care and treatment in their early stages. Recognition of the curability of mental disorders when they are treated early is a great factor in overcoming popular prejudices against the acceptance of hospital treatment in the early stages of the disorder. The ideal method in dealing with insanity, as with tuberculosis, is to diagnose and treat the cases in their incipiency while the disorder is curable. Many high-class sanitariums and health resorts are, in reality, institutions for the treatment of those who would be in insane hospitals if they did not have the financial means to secure private treatment and care.

Evidences of Insanity.—The principal direct evidences of insanity are confusion of mind, delusions, illusions, and hallucinations.

Evidences of mental confusion are:

Mistakes in familiar names, places, and dates.

Failure of memory for recent events.

Inability to concentrate the mind on a subject.

Wandering of thought from one subject to another.

Emotional excitement or depression.

Marked change in mentality or behavior.

Delusions are marked errors of judgment. Common examples of delusions are those of the following conditions:

Sudden gain of wealth or loss of property.

The possession of unlimited power or the onset of great weakness.

Suspicion of near relatives and close friends.

Visionary plans and ideas, such as the invention of an auger to bore a square hole.

Changed identity, such as the belief of being President of the United States.

Ideas of being inspired by spirits.

Fixed beliefs in being persecuted by personal enemies.

Illusions are erroneous interpretations of impressions on the senses. Voices of persons talking on the street may be interpreted as the calls of spirits; the flicker of a light as the signal of an enemy; or the bad taste of a coated tongue as that of poison in the patient's food.

Hallucinations are imaginary sense impressions for which there are no physical bases. Common examples of hallucinations are visions of angels or devils in the patient's room, and hearing the voices of dead persons.

Lesser degrees of mental confusion, delusions, illusions, and hallucinations occur in normal persons. Many persons, for example, have illusions and hallucinations of seeing ghosts at night. The visions of the insane are similar to the dreams of normal persons; but the difference is that a normal person realizes their fantastic character with the coming of daylight or after an explanation of the phenomena; while the insane are unconvinced by argument or explanation, but believe themselves to be right and everybody else wrong.

Commitment to Hospitals.—The laws of the several states provide for the legal committment of insane persons to hospitals when they will not go voluntarily or do not have sufficient intelligence to do so. The laws of New York State charge the health officer, jointly with the superintendent of the poor and the town overseer, with the duty of caring for insane indigent persons. It also charges the health officer with the duty of examining and caring for any person under arrest who is apparently insane (Insanity Law, Section 87). It is important that the proper legal steps for commitment of irresponsible cases be followed in order that the patients may be held for treatment for a sufficient time until their mentality can be restored, and in order that prejudiced friends may not interfere with the treatment.

When a health officer receives a report of a case of suspected insanity, his first duty is to see the patient receives proper care and attention, at public expense if necessary, until his mental condition can be determined. It is the intent of the law that a suspected person shall not be confined in a jail; but when a homeless patient is violent and destructive, there may be no other place in which he may be made comfortable. If a jail must be used as a detention place, the invariable rule is that an efficient attendant shall remain in the room with the patient at all times.

The next duty of a health officer is to secure the commitment of the patient to a hospital. This is a legal procedure that is equivalent to a charge, trial, and sentence in a court. The commitment papers are on blanks provided for that purpose, and consist of three parts, as follows:

1. An application by a proper person that the patient be examined and committed.
2. A record of the evidence of the insanity of the patient.
3. A formal order by a judge committing the patient to a particular hospital.

An application for commitment may be made by a relative, or by a guardian or intimate friend, or by an overseer of the poor, or by an officer in charge of the patient. It must contain a sworn statement of the patient's acts which indicate insanity.

The evidence of insanity consists of the record of an examination made by two physicians who are legally qualified by law to act as examiners in lunacy. A health officer may act as one of the examiners in New York State The evidence is of the same nature as that given in a law court. It must be sufficient to justify a verdict of insanity if the case should come to trial, as many of them do. The record will usually contain information along four lines, as follows:

1. The physical condition of the patient.
2. What the patient did in the presence of the examiners.
3. What the patient said to the examiners.
4. Statements made by other persons regarding the actions of the patient.

The most convincing evidences of insanity are fixed delusions, illusions, and hallucinations. If the existence of any of these can be established, a court will usually accept it as positive evidence of insanity.

After the application and the examination blanks have been made out, the papers are taken to a judge for his official action. The judge will consider the application and the medical evidence as he would the charge and testimony in a law suit. If he finds them sufficient, he will sign an order of commitment.

If there is opposition to the commitment, the judge will hold a trial of the case. The procedure in the trial will be the same as that in other law suits. If the case comes to trial, the health officer and medical examiners must be prepared to undergo cross-examinations regarding the evidence which they recorded on the commitment blank.

It is desirable that patients shall be informed of their mental condition, of the imaginary nature of their delusions and illusions, and of the probability of their speedy improvement or cure; and it is also desirable that they be told that they will be taken to a hospital for the treatment of mental diseases. When this information is imparted tactfully and firmly, patients usually consent to go to the hospital. Nothing is gained by concealing the nature of the disorder or by deceiving them regarding the treatment. It is well to talk to insane patients as if they were of sound mind. Nearly every insane person can reason normally along most lines of thought, and can be led and directed like patients in a delirium of fever.

If force must be used in transferring an insane person to a hospital, two or three strong attendants can hold and carry the patient in such a manner that only a minimum amount of struggling is possible. The halfway use of force permits struggling, arouses fear, and often results in physical injury; but a resisting patient will usually yield quickly to firm, efficient force which produces no physical discomfort.

Besides the full form of legal commitment, the laws of New York State provide three other methods by which a health officer can place an insane patient in a hospital:

1. A patient may go to a hospital voluntarily. It is desirable that patients in the premonitory stages of mental disorder should accept preventive treatment which is analogous to the treatment of diphtheria with antitoxin in the earliest stage of the disease.

2. If no judge can be reached and the case requires immediate treatment, a health officer may send the case to a hospital with a copy of the application and medical examination. The superintendent can then legally hold the case for ten days while waiting for a judge to sign the commitment papers.

3. If a case involves immediate danger to life or property, a health officer may make arrangements with the superintendent of a hospital to receive the case without any papers except the health officer's formal statement regarding the emergency character of the case. The formal papers are then to be made out as soon as possible.

Clinics for Mental Disorders.—Clinics are needed for the treatment of cases of mental disorder which are not sufficiently grave to require their entrance into a hospital, and yet need oversight and advice. These cases are: 1, those discharged from hospitals; and 2, those who are able to work and to control their actions in society. Those clinics which have been established are well patronized and are proving a great success in the prevention of grave forms of mental disorders. Their establishment in centers available to rural districts is a necessary development in public health work.

The Feeble-minded.—Some weak-minded persons are adults who have developed normally, and who suffer from a simple decay of all their faculties; but the term "feeble-minded" is restricted to those who are in that condition from birth. Feeble-minded men and women have the physical bodies of adults, but the minds of children. This class of persons are of special interest to the health officer on account of their close relation to disease, poverty, prostitution, and crime, and to all the problems connected with these conditions.

The degree of mental deficiency is expressed by the age at which a normal child would have the mentality of the affected person. Those whose mental development is that of one-year-old infants are called idiots. Those with the mentality of four-year-old children are called imbeciles. Those whose mental development is that of children from five to fourteen years of age are called morons. The class of morons are subdivided into low, middle, and high grade.

Standard tests for feeble-mindedness are those known as the Binet tests. They consist of questions and directions corresponding to the ability of average children at various ages. A short, simple form of the tests which can be used by a health officer is as follows:

Three Years

1. Point to your eyes; nose; mouth.
2. What is this? Shows a key; knife; penny; watch.
3. Are you a boy or a girl?
4. What is your name?

Four Years

5. Counts four pennies.
6. What must you do when you are sleepy? cold? hungry?
7. Repeats 4739; 2854; 7261.
8. Repeats, "We are going to have a good time in the country."

Five Years

9. Recognizes red, yellow, blue, green.
10. Defines in terms of use, chair, horse, fork, pencil, doll.
11. Carries out the order, "Put this key on the chair, shut the door, and bring me the box from the chair."
12. Gives age.

Six Years

13. Which is your right hand? Your left ear?
14. Counts 13.
15. Knows nickel, penny, quarter, dime.
16. Is this morning or afternoon?

Seven Years

17. How many fingers on the right hand? left hand? both hands?

18. Repeats 31759; 42385; 98176.

19. Tells difference between a fly and a butterfly; paper and cloth; wood and glass.

20. Knows the days of the week.

Eight Years

21. Counts from 20 to 1.

22. Tells the similarity between wood and coal; an apple and a peach; a ship and an automobile.

23. Defines better than in terms of use, chair, horse, fork, pencil, doll.

24. Recognizes six coins.

Nine Years

25. Gives date.

26. Gives the months of the year.

27. Makes change, 10 — 4, 15 — 12, 25 — 4.

28. Repeats backward 6528, 4937, 3629.

Ten Years

29. Recognizes the absurdities in the following statements: A man said: "I know a road from my house to the city which is downhill all the way to the city and downhill all the way back home."

An engineer said that the more cars he had on his train the faster he could go.

Yesterday the police found the body of a girl cut into eighteen pieces. They believe that she killed herself.

There was a railroad accident yesterday, but it was not very serious. Only 48 people were killed.

A bicycle rider, being thrown from his bicycle in an accident, struck his head against a stone and was instantly killed. They picked him up and carried him to the hospital, and they do not think he will get well again.

30. Draws designs.

31. What ought you to say when some one asks your opinion about a person you don't know very well?

What ought you to do before undertaking (beginning) something very important?

Why should we judge a person more by his actions than by his words?

32. Repeats 374859, 421746.

Over Ten Years

33. Uses three words in one sentence: money, river, New York.

34. Repeats, "Walter likes very much to go on visits to his grandmother, because she always tells him many funny stories."

35. Names 60 words at random in three minutes.

36. A person who was walking in the forest near here suddenly stopped much frightened and hastened to the nearest police station and reported that he had seen hanging from a limb of a tree a —— what?

When a rapid examination of an adult is to be made, the examiner may use tests numbered 4, 18, 20, 21, 26, 27, 32, and 35, and also the following general questions:

When is Christmas? Thanksgiving?

When is your birthday? In what year were you born?

Who is the President of the United States? Who was the first President?

Who was the Civil War President?

What countries are at war?

Name five cities in the United States.

How far is this from New York? (or from the nearest town?)

How much does it cost to go?

A health officer can carry on the following activities in relation to the feeble-minded:

1. Examining suspected cases, especially those under arrest, and inmates of institutions for dependent and delinquent persons.
2. Promoting special classes for those retarded in school, and especially forming manual training classes.
3. Securing the employment of feeble-minded adults where they will be protected from temptation and from those who would take advantage of their condition.
4. Securing proper institutional care for the more serious cases, and promoting the establishment of more institutions for them.
5. Promoting measures for the prevention of marriage and procreation among the feeble-minded, with special consideration of measures for securing sterility without producing other evident effects.

CHAPTER XXXI

VERMIN

Disease-carrying Vermin.—It was an old observation that certain diseases were associated with filth, some with the night air of swamps and marshes, and others with particular places. The mysterious prevalence of many of these diseases has been explained by the discovery and demonstration that they are transmitted by insects and other vermin. The principal vermin with which a health officer has to deal are flies, mosquitoes, lice, bedbugs, ticks, fleas, and rats. A number of tropical diseases which are rarely seen in temperate zones are spread by means of insects which are found only in hot climates.

FLIES

Flies transmit diseases either by biting or by merely acting as the agents for carrying germs which accidentally adhere to their bodies. No biting fly of the woods and fields of the United States is known to transmit any disease. The common stable fly was formerly supposed to transmit poliomyelitis by its bite, but that theory has been abandoned.

The two flies which constitute health problems in the United States are the house-fly and the blow-fly. Both are exceedingly common during the warm months, and yet their breeding could readily be controlled, and they could be exterminated by the co-operative efforts of every person in a community. They are often the means of spreading typhoid fever, dysentery, summer diarrhea, and other infectious diseases.

Source of Disease Germs.—Flies transmit diseases because of their habits of feeding on wet filth. If all the excretions from human beings were screened or covered or destroyed, flies could neither obtain disease germs nor transmit diseases. Some of the germs adhere to the outside of the bodies of the insects, and some are swallowed, escape digestion, and are excreted in a living state. A fly is a shaggy creature. Although it appears to be shiny and glistening, its body is covered with hairs and bristles which entangle great quantities of dust, dirt, and bacteria. It tries to keep itself clean by rubbing its feet together and over its face and wings, but the coarseness and abundance of the hairs make the task impossible. When a fly is magnified under a microscope, it appears like a bristly monster which has been wallowing in the dust. If the magnification is sufficiently great, the bacteria on the bristles look like grains of sand on the horns of a great beast.

Every fly is covered with bacteria whose numbers depend largely on their abundance in the filth on which it alights. A method of estimating their number is to shake the fly in a bottle of sterile water and plate the water as in the bacteriologic examination of milk. From 300,000 to 3,000,000 bacteria may usually be obtained from the outside of its body, and as

Fig. 29.—House-flies on a collection of filth.

many more from its digestive tract. The bacteria are those of the substance on which the insect alights. Flies nearly always harbor great numbers of colon bacilli which they obtain from the excretions of human beings and animals. If the excretions contain disease germs, the flies which alight on them will carry the germs on their bodies and in their intestines.

Inoculation by Flies.—A fly does not bite or pierce the skin, and cannot inject germs or poisons into the skin. Its mouth consists of a flexible tube, like an elephant's trunk, ending in a flat disk with which it takes its food by suction. It can feed only on liquid matter. When it tries to eat a dry substance, it dissolves the food with tiny drops of liquid which it regurgitates from its stomach. A fly pours filth and bacteria from its last meal upon our food, our skin, our mouths, and our eyes. It pollutes them with its intestinal excretions, and sprinkles them with the filth which it rubs from the bristles on its body. It leaves a trail of bacteria on every substance over which it crawls. It spreads disease germs wherever it goes, and well deserves the name—deadly typhoid fly.

Life-history.—House-flies breed in manure and most other kinds of decaying matter. Their preference is stable manure, but they will breed in pig-pens, garbage heaps, hen-roosts, privies, and rotting vegetable matter. Blow-flies breed in putrefying flesh. Every fly passes through the three stages of egg, larva, and pupa before it becomes a winged creature.

Fig. 30.—A house-fly, showing the hairs on its body.

A fly is hatched from a white or yellow egg which is laid by an adult fly. A female usually lays two or three hundred eggs in bunches, called fly blows. The blows on meat are usually the eggs of blue-bottle flies, but house-flies often lay their eggs in masses on meat and fish.

Fly blows hatch into wormlike larvæ called maggots. Every maggot is a young fly. It grows rapidly, moults its skin several times, and completes its growth in about a week. When it reaches a length of about $\frac{3}{4}$ inch, its skin hardens, and it becomes a brown, motionless object which looks like a large, fat grain of wheat. This is the pupal form, and while it remains in this stage, its wings and legs grow, and it develops into a full-grown fly. Every fly emerges from its pupal case fully grown. Small flies are not young flies that are growing into big ones, but they belong to other species than house-flies or blow-flies. The complete cycle from the egg to the full-grown fly usually requires from ten to fourteen days.

Maggots about to change to pupæ will burrow into the soil if they can reach it. Many maggots and pupæ may usually be found in the ground on the edge of a manure pile, even when the soil is compact and hard.

Most flies are killed by the frosts of autumn, but a few females pass the winter in a dormant state in attics, behind chim-

Fig. 31.—House-fly's foot (×100).

neys, and in other protected places, and become the ancestors of the next summer's fly crop. A fly caught in winter is usually distended with eggs. A few larvæ and pupæ may survive the winter in protected heaps of garbage and manure.

Bacteria which a maggot eats may remain alive in the winged fly, although their numbers are reduced owing to the phagocytosis which takes place during the pupal transformation. A fly that is hatched in human excretions may still carry the bacteria of diseases after it reaches the adult stage.

Extent of Danger.—Flies were formerly responsible for a large proportion of the cases of epidemic typhoid and paratyphoid fevers and dysentery in soldiers' camps owing to the disposal of human excretions in uncovered and unprotected trenches, and to the breeding of flies in horse manure and garbage. There is danger of the spread of intestinal diseases whenever the excretions from a case of infectious intestinal disease are emptied into a privy to which flies have access. A large proportion of the diarrheas of infants and children is caused by house-flies which carry the intestinal discharges from a sick child to the food or mouths of other children. A great part of the unhealthfulness of hot weather is due to the flies which are prevalent during summer.

Fig. 32.—A fly's leg, showing the coarse hairs with which it is covered (×50).

When flies have been marked or colored for identification and released, they have been captured in traps two miles from the point at which they were set free. A breeding-place will supply flies to an area at least 4 miles in diameter.

Control of Fly-borne Diseases.—The control of fly-borne diseases consists (1) in guarding the sources of fly infection, and (2) in measures for the exclusion and destruction of flies themselves.

The sources from which flies get the germs of infectious diseases on their bodies are human excretions and persons who are afflicted with infectious diseases. No fly could pick up infectious matter if all human excretions, sewage, and garbage were covered fly-tight, and the insects were not permitted to come near a person who has an infectious disease. It is the duty of every health officer to insist on fly-tight privies and the exclusion of flies from sick rooms.

Antifly Measures in Houses.—Every fly may justly be considered to be a dangerous pest whose presence in a house is a menace to the health of the inmates. Screens to exclude flies, and brushes to drive out the few which gain entrance, are necessary articles of the sanitary equipment of a home. Other useful articles of quipment are fly swatters, traps, sticky paper, and poison paper.

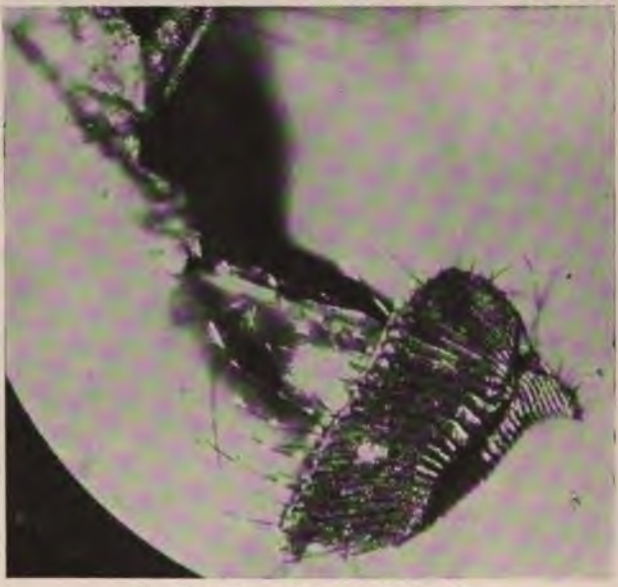

Fig. 33.—House-fly's mouth (×100).

A 1 per cent. solution of formaldehyd or of salicylate of soda is deadly to flies that drink it. A fly requires an abundance of water. If a room is closed for a few hours and darkened except one window in which a saucer of the solution is placed, the flies will go to the window and, becoming thirsty, will be likely to drink their poison. The solutions are useless in an ordinary kitchen or dining-room, for the flies will be able to get water elsewhere.

Pyrethrum powder blown through the air of a room, or the smoke of the burning powder, is stupefying to flies for a short time, but seldom kills them. If pyrethrum is used, the flies which fall to the floor must be swept up and killed.

A crude, old-fashioned method of catching flies is to tie twigs of bayberry or sweet fern in bunches about the size of one's head, and suspend them in the top of a room or tent. The flies will alight on them at night and may be caught in a pillow-case or bag slipped over the bunches.

Fly-traps.—Practical outdoor measures for the extermination of the fly pest are trapping and the control of their breeding-places. White houses on sunny hillsides in sections of a city or village remote from fly breeding-places are sometimes afflicted with plagues of flies. About the only practical means of reducing the number of flies after they have developed is to catch them in traps. An efficient fly-trap is a box made of wire netting 2 feet square. Its bottom is a cone inverted over bait.

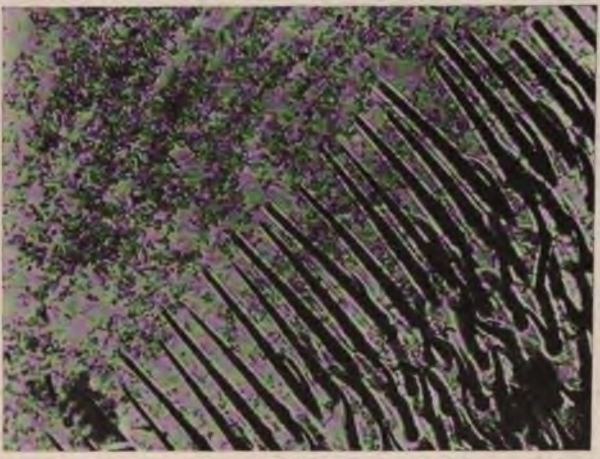

Fig. 34.—Photomicrograph of the edge of a fly's wing laid upon a pure culture of diphtheria germs (×500).

The flies eat the bait and walk up the cone through a small opening in the top and into the upper part of the trap. Flies are attracted to the bait by its odor. A saucer of vinegar or stale beer mixed with molasses or moist sugar makes an excellent bait. The number of flies caught may be estimated on the basis of 13,000 flies to each quart.

Control of Breeding-places.—The most effective measure for exterminating flies is the control of manure piles, pig-pens, dead animals, and other decaying matter in which flies breed. Flies prefer to lay their eggs in fresh, damp manure. If the manure is carted away frequently and spread upon the land, it will dry and maggots cannot mature in it. The removal must be done at least once a week, and during hot weather, when the maggots grow rapidly, twice a week. If manure is removed from the vicinity of houses, and is piled in a firm, compact heap, few flies will breed in it, especially if the outside is kept dry. When only a small quantity of manure is produced, it may be stored in cement bins which are covered to exclude flies. This method of storing manure is required by the ordinances of some villages and cities.

Borax in the proportions of 1 pound to each 8 bushels of stable manure is efficient in preventing flies from breeding. When the manure is snugly piled, sift the powder over the heap and sprinkle it with water in order to dissolve the chemical and carry it through the mass. Powdered hellebore is also efficient used in the same quantities as borax.

Pig-pens and cow-yards present the greatest difficulty in the prevention of fly breeding, for their edges, which the animals cannot reach, usually contain maggots and pupæ all through the summer. Cleanliness and dryness are essential in preventing fly breeding in the pens.

Education.—A rural health officer will often have difficulty in deciding how much antifly work he can do, especially among farmers and liverymen. His first step must be to educate those who maintain fly breeding-places. It is surprising how few persons know what maggots and fly pupæ are. An effective means of educating a doubting farmer is to place a few maggots and pupæ in a covered jar or tin can with a little manure, and let him see what comes from them. Another means of education is to cut open a pupa case with care and show the farmer the young fly in it. When farmers and their wives and children understand how and where flies breed, they will show a greater willingness to co-operate in antifly work.

MOSQUITOES

Mosquitoes are always nuisances, and sometimes they constitute a serious menace to health. Certain kinds are the only known means by which malaria and yellow fever are spread. The saliva which a mosquito injects when it sucks blood causes an itching papule on the skin of a susceptible person. The health officer may properly be a leader in antimosquito work; and wherever malaria or yellow fever exists, it is his duty to promote the work of exterminating the pests by every means in his power. Adult mosquitoes live mostly on plant juices. Only the females suck blood, and probably only a few of them have the opportunity to obtain that food.

Mosquitoes cling to grass and bushes where they are protected from winds. Shrubbery and tall grass around houses do not breed mosquitoes, but only afford hiding places for them.

Life-history.—Mosquitoes breed in still water, especially that which is stagnant and contains an abundance of food. They pass through the stages of egg, larva, and pupa before they reach the adult form. The life-histories of the different species vary in their details, but that of the common rain-barrel mosquito is typical of all the rest. The eggs of this species are laid in neat bunches which float on the surface, and look like flakes of soot. The larvæ which hatch are called wigglers, from their habit of wiggling through the water with quick, jerking

Fig. 35.—Adult mosquito emerging after completing the under-water stage of its life.

movements. They breathe through tubes located in the hinder ends of their bodies, and when quiet they hang with their heads downward and with the end of their breathing tubes at the surface of the water in order to obtain air. They change to pupæ in about a week if the weather is warm, and then appear as humpbacked creatures which still have the power of moving quickly. After two or three more days the skins of the pupæ split open and the winged mosquitoes emerge at the surface of the water and fly away.

Anopheles Mosquitoes.—Over fifty species of mosquitoes breed in New York State, and probably a hundred in the United States. Those which produce malaria belong to the genus

Anopheles. The two most common species are the *quadrimaculatus*, which has four black spots on each wing, and the *punctipennis*, whose wing has a yellow spot. The usual breeding-places of the *Anopheles* are natural upland pools in woods, marshes, and swamps. They do not breed in salt marshes or in water so foul that it is offensive. Their larvæ may be recognized by their resting position, which is at the surface of the water and parallel with it. The adult *Anopheles* may be recognized by its body pointing away from the surface on which it alights. The *Anopheles* mosquitoes are not strong fliers, but they may be carried 2 or 3 miles by the wind. They do not fly or bite by day, but are active in the forepart of the evening. A person who stays indoors during the first part of the night behind screens which the mosquitoes cannot pass will not become infected with malaria. The peculiar hours kept by the *Anopheles* mosquitoes gave rise to the belief that the night air during the evening was full of miasma which disappeared before dawn.

Aëdes Calopus.—The yellow fever mosquito belongs to the [illegible]e genus *Aëdes*, which was formerly called *Stegomyia*. It is activ[illegible]e only by day and around lights at night. It breeds in smal[illegible]ll artificial collections of water in the vicinity of houses, such a[illegible]s cisterns, water-tanks, and rain-barrels. It is a domestic insec[illegible]t, and seldom goes more than a few hundred feet from huma[illegible]n habitations. The work of exterminating it in its breedin[illegible]g-places does not need to be carried on more than a quarter of a mile from a village or dwelling-house.

Culex Mosquitoes.—The ordinary mosquitoes belong to t[illegible]he genus *Culex*, and are harmless except for the great annoyan[illegible]ce of their bites. There are numerous species which may roug[illegible]ly be divided into three groups, the domestic, the fresh-water or swamp, and the salt marsh mosquitoes. The domestic spec[illegible]ies breed in rain-barrels, water-buckets, cesspools, and other col[illegible]lec-tions of stagnant water in the vicinity of houses and barnyards. No water is too foul for them, and their most prolific breeding-places are uncovered cesspools and barrels of liquid manure. They do not fly far, and the destruction of a single breeding place near a house will usually be followed by a great reductio in the number of mosquitoes at that place.

The wild, fresh-water species breed in swamps, marshes, a pools. The first broods appear early in spring, and are hatc from eggs that are laid in the mud in the fall. Roadside puddles in the early spring are often swarming with their l They usually appear in distinct broods which hatch after rainfall has flooded the eggs which were laid at the edges pools while the water was low. These mosquitoes are travelers, and those from a swamp may infest a neighborhood for several miles around.

The salt marsh mosquito breeds only in the water of salt marshes along the seacoast. The common kind may be recognized by the broad transverse stripes of white upon its legs. It is a great traveler, and is sometimes found in swarms at sea out of sight of land, and for 20 miles inland. A large proportion of the mosquitoes within 20 miles of the seacoast are bred in salt marshes. Their breeding habits are similar to those of the swamp varieties.

Control of Mosquitoes.—The control of the yellow fever mosquito is universally recognized as a grave public health problem. The control of the malarial mosquito is usually assumed by boards of health in only the richer and more thickly settled municipalities. The extermination of the culex species has usually been considered principally as an economic problem affecting real estate values. But there is a growing sentiment in favor of general antimosquito work, and the demonstration of its success at a comparatively small cost in the vicinity of New York City is awakening boards of health and civic societies to the importance and practicability of the work. It is the duty of every health officer to become familiar with the methods of mosquito prevention. If the culex mosquitoes are controlled, the disease-bearing species will be included in the extermination. The control of mosquitoes and mosquito-borne diseases will include the following measures:

1. Screening houses against mosquitoes, especially those houses which are occupied by persons who have malaria or yellow fever.
2. Emptying or covering all places for the collection of standing water, such as rain-barrels, cisterns, cesspools, gutters, tin cans, hollow trees, stumps, and flower vases.
3. Filling, draining, or ditching pools, swamps, and marshes.
4. Covering ponds, pools, and small collections of water with a thin film of oil which prevents the larvæ from breathing.
5. Stocking pools, fountains, and reservoirs with gold fish—a hardy specie of carp—which eat the larvæ.

The control of mosquitoes is always a community problem, and its success requires the co-operation of every householder and land-owner. The laws of New Jersey and New York authorize counties to do the work. It is essential that it be done under the direction of an expert who will make a complete survey of the whole territory, locate the breeding-places, identify the species of mosquitoes that are found, and co-ordinate and supervise all phases of the preventive and corrective measures.

The antimosquito work of a health officer is principally educational. Most people do not know what young mosquitoes are and where they breed. The health officer can give talks to school children, and supply them with bottles of wigglers. The demonstration of their transformation into winged mosquitoes is an effective means of arousing interest in the mosquito problem. The health officer will also find real estate dealers and civic societies among his assistants in mosquito extermination.

LICE

Three kinds of lice may infect the human body: 1, the head louse, Pediculus capitis, in the hair of the head; 2, the body louse, Pediculus corporis, in the underclothes; and 3, the Pediculus pubis, on the covered hairy parts of the body.

The louse is a biting insect. It produces an intense itching of the skin, and its presence may be suspected when scratch-marks are found on the skin. City hospitals sometimes admit serious cases of illness due to sores caused by scratching on account of lice. But lice are important to the health officer principally because they are the only known carriers of typhus fever. Both head lice and body lice may transmit the disease by sucking up the germs with the blood of an infected person and transmitting them to other persons whom they bite. It was supposed that typhus fever was almost completely eradicated from the United States, but a mild form, called Brill's disease, is frequently seen. Typhus is endemic in Mexico, and in the Balkan States, and Asia Minor, and its control has been an exceedingly grave problem in the European War. The methods for its suppression are directed against lice. Epidemics of the disease may appear in the United States, as they formerly did, unless health authorities are vigilant in the extermination of lice.

Life-history.—Lice hatch from white eggs called *nits*. Those of the body louse are attached to the underclothing, especially the seams about the shoulder. Those of other species are attached to hairs near the roots, and as the hairs grow, the eggs are carried away from the body. The time during which the lice have infested the body may be estimated by the length of the hair between the eggs and the skin. The eggs usually hatch in about two weeks, and the empty egg cases are left attached to the hairs or clothes. The young resemble the adults, and there is no transformation such as occurs among the young of flies and mosquitoes.

Head lice are common among school children over the whole United States, and from 5 to 10 per cent. are found harboring them wherever careful examinations are made. The lice are spread principally by means of hats. The control of infected children is within the scope of the duties of a health officer, and it is proper for him to exclude those children on whom either lice or nits are found.

The extermination of head lice requires thorough measures. A harmless and efficient method is to saturate the hair with equal parts of olive oil and kerosene, bind it up with a thick towel, and leave it on all night. This will kill the adults and most of the nits. Wash the head with soapsuds in the morning. Then wet the hair with vinegar in order to dissolve the glue which binds the eggs to the hair, and comb out the loosened nits. If the vinegar and combing are omitted, some of the unhatched eggs may escape destruction and bring forth a new crop of lice.

If a school child has lice, its brothers, sisters, and parents usually have them also. Home visitations and the treatment of whole families is necessary in exterminating lice from a school. The work is done successfully only in those communities which employ a public health nurse.

Body Lice.—The control of body lice is a troublesome problem owing largely to the difficulty in discovering the cases, and of reaching all the clothes of the affected person. The lice seldom remain on the body, but are found on the clothing. Boiling or baking, or subjecting the clothes to steam under pressure will kill both the lice and their nits. Soaking the clothing in a 1 : 500 solution of bichlorid of mercury is also effective. Those who handle the affected persons and their clothing are likely to take the lice unless they use great care to guard against them.

Pubic lice may be destroyed by the application of mercurial ointment or a 1 : 500 solution of bichlorid. Either one is to be washed off with soap and water after about ten minutes.

BEDBUGS

Bedbugs (Cimex lectularius) are biting insects. The germs of tuberculosis have been found in their bodies, and they may harbor other disease germs. The insects are widely distributed and it is probable that some have been introduced into every household at some time. One may be recognized by its offensive odor. When a house becomes infested with them, they crawl into cracks and behind loosened wall-paper, where they may live for weeks or months without food. Their eggs are laid in the cracks and crevices in which the insects hide.

The measures for the extermination of bedbugs are a thorough housecleaning, the removal of all loose wall-paper, boiling the bedclothing, and soaking the joints of the bed and cracks in the floor with gasolene, or kerosene, or a strong bichlorid solution.

TICKS

Ticks are eight-legged, blood-sucking creatures which are related to the spiders. An empty tick is about $\frac{1}{8}$ inch in diameter and resembles a bedbug; but when it feeds, it distends itself with blood until it is $\frac{1}{2}$ inch or more in diameter. It attaches itself to the skin so firmly that its head often breaks off when its body is pulled in attempts to remove it. A common species of tick is found in the woods and often infests dogs and persons. Ticks are hatched from eggs which are laid in masses on the ground. The young attach themselves to small animals, such as mice, ground squirrels, and other rodents, and live by sucking their blood. They fall off, undergo a transformation, and reattach themselves to an animal. They repeat the process and finally reach their adult form.

Ticks are important to the health officer because they may transmit diseases. One species (Margaropus annulatus) transmits Texas fever to cattle. Another tick (Dermacentor venustus) is the cause of Rocky Mountain fever. This is a disease resembling typhus fever. The tick which causes it is found on numerous species of wild animals, but chiefly on domestic animals. The control of the disease consists in measures for the extermination of ticks on horses and cattle, such as dips, sprays, and washes containing arsenic or other poisonous substance.

Relapsing fever is sometimes caused by a tick, but it may also be transmitted by other biting insects.

FLEAS

Fleas are blood-sucking insects. They are of importance to the health officer chiefly because those of certain species may transmit the plague, provided they bite a person or animal that has the disease. The species which are specially implicated with the plague in the United States are the rat flea (Ceratophyllus fasciatus) and the squirrel flea (Ceratophyllus acutus). One species (Pulex irritans) infests human beings, but it is rare in the United States and is usually harmless. The common American flea that bites persons is the dog or cat flea (Pulex serraticeps), but it usually attacks only certain persons and avoids others. A flea that is peculiar to one specie of animal may bite another species if it cannot feed upon the one which it prefers, and this peculiarity accounts for the transmission of the plague by fleas from infected rats and squirrels.

A flea is hatched from eggs which are usually laid among the hairs of the animal on which it lives. They, or the newly hatched young, fall upon the ground or on carpets and floors. The young are wormlike larvæ which live upon vegetable matter or house dust. They spin cocoons in which they pass the pupal stage, and finally emerge as fully developed fleas which return to an animal at the first opportunity.

Fleas sometimes become abundant in houses. These are probably hatched from eggs which fall from infested dogs and cats. It is almost impossible to get rid of them without removing the furniture and carpets in which they hide. Scrubbing the floors with an emulsion of kerosene and soapsuds will kill many of them, and flake naphthalene sprinkled on the floor will usually drive away the rest.

RATS

Rats are of importance to the health officer because they may transmit diseases, especially plague and trichinosis (page 312). Plague is a disease of rodents, and in America it is found among the rats and ground squirrels of the localities where it has appeared. An animal becomes infected by contact with one which has the open lesions of the disease, by eating the flesh of those which have died of plague, and by the bites of fleas from the sick. The infection is usually carried to human beings by means of fleas from the bodies of rats that have died from plague. The preventive measures against plague are directed principally against rats.

The common rats of America are burrowing animals, and their underground habits and their intelligence render their extermination difficult. They can live upon almost any kind of food that will support the life of any of the other higher animals. Their activity, strength, and gnawing powers enable them to penetrate almost every storehouse of food that is not specially guarded. They are pests on board of ships, in sewers, along wharves, and in heaps of garbage and rubbish. Since they are not at all particular in their food, they can live and flourish where other animals would starve. Their control is possible only if it is undertaken as a community problem, as has been done in Manila, San Francisco, and other places in which plague has appeared.

The means for the control of rats are:

1. Capturing them by such means as trapping and shooting, and hunting them with dogs, cats, and ferrets. Very little will

be accomplished by these methods unless they are excluded from their usual food supplies, and most of their holes and runways are closed.

2. Poisoning them with arsenic, phosphorus, strychnin, barium carbonate, or cyanid of potassium.

3. Bacterial rat viruses. Those on the market belong to the paratyphoid group and are more infective for domestic animals than for rats. They are not successful against the rat, but are dangerous to domestic animals and to man.

4. Clearing away rubbish and garbage in which the rats hide and breed, and repairing floors and raising them above the ground in order that cats and other natural enemies may have access to their underground retreats.

5. Rat-proofing buildings. Rats will not usually remain in a building unless they can burrow beneath it, or hide in holes and crevices, or in heaps of rubbish. Cement underground construction, and tight, raised floors will usually exclude rats, and the few that may enter will soon leave or die if they cannot obtain water and food.

6. Guarding ships. Plague is usually carried from place to place by means of rats on ships. Elaborate measures are taken for the control of rats along the water fronts in plague districts. Ships are moored a few feet from shore, their cables are provided with flanges which prevent the rats from crawling along them; the gang-planks are kept raised when not in use; and the holds of the vessels are fumigated with cyanid gas in order to destroy any rats that may have passed by the guards.

FUMIGATION

Insects, rats, and other vermin in rooms, the holds of vessels, and other confined spaces may be killed by fumigation with sulphur dioxid or with hydrocyanic acid gas. Sulphur dioxid, SO_2, is formed by burning powdered sulphur. From 2 to 5 pounds of sulphur are required for each 1000 cubic feet of air space, and the room or compartment must be tightly closed and kept closed for three or four hours. The method of using the gas is as follows:

Place the sulphur in flat iron pots which are set in shallow tubs of water. Make an excavation in the center of the sulphur, pour in an ounce of alcohol, and set it on fire. The heat of the combustion will melt the surrounding sulphur which will run down and feed the flame.

An objection to sulphur is that it corrodes metals and rots cloth with which it comes in contact. The corrosive action is due to sulphurous acid, H_2SO_3, which is formed when the dioxid unites with the vapor of water. The action may be prevented by covering the metal with vaselin or other oil, and by having the room and the air as dry as possible. The presence of moisture is not necessary in killing animal life, although it is in destroying the life of bacteria. The advantages of sulphur fumigation are its efficiency, the ease with which sulphur may be obtained and burned, and its safety to human beings, for the odor of the gas gives warning of its presence before it accumulates in dangerous amounts.

Hydrocyanic acid gas is intensely poisonous. A few whiffs are deadly to human beings, but its poisonous quality makes it efficient in killing vermin. It has only a slight odor, and it may be present in the air in dangerous amounts without its smell betraying its presence. When it has been used in a room or compartment, provision must be made for opening the windows or other ventilators from the outside, and free ventilation must be carried on for some hours before a person may safely enter. Hydrocyanic acid fumigation is not safe except when it is done by a careful, experienced operator, but the method is easy and efficient when it is done by an expert. It is frequently used for killing insects in greenhouses, for it is harmless to plants.

The method of cyanid fumigation is as follows:

Potassium cyanid,	1.0 part;
Sulphuric acid,	1.5 parts;
Water,	2.25 parts.

Use 10 ounces of cyanid to each 1000 cubic feet of space. Add the sulphuric acid to the water in a glazed earthen jar. Add the cyanid and leave the room at once and without breathing.

The method used on shipboard is to generate the gas in a tightly closed tank from which a pipe conducts the gas into the vessel's hold.

CHAPTER XXXII

MILK

There is a direct relation between a milk-supply and the health of the people of a community. Milk may contain disease germs when it is drawn from a diseased cow. Disease germs may be introduced into it by unhealthy workmen or from unclean containers; and the ordinary changes which milk undergoes may render it unwholesome. The supervision of milk-supplies is one of the important duties of a health officer.

Composition.—Milk contains all the elements of a complete food in about the following proportions:

	Per cent.
Protein	3.6
Fat	3.8
Sugar	4.7
Ash	0.7
Water	87.2
Total	100.0

These proportions vary in different animals, and in the same animal at different times. The extreme variations in apparently normal milk drawn from healthy cows is about as follows:

	Per cent., low.	Per cent., high.
Protein	2.1	8.5
Fat	2.2	9.0
Sugar	4.0	6.0
Ash	0.6	0.9

There is an approximate relation between the percentage of fat and that of the other constituents of milk. When the fat content is high, the percentage of the other constituents is usually high also; and a low percentage of fat is usually accompanied by a low percentage of the other solids. The percentage of fat is, therefore, a reliable indication of the value of a sample of milk.

The laws of the various states fix minimum standards for the composition of milk that is offered for sale. The New York standard is that milk shall contain at least 3 per cent. of fat and 11½ per cent. of total solids (Agricultural Law, Section 30).

A health officer must consider the natural variations in the composition of milk in judging the value of a milk analysis.

Strippings, or milk drawn from a nearly empty udder, contains five or ten times as much fat as the first milk drawn from a full udder. Milk produced by cows of the Jersey breed will usually contain from 30 to 50 per cent. more fat than those of the Holstein and similar breeds. Evening milk contains slightly more fat than morning milk, and that produced in late fall and winter is richer than that produced during the summer.

Adulteration.—A lowering of the percentage of fats and solids in milk is caused principally by the removal of cream or the addition of water. These processes constitute two forms of adulteration according to the New York State Agricultural Law, Section 30. Neither process affects the wholesomeness of the milk, but selling adulterated milk or offering it for sale as whole milk is a fraud. The Department of Agriculture is charged with the detection of adulterated milk in New York, but a health officer is frequently consulted regarding suspected adulterations. Three tests which are usually made in detecting adulterations of milk are: 1, the specific gravity; 2, the Babcock test for fats; and 3, the percentage of total solids.

Specific Gravity.—Milk that has been skimmed or watered may usually be detected by means of its specific gravity. The specific gravity of milk that is above the minimum standard of composition is between 1.030 and 1.034. Removing the cream increases the specific gravity, since fat is lighter than whole milk. Adding water lowers the specific gravity, since it reduces the percentage of solids which are dissolved in the liquid part of milk. If the specific gravity of a sample of milk is below 1.030 or above 1.034, the milk may be considered to be adulterated. It is possible to remove the cream and to add a sufficient quantity of water to preserve a normal specific gravity, but a sample of such milk would be so thin and blue as to be suspicious.

The specific gravity of milk is usually taken by a special form of hydrometer, called a lactometer; but a health officer can take it with an ordinary urinometer. The standard test is made at a temperature of 60° F. If it is made at another temperature, a correction is to be made by adding 0.0001 to the reading for every degree below 60° F. For example, if the specific gravity is 1.032 at a temperature of 55° F., the corrected reading would be 1.0325.

Test for Fat.—The test for fat is nearly always made by the Babcock method, in which the casein is destroyed by sulphuric acid and the fat is liberated and collected as a clear oil. The apparatus required is a graduated pipet, a centrifuge, and a special flask with a neck holding 2 c.c. and graduated in tenths and hundredths parts. The method is as follows: Mix 17.5 c.c.

of milk with 17.5 c.c. of sulphuric acid (sp. gr. 1.825) in the flask, and centrifuge the mixture four minutes. Add boiling water until the contents begin to rise into the neck, and centrifuge two minutes. Add more boiling water until the contents rise nearly to the top of the graduated part of the neck, and centrifuge one minute. The melted fat will then have collected as a clear yellow oil, and its quantity may be read by means of the graduations on the flask. The weight of 2 c.c. of butter-fat is 10 per cent. of the weight of the 17.5 c.c. of milk that was used. If the fat is measured by 0.4 of the graduations on the neck of the flask, its quantity is 0.4 of 10 per cent., or 4 per cent. of the milk.

The price of milk at dairies and creameries is usually governed by its percentage of fat as determined by the Babcock method.

Total Solids.—The percentage of total solids in milk may be found by evaporating a known quantity of milk, and comparing the weight of the dry residue with the weight of the sample of milk.

There are several formulas for calculating the percentage of total solids when the specific gravity and the percentage of fat are known. A simple formula is as follows:

Percentage of total solids = $\frac{S}{4}$ + 1.2 F. + 0.14, in which S. is the two figures standing for hundredths and thousandths in the number expressing the specific gravity, and F. is the percentage of fat. For example: A sample of milk has a specific gravity of 1.033 and contains 3.8 per cent. of fat:

$$\frac{33}{4} = 8.25$$
$$3.8 \times 1.2 = 4.56$$
$$0.14$$
$$\text{Total solids} = 12.95 \text{ per cent.}$$

Wholesome Milk.—A health officer is concerned chiefly with the wholesomeness of milk independently of its chemical composition. Unless great care is taken in its production, handling and keeping, milk undergoes rapid changes which render it an unwholesome food, especially for children and babies.

The changes are produced principally by bacteria which enter the milk after it has been drawn from the cow, and which multiply in the milk. Their source is ordinary dust and dirt from the cows, stables, workmen, utensils, and milk rooms. Cleanliness is the principal condition on which the wholesomeness of milk depends. Milk which is perfectly clean contains few bacteria, and will undergo changes so slowly that it may be marketed and kept for a reasonable length of time before undesirable changes occur. The most reliable test for the wholesomeness of milk is the number of bacteria in each cubic centimeter. First-class milk contains less than 10,000 bacteria in each cubic centimeter. Milk of fair quality may contain 200,000 bacteria, and milk of poor quality, several million per cubic centimeter. Milk is seldom so dirty that it contains millions of bacteria for some hours after it has been drawn from the cow. The greater number of bacteria in the poorer grades of milk consist of the organisms which have multiplied from those which were originally in it.

Sediment Test.—Milk that contains visible dirt in the sediment is almost sure to contain great numbers of bacteria. If particles of dirt can be seen in the bottom of a bottle of milk, that milk is unwholesome, especially for children. A test for visible particles of dirt in milk is to strain the milk through a pad of absorbent cotton. Line a small kitchen funnel with a layer of absorbent cotton about $\frac{1}{8}$ inch thick, and pour the contents of a milk bottle through it. Every particle of dirt will be clearly visible on the white cotton. There is one form of sediment tester in which the milk is strained through prepared disks of cotton which may be preserved as a record of the cleanliness of the milk. A sediment tester has a considerable educational value in demonstrating dirt in milk to farmers and dairymen.

Bacterial Examination.—A bacterial examination of milk is usually made to determine the number of bacteria, regardless of their kind. The examination consists either in making cultures from the milk and counting the colonies which develop; or in making a smear of the undiluted milk and counting the individual bacteria.

The method of examining milk by cultures is as follows: Make a series of dilutions by adding 1 c.c. of milk to 9 c.c. of sterile water; 1 c.c. of this dilution to 9 c.c. of water, and so on. The amount of milk in each cubic centimeter of these dilutions will be $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$ c.c., etc. Make a culture from each dilution by placing 1 c.c. on a Petri dish and adding the liquefied culture-medium. Incubate the culture for forty-eight hours at the body temperature and count the colonies which develop. The number of bacteria in each cubic centimeter of milk will be indicated by the number counted in a dish, multiplied by the dilution of the milk that was poured into the dish. If too high a dilution is used, the number of colonies will be small; and if too low a dilution, the number of colonies will be so large as to be uncountable. The most accurate result is that obtained from a dish on which about 200 colonies have developed. Milk of poor quality may require a dilution of 1 : 10,000 or 1 : 100,000. In the routine examination of milk in New York City two dilutions are used, one a 1 : 100, and the other a 1 : 10,000 dilution.

The method of directly counting bacteria in milk is as follows: Using a standard loop of platinum wire that will take $\frac{1}{100}$ c.c. of milk, smear a loopful evenly upon a slide over a ruled area 1 cm. square, and allow it to dry. Extract the fat with xylol. Fix the film with alcohol and stain it with methylene-blue. Examine the specimen with an oil-immersion lens whose field of view has an area of 0.16 millimeter, and count the bacteria in 100 fields. This number multiplied by 5000 gives the number of bacteria per cubic centimeter of milk. If the tube length of the microscope is adjusted to such a length that the field of view has a diameter of 0.16 millimeter, the area of the field will be 0.0002 cm., and of 100 fields, 0.002 cm. But since the depth of the film is $\frac{1}{100}$ cm., the volume of milk examined in 100 fields is 0.0002 c.c. or $\frac{1}{5000}$ c.c. If the number of bacteria per cubic centimeter is only a few thousand, most of the fields examined will contain no bacteria at all; but if the bacteria number hundreds of thousands, a few will appear in each field. The method of direct examination of milk bacteria is used principally in field work to make an approximate estimate of the quality of milk at the receiving dairies. A few slides can be quickly made and examined in an office, and the examiner can give an opinion at once whether or not the milk is of fair quality.

The number of bacteria found by the direct method of examination is usually at least double the number found by culture method, for in the direct method every bacterium is counted, whether it is living or dead, or is single or in a clump. In the cultural method only living bacteria are counted, and since each clump forms only a single colony, it is counted as a single bacterium. The cultural method is the standard one that is used in laboratory examinations.

Taking Samples.—A health officer frequently has to take samples of milk for bacterial examination. The standard outfit supplied to milk inspectors in New York City consists of sterilized ½-ounce bottles; a box of sterilized tubes of aluminum, each about ⅛ inch in diameter and 18 inches long, for taking samples; and a carrying tray in which the boxes of samples may be packed in ice. A health officer can obtain similar bottles and tubes of glass at a drug store, sterilize them by boiling, pack the samples in ice, and see that they reach the laboratory as soon as possible. It is best to send them by special messenger in order to avoid delay and legal questions regarding the identity of the samples.

Bacteria are not evenly distributed through a bottle or can of milk, but their number is greater in the cream layer and sediment, and least in the center of the container. It is necessary to shake the container or stir the milk in order to obtain a true sample. Use a clean implement for stirring the milk in each container, and a fresh tube for taking each sample. If milk is bottled, a health officer may send a whole bottle to the laboratory.

Bactericidal Action of Milk.—After milk has been drawn from a cow, the number of colonies of bacteria that may be grown from a sample diminishes for a few hours, and then increases. The apparent diminution in the number of bacteria has been taken as an indication that milk contains a ferment that destroys bacteria. The diminution may be explained by the death of those which require a temperature of the body for their life and growth. It may also be explained by the clumping or agglutination of the bacteria, since each clump will make only a single colony in the culture.

Kinds of Bacteria in Milk.—The bacteria that are usually found in milk may be divided into four groups: 1, those producing lactic acid; 2, those of fermentation and decay; 3, those of human diseases; 4, those that are inert.

Lactic Acid Bacteria.—Bacteria which produce lactic acid are the cause of the souring of milk. Fresh milk is only very faintly acid. Its casein is held in solution by phosphates. When lactic acid is produced in considerable quantity, it unites with the phosphates, and the casein then solidifies and separates a curd.

Lactic acid, and other substances produced by the lactic acid bacteria, are not harmful to human beings, and milk soured by pure cultures of the bacteria is wholesome even for children and babies. Koumiss and other preparations of soured milk are produced by the growth of pure cultures of special forms of the lactic acid bacteria. The lactic acid bacteria restrain the growth of most other kinds of bacteria, and so food products, such as butter or cheese, which are made from soured milk, are usually wholesome whether the souring is done by means of pure cultures or by natural processes.

The lactic acid bacteria usually grow more rapidly than most other kinds. If they have not multiplied sufficiently to give milk an acid reaction or sour taste, it is usually considered that other kinds of bacteria have not multiplied sufficiently to render the milk unwholesome. The presence or absence of souring is a fairly reliable test of the wholesomeness of milk for adults, but not of milk for babies.

Bacteria of Fermentation and Decay.—Unpleasant odors and tastes in milk may be due to the food of the cows, or to gases absorbed from substances stored near the milk; but some of them are caused by the ordinary bacteria of dust and dirt, and of the soil and air. They consist largely of those of fermentation and decay which multiply manyfold in milk and produce a series of changes which would finally result in the decomposition and putrefaction of the milk if they should be allowed to continue. These bacteria and the substances which they produce are unwholesome and often poisonous, especially for babies. They may cause summer diarrhea in infants. Some milder forms of the sickness seem to be the result of a susceptibility of young children to the proteins that are usually found in the lower grades of market milk as a result of bacterial growth. The repeated use of the milk gradually induces an immunity which enables older children to take even the poorer grades of milk with safety. A baby may become immune to the protein of the milk which it ordinarily takes, and may be made sick when its food is changed to milk which is of a better grade, but whose bacterial growth is different from that to which it has been accustomed. Preventing bacteria of dust and dirt from entering milk is one of the principal things for a dairyman to have in mind in producing milk that has a high grade and is wholesome.

Whether the bacteria of fermentation and decay or those producing lactic acid grow the faster will depend largely on the temperature at which milk is kept. If the temperature is that of an ordinary living-room or higher, the bacteria of fermentation and decay are likely to predominate and render the milk dangerous before it sours. If it is kept at a temperature of an ordinary ice-box or lower, the lactic acid bacteria usually predominate and the milk remains wholesome until it turns sour.

Bacteria are necessary in making butter and cheese, for the products that are made from sterilized milk are almost tasteless. The quality of cheese depends largely on the growth of special kinds of bacteria which develop the special flavors and tastes of the various brands. The beneficial bacteria in milk and cream are of the lactic acid type, and as they grow, they tend to kill the other kinds of bacteria, including disease germs. For this reason butter and cheese made from a poor quality of milk may be wholesome and free from harmful bacteria. Still, this disinfecting action is not sure, and a health officer must consider butter, cheese, and other products to be dangerous when they are produced from milk containing disease germs.

Disease Germs in Milk.—Milk sometimes contains the specific bacteria which produce diseases in human beings. The presence of the germs nearly always becomes known only by an outbreak of sickness among those who drink the milk, for the germs are usually very few in number. A dozen germs in each cubic centimeter of milk would be sufficient to cause a disease, but it is almost impossible to recognize this number in a sample which contains thousands of other kinds of bacteria. Disease germs may be suspected when the milk is handled by a workman who has a transmissible disease, for the most common source of the germs is a person who handles the milk.

Disease germs reach the milk by means of the hands of those who handle the milk, of workmen coughing or sneezing over the milk, or of polluted water used in washing the milk containers. The germs of bovine tuberculosis and of a few other cow diseases may also be found in milk, and may be transferred to human beings.

The common diseases which have been proved to be transmitted from person to person by means of milk after it has been drawn from the cow are tuberculosis, septic sore throat, scarlet fever, typhoid fever, and diphtheria. The New York State Sanitary Code, in the chapter on milk, mentions these diseases, and also cholera, amebic or bacillary dysentery, paratyphoid fever, and smallpox as likely to be milk-borne. The code also requires that every case of any of these diseases on a dairy farm shall be reported to the State Commissioner of Health immediately, and that the sale of dairy products from the dairy farm in which the sick person lives or works shall be stopped, except under the following conditions:

"(*a*) That such foods are not brought into the house where such case exists.

"(*b*) That all persons coming in contact with such foods eat, sleep, and work wholly outside such house.

"(*c*) That such persons do not come in contact in any way with such house, or its inmates, or contents.

"(*d*) That said inmates are properly isolated and separated from all other parts of said farm or dairy, and efficiently cared for.

"(*e*) That a permit be issued by the health officer."

For characteristics of a milk-borne epidemic see page 173.

The duty of a health officer is plain when a workman in a dairy has a communicable disease, but he is often in doubt when the disease is mild or obscure. Yet a person having a disease in a mild form is more likely to infect milk than one sick in bed, for he continues at work. A safe course for a health officer to follow when in doubt regarding a disease on a dairy farm is to advise that every person who has a sore throat or intestinal disturbance shall be excluded from the dairy. He can usually get a dairyman to follow his advice by pointing out to him the money value of avoiding all suspicion regarding the milk.

Transmissibility of Bovine Diseases to Man.—A few diseases which primarily affect cows may be transmitted to human beings by means of the milk of diseased animals. Milk from unhealthy cows is always to be regarded with suspicion, and public sentiment will uphold a health officer in excluding such milk from the market, even though no disease germs or unwholesome products can be demonstrated in it. It is to a dairyman's financial benefit that he exclude all diseased stock from his herd. A health officer is frequently consulted regarding the health of cows, and he ought to know the signs and the effects of diseases that may be transmitted by means of milk.

Tuberculosis.—The principal disease which is transmitted to human beings by means of milk from diseased animals is tuberculosis caused by the bovine type of tubercle bacilli. There was formerly much controversy whether or not bovine tuberculosis could be transmitted to human beings. Accurate tests and extended observations prove that adults are immune to bovine tubercle germs, but that children are not. Bovine bacilli are seldom found in tubercular lungs, and less rarely in affected bones and joints; but they are frequently the cause of tuberculosis of the glands of the neck, of the abdominal organs, and of generalized tuberculosis. About 10 per cent. of the children who die from tuberculosis have the bovine type of germs.

Tubercle bacilli pass from the cow to human beings by means of milk and seldom by any other route. The recognition of tubercle germs in milk cannot be made with certainty by staining methods or a microscopic examination, for many kinds of hay bacilli are acid fast, and almost exactly resemble tubercle bacilli in form and staining qualities (page 292). The test for tubercle bacilli in milk is made by centrifuging the milk and injecting some of the sediment and some of the cream into guinea-pigs (page 293).

Tuberculosis may affect almost any organ of a cow's body. If the udder is affected, the germs may be found in the milk when it is drawn from the cow; but most of the tubercle germs in market milk come from manure and other dirt containing germs which have been expelled from the respiratory and intestinal tracts of diseased cows.

Two methods of detecting tuberculosis in cows are: 1, a physical examination, and 2, the tuberculin test. Tuberculosis may be suspected when a cow has a cough, or is losing flesh without apparent cause, or has enlarged glands, or an intestinal disturbance. The disease gives the same physical signs in a cow as in a human being.

Many cows give off tubercle bacilli before the signs of the disease are evident. The disease may be detected in its early stages by means of the tuberculin test, which is performed as follows: Take the cow's temperature at three-hour intervals for twenty-four hours in order to obtain the usual range of temperature of that particular cow. Inject the tuberculin subcutaneously and continue to take its temperature for another twenty-four hours. A rise of temperature of 2° or 3° F. indicates tuberculosis.

The tuberculin test requires a considerable degree of skill and judgment, and is subject to many sources of error. Many cows with advanced tuberculosis do not react to the test, but these usually show evident physical signs of the disease. After a cow has been injected with tuberculin, there will usually be no reaction to another test made within a month afterward. However, if a test is made in the proper manner by a skilled and honest veterinarian, it is a reliable indication of the presence or absence of tuberculosis.

Tuberculosis is common among cattle. If a cow is free from the disease, the animal may catch it and develop it in an advanced form in a few months. It is a routine practice in the best dairies to apply the tuberculin test to the entire herd every six months, and to remove all the animals that react.

Tubercular cows may be divided into two groups—those which give off tubercle bacilli and those which do not, or the spreaders and the non-spreaders. The spreaders are those whose udders, lungs, or intestines contain open sores from which the germs may escape. Non-spreaders may not be dangerous so long as we are sure that they do not give off tubercle bacilli, but they may become spreaders at any time. A tubercular cow is a source of danger to other cows and to human beings, and the control of all affected cows is necessary for the preservation of public health. The laws of New York State require that all cattle known to have tuberculosis shall either be slaughtered or else be isolated under a permit from the State Commissioner of Agriculture, and their milk must not be sold or manufactured into butter or cheese unless it is first pasteurized at a temperature of 185° F. (Agricultural Law, Section 94).

Inflamed Udders.—An inflammation, or hardening, or caking of the udder frequently occurs in cows, and the milk of such cows usually contains flakes of curds derived from the hardened area. The disease is usually caused by bacteria of a streptococcus type, which do not seem to be virulent to human beings. It usually affects only one-quarter of the udder, and dairymen often throw away the milk from that part and use the milk from the rest of the udder. This is a dangerous practice, and it is the duty of a health officer to exclude all the milk from an affected cow as long as the disease lasts.

The germs of human septic sore throat may grow in the udder of a cow, but they are only mildly virulent to a cow and usually produce only a slight inflammation. A cow that harbors the germs is simply a carrier, and will soon excrete the germs, provided it is not continually reinfected by a human carrier (page 227).

Contagious Abortion.—This condition is caused by a specific bacterium which is transmitted by means of the male animal. It is possible that the milk of an affected animal may be unwholesome to infants. The disease does not usually have a great effect on the health of the cows, but its presence in a herd produces great financial loss on account of the inability of cows to bear calves.

Other Diseases.—The germs of paratyphoid fever may grow in cows and produce a form of septicemia. The meat of affected animals is the cause of much of the so-called ptomain poisoning among human beings, and their milk is a grave source of danger.

Foot-and-mouth disease in cows produces a sickness which may be compared with measles in human beings. It may be recognized by an eruption or sores in the mouth, and by a sudden fever and a fall in the milk production. It is seldom fatal, but an affected cow will produce only a small quantity of milk for a year or more. The disease causes great financial loss, and may also be transmitted to human beings. It is as contagious as measles, and the federal laws require the immediate destruction of an entire herd when a single one of the animals is found to be affected.

Cowpox, or vaccinia, may be transmitted to man. It frequently exists in a mild form, and is usually mistaken for ordinary sores on the teats. It seems to have no bearing on public health, but a health officer should remember the possibility of the disease.

Anthrax, glanders, rabies, and tetanus are rare diseases which a health officer may unexpectedly find in a dairy, and which require an immediate quarantine of the affected animals in order to prevent the possible transmission of the diseases to persons.

Pasteurization.—Milk free from disease germs may be produced from healthy cows by healthy dairymen who follow clean methods of production. But it is not always possible to be sure of the healthfulness of the cows and workmen, or of cleanliness in producing and handling milk. Pasteurization supplements clean methods of production, and insures a milk-supply that is free from disease germs. It will not undo all the evil effects of disease germs and dirt, or restore freshness to milk that is already spoiled, but it will destroy the specific germs that produce human diseases. If a health officer has good reasons to suspect that a certain milk-supply contains disease germs, he may allow the milk to be sold, provided it is efficiently pasteurized.

The milk-supply of New York City comes from a radius of hundreds of miles, and the number of producers is so large that a strict supervision of the dairies and the workmen is impossible. When a milk-borne outbreak of disease has occurred in the city, it has been difficult or impossible to trace the germs to the guilty dairy. The Department of Health, therefore, requires that all milk sold from ordinary milk wagons and depots shall be pasteurized.

Pasteurization means heating milk to a temperature and for a length of time which is sufficient to kill the harmful bacteria without producing undesirable or harmful changes in the milk itself. The standards of temperature and time of pasteurization vary considerably. The standard fixed by the sanitary code of New York State is that milk shall be subjected to a temperature of 142° to 145° F. for not less than thirty minutes. A boiling temperature would render milk practically sterile, but it would give the milk an unpleasant taste, and would produce other undesirable changes in the milk. When pasteurization is properly done, the milk is unchanged in its taste and appearance, in its physical and chemical properties, and in its digestibility and nutritive value.

It is sometimes claimed that an exclusive diet of pasteurized milk may produce scurvy and rickets in babies. Any form of milk fed alone for months may produce evidences of malnutrition. A teaspoonful of orange-juice three or four times a week will supply the missing food elements and prevent scurvy and rickets when pasteurized milk is fed to infants.

The only object of proper pasteurization is to kill bacteria in milk. It will not destroy toxins and other poisons that were formed in the milk before it was pasteurized. The New York State Sanitary Code forbids the labeling of milk as pasteurized unless it was sweet and wholesome when it was pasteurized, as proved by a bacterial count.

Pasteurized milk will keep sweet longer than untreated milk, but it will finally become sour and spoiled, for the low temperature of the pasteurization does not kill the more persistent bacteria or their spores. It is necessary to take the same care of pasteurized milk as of raw milk.

Test of Efficiency of Pasteurization.—A standard test for the efficiency of pasteurization is the determination of the presence of living colon bacilli in milk. Colon bacilli derived from the intestine of the cow are found in all commercial milk. They are somewhat more resistant to heat than the specific bacteria of diseases. If all the colon bacilli are killed by the process of pasteurization, we may be confident that the bacteria of human diseases are also killed; while if the colon bacilli survive, there is a chance that some bacteria of disease may survive. The tests are the same as those for colon bacilli in water, and are made by inoculating milk into fermentation tubes of dextrose broth, and by confirmatory tests of platings upon special media (page 456).

Commercial Methods of Pasteurization.—There are two methods of pasteurizing milk: the flash and the holding systems. The flash system consists in passing the milk through tubes which quickly raise its temperature to 160° or 170° F., and then through other tubes which make it ice cold. The whole cycle of heating and cooling requires only about five seconds. This system is often uncertain in its results, and requires constant and expert attention. The comparatively high temperature of the process is likely to give the milk an unpleasant taste.

The holding process consists in heating the milk to 145° F. and holding it at that temperature in a tank for at least half an hour. The results of this method are more uniform and efficient than those of the flash method. The low temperature does not affect the taste of the milk, while the length of the application of the heat insures the death of the bacteria.

Pasteurizing milk on a commercial scale requires a rather complicated and expensive outfit, and a considerable degree of skill in its operation. Great cleanliness must be observed, and all parts of the apparatus must be thoroughly cleaned and sterilized after it is used, and all joints and connections must be maintained in a perfect condition, for a bit of milk or slime left in any part may reseed the entire supply with bacteria that are undesirable or harmful. The smallest apparatus that is economic and efficient is designed for about 400 quarts daily. When a smaller quantity is pasteurized, the variations in temperature render the process uncertain. The large size of the plant renders pasteurization impracticable for a rural dealer whose daily output is 100 quarts or less. There is a great need for a pasteurizer with a daily capacity of 50 quarts.

An ideal method of pasteurization is first to bottle the milk and then to heat both the milk and the container. This process is not practicable on a commercial scale on account of the cost of heating the bottles themselves, and of the quantity of heat required to heat the space in which the bottles are held during the process. A considerable time is also required to heat the milk in quart units and to cool it again.

Home Pasteurization.—When a community is threatened with an epidemic, or when an infant's food must be prepared, a health officer may be asked how to pasteurize milk at home. The outfit needed to pasteurize a few pints of milk in the kitchen is a double boiler and a thermometer. The pasteurization cannot be done accurately unless the temperature is regulated exactly. One can use a cheap bath thermometer with the wooden case removed. Heat the milk in the inner container and stir it frequently. Watch the temperature, and when the thermometer reads 145° F., remove the boiler to a cooler part of the stove. Continue to watch the temperature and to maintain it between 140° and 145° F. for thirty minutes. Then cool the milk in an ice-box or in fresh water from a pump or well. A person will readily learn the exact amount of fire and time to be used, and the proper position of the container on the stove, and will then be able to pasteurize the milk with as great ease and certainty as to cook a beefsteak.

Emergency Pasteurization.—A health officer may suddenly be confronted with the necessity of pasteurizing the output of a dairy on account of the discovery of a case of septic sore throat or scarlet fever or other disease which may infect the milk. If the dairy is provided with steam for heating the water used in washing the containers, or with other facilities for heating a large quantity of water, a can or two of milk may be pasteurized by a method like that used in pasteurizing milk in the home. Prepare a vat or deep tub of boiling water. Set a can or deep pail containing the milk in it, and keep the water at a boiling temperature. Stir the milk frequently, and take its temperature every few minutes. When the temperature reaches 145° F. remove the can from the water and protect it from drafts. A 40-quart can will require about thirty minutes to reach a temperature of 145° F., and will remain above 140° F. for thirty minutes more.

Cooling Milk.—It is almost impossible to produce milk free from bacteria, or to destroy all the bacteria by pasteurization. It is, therefore, necessary to prevent bacteria from multiplying in milk. The only allowable method of preserving milk on a commercial scale is by cooling it. A low temperature restrains the growth of all kinds of bacteria. The degree of temperature needed to preserve milk will depend largely on the length of time that the milk is to be kept. A temperature of 60° F. will be sufficient if the milk is to be used within twenty-four hours. The milk-supply of New York City is often four days old when it reaches the consumer; and the Department of Health therefore requires that milk shall be kept at or below 40° F. during its transportation.

Preservatives.—Bacteria in milk may be destroyed by the use of chemicals, such as peroxid of hydrogen, borax, or salicylic acid. Any chemical is likely to change the composition of milk and to make it unwholesome whether or not the chemical itself is harmful. The use of any preservative in milk is forbidden by law in New York State (Agricultural Law, Sections 30–34).

THE PRODUCTION OF WHOLESOME MILK

The wholesomeness of milk depends principally on the degree of its freedom from bacteria or their products. It is almost impossible to produce milk that is entirely free from bacteria, for some bacteria are found in the openings of the milk-ducts of healthy cows and for a considerable distance up the ducts. By far the greater number of bacteria in milk come from ordinary dirt, and may be kept out of the milk by cleanly methods of producing and handling the milk. The few bacteria that are found in even the best milk may multiply to millions and may make the milk unwholesome unless great care is taken to prevent their growth and increase. The production of wholesome milk on a commercial scale requires (1) healthy cows, (2) cleanliness through all stages of its production, and (3) the application of cold to prevent the growth of bacteria during the transportation and storage of the milk.

Score Card.—The details of equipment and methods which are necessary in producing wholesome milk are enumerated on a standard score card which was devised by the Bureau of Animal Industry of the United States Department of Agriculture. A copy of this score card is found on page 359. Other systems of scoring have been adopted by New York City and other municipalities, but the essential principles are the same in all.

Each item on a score card is assigned a value depending on its importance in influencing the bacterial count of milk. For example, perfect cleanliness of the cows counts 8, while cleanliness of the stable floor counts 2. The system is not perfect, for the scoring is done at infrequent intervals, and an accident or carelessness between times may allow dirt to enter the milk and produce a temporary increase in the bacterial count.

OFFICIAL DAIRY SCORE CARD

Owner or lessee of farm...
P. O. Address.. **County** ....
Total number of cows............**Number milking**..................**Gallons of milk produced daily**....................
Product is sold by producer in families, hotels, restaurants, stores, to..................................**dealer.**
For milk supply of ....
Permit No.......................................**Date of inspection**.., **191**

EQUIPMENT.	SCORE. Perfect.	SCORE. Allowed.
COWS		
Health	6	......
Apparently in good health 1		
*If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed....5		
(If tested within a year and reacting animals are found and removed, 3.)		
Food (clean and wholesome)	1	......
Water (clean and fresh)	1	......
STABLES		
Location of stable	2	......
Well drained....1		
Free from contaminating surroundings....1		
Construction of stable	4	......
Tight, sound floor and proper gutter....2		
Smooth, tight walls and ceiling....1		
Proper stall, tie, and manger....1		
Provision for light; Four sq. ft. of glass per cow (Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)	4	......
Bedding	1	......
Ventilation	7	......
Provision for fresh air, controllable flue system....3		
(Windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5)		
Cubic feet of space per cow, 500 ft....3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., o.)		
Provision for controlling temperature....1		
UTENSILS		
Construction and conditions of utensils	1	......
Water for cleaning (Clean, convenient, and abundant.)	1	......
Small-top milking pail	5	......
Milk cooler	1	......
Clean milking suits	1	......
MILK ROOM OR MILK HOUSE		
Location: Free from contaminating surroundings	1	......
Construction of milk room	2	......
Floor, walls and ceiling....1		
Light, ventilation, screens....1		
Separate rooms for washing utensils and handling milk	1	......
Facilities for steam (Hot water, o.5.)	1	......
Total	40	......

METHODS.	SCORE. Perfect.	SCORE. Allowed.
COWS		
Clean (Free from visible dirt, 6.)	8	......
STABLES		
Cleanliness of stables	6	......
Floor....2		
Walls....1		
Ceiling and ledges....1		
Mangers and partitions....1		
Windows....1		
Stable air at milking time	5	......
Freedom from dust....3		
Freedom from odors....2		
Cleanliness of bedding	1	......
Barnyard	2	......
Clean....1		
Well drained....1		
Removal of manure daily to 50 feet from stable	2	......
MILK ROOM OR MILK HOUSE		
Cleanliness of milk room	3	......
UTENSILS AND MILKING		
Care and cleanliness of utensils	8	......
Thoroughly washed....2		
Sterilized in steam for 15 minutes....3		
(Placed over steam jet, or scalded with boiling water, 2.)		
Protected from contamination....3		
Cleanliness of milking	9	......
Clean, dry hands....3		
Udders washed and wiped....6		
(Udders cleaned with moist cloth, 4; cleaned with dry cloth or brush at least 15 minutes before milking, 1.)		
HANDLING THE MILK		
Cleanliness of attendants in milk room	2	......
Milk removed immediately from stable without pouring from pail	2	......
Cooled immediately after milking each cow	2	......
Cooled below 50° F (51° to 55°, 4; 56° to 60°, 2.)	5	......
Stored below 50° F. (51° to 55°, 2; 56° to 60°, 1.)	3	......
Transportation below 50° F. (51° to 55°, 1.5; 56° to 60°, 1.) (If delivered twice a day, allow perfect score for storage and transportation.)	2	......
Total	60	......

Equipment................................ + **Methods**.................................... = ... **Final Score**

Note 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

Note 2.—If the water is exposed to dangerous contamination, or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

* Alternate. If the milk is pasteurized by the holding process, score 5.

A farmer or dairyman who sells milk is supposed to have his dairy in a reasonably good condition, and to exercise reasonable care at all times. Milk may be made dangerous if it is subjected to a single unclean process. A note at the bottom of the card provides for limiting the score if any condition is exceptionally unfavorable, and for making the score zero if the water is contaminated or an infectious disease is present in the cows or in the dairy attendants.

Health officers and inspectors use the score card in inspecting dairies, and in detecting conditions which may affect the wholesomeness of the milk. If the stable and dairy are cleanly and the methods which are followed are satisfactory, the milk will usually have a low bacterial count. The score card cannot take the place of a direct bacterial examination of the milk, but if a milk has a high bacterial count, an inspection of the dairy according to the methods of the score card will usually reveal the source of the contamination, and will lead to the discovery of the proper remedy.

A health officer can also use the score card in instructing farmers and dairymen how to produce wholesome milk. The score card includes nearly every point which affects the bacterial count of milk. The farmer who has a copy of the scoring of his dairy can use it as a guide in making the necessary improvements to his outfit and corrections to his methods.

Grading Milk.—The score card is also used in grading milk. It does not score the milk itself, but the conditions under which the milk is produced. It suggests the grade of milk which we may expect under the conditions of the scoring; while a bacterial count reveals the actual condition of the milk at the time that the sample was taken. The bacterial count is a check upon the scoring system; while the scoring will reveal the probable sources of the bacteria when the count is high. The most practical system of grading milk is that founded upon a combination of the score card and the bacterial count.

It often happens that dirty milk containing many bacteria is produced in a dairy which has a high score, and that a high grade of milk is produced in one having a low score. A person without a natural tendency to be clean and careful will produce dirty milk even when his equipment and methods seem to be perfect. On the other hand, a person with cleanly instincts and habits will produce clean milk amid unfavorable surroundings. Cleanliness in producing wholesome milk is like surgical cleanliness. A health officer must take into consideration a dairyman's personal equation of cleanliness in judging the wholesomeness of his milk.

Milk is usually graded as A, B, or C, and each of these grades is divided into raw and pasteurized, making six in all. The standards differ in various localities. Those required by the sanitary code of New York State are shown by the following table:

Grade.	Cows. Test required.	Maximum bacterial count per cubic centimeter.	Score card.	Time of delivery.
Grade A, raw.	Tuberculin test neg.	60,000.	Equip.....25 Methods...50 Total.....75	36 hours.
Grade A, pasteurized.	Phys. exam. neg.	200,000 before pasteurizing and 30,000 afterward.	Equip.....25 Methods..43 Total.....68	36 hours after pasteurizing.
Grade B, raw.	Phys. exam. neg.	200,000.	Equip.....23 Methods...37 Total.....60	36 hours.
Grade B, pasteurized.	Phys. exam. neg.	150,000 before and 100,000 after.	Equip.....23 Methods...35 Total.....58	48 hours after pasteurizihg.
Grade C, raw.	None.	No limit.	Total.....40	48 hours.
Grade C, pasteurized.	None.	No limit.	Total.....40	48 hours after pasteurizing.

Grade A milk raw and Grade A pasteurized are produced under the most approved methods of care and cleanliness, and are the only two grades that are up to the standard of cleanliness and wholesomeness that may reasonably be required of dairymen under modern conditions. Two difficulties in the way of requiring that all milk shall be Grade A are the cost of production and the lack of dairymen who have sufficient skill and inclination to produce enough first-class milk to supply the market. While the farmers and dairymen with business ability can produce Grade A milk at a profit under present conditions and prices, the smaller and less skilled producers are less able to do so. We are, therefore, confronted with the necessity either of accepting a lower grade of milk or of producing a milk famine and upsetting the whole economic system of farmers.

Grade B milk is of fair quality, and if it is pasteurized with care, it will be free from the germs of human diseases. It is the lowest grade of milk that may be safely allowed on sale. If a board of health should forbid the sale of milk that has a lower grade, the order would promote the healthfulness of a community, and would not usually interfere with economic conditions.

Grade C milk is that which is produced under few or no restrictions. The only use to which it may safely be put is that of cooking.

Certified Milk.—In addition to the six usual grades of milk the sanitary codes of New York State and New York City recognize a grade called *certified milk*, or *Grade A Certified*. This milk is produced with the greatest care that is possible under commercial conditions, and its purity, freshness, and wholesomeness are certified by a responsible commission appointed by a county medical society which is under and chartered by the State Medical Society. A bacterial examination of the milk is made almost daily, the dairies are scored at frequent intervals, and the cows are tested with tuberculin at least once a year and all suspicious animals are removed. The maximum bacterial count allowed is 10,000 per cubic centimeter. Certified milk is as pure and wholesome as any unpasteurized milk can be. If there is a lingering doubt regarding its wholesomeness, pasteurization will render it safe beyond reasonable doubt.

Permits to Sell Milk.—Milk influences public health so directly that the people demand that the department of health shall supervise its production and distribution. The object of the supervision is not to restrict the output of milk, but to improve its quality. Inspectors and health officers are not expected to try to put any milkman out of business, but to help him to increase the quality and amount of his product. Many people who fear to use milk would buy it if they were assured of its quality and wholesomeness. The intelligent supervision of all milk-supplies is becoming more and more a duty which is expected from health officers. The Sanitary Code of New York State requires that every person selling milk shall obtain a permit annually from a local health officer, and that no permit shall be issued until the dairy has been found to score at least 40 per cent. within six months. This is a low score, but the local health board of any municipality may raise the requirements. It is necessary that every health officer shall know how to use a score card, and how to interpret the items of the score.

Using a Score Card.—A score card is divided into two parts—equipment and methods. The total of the items of perfect score for equipment is 40, and for methods it is 60. The equipment is of less importance than the way it is used, and a health officer will consider its usefulness and practicability rather than its cost. It is not necessary that a farmer build an expensive barn and install complicated machinery in order to produce wholesome milk. The quality of milk is affected by the floor plan and location of the buildings much more than by the amount of money spent on them. It is far more important that a stable be kept clean than that it be made out of new and expensive materials. The standards of construction and repair that yield the most efficient and economic results are those which a farmer of ordinary means and intelligence would approve. It is the duty of the health officer to consider the interests of the producer as well as those of the consumer.

Scoring a dairy is an official act, and the health officer, or his representative, must personally judge each item on the card by an actual observation. It is best that the scoring be done in the presence of the dairyman, both for his instruction and also to prevent disputes.

The health officer can score the equipment accurately, for it is permanent and can readily be inspected. But he may have some difficulty in seeing the workmen perform every process, and he cannot be sure that they will always be as careful as they are while he is looking at them. This variability and the uncertainty in judging methods as compared with equipment must be considered in the interpretation of a score card.

When a health officer starts to score a dairy, it is a good plan for him to give the dairyman a copy of the score card, and to score the items in the order in which they appear on the card, and to explain each point and its bearing on the cleanliness and wholesomeness of the milk. The points on the score care will be discussed in the remainder of the chapter.

The Cows.—The first item on the score card relates to the health of the cows. A health officer will judge their health by three methods: 1, an inspection; 2, a physical examination; and 3, the tuberculin test.

A mere inspection of the herd has a considerable value, for if a cow becomes sick, she usually shows the illness by her appearance and actions. The presence of a cow that appears to be unhealthy is sufficient ground for a health officer to require the isolation of the animal until the nature of the disease can be determined. An unhealthy animal has no place in a dairy herd.

A physical examination of the cows such as health officers can make will have a considerable value in determining their health. A simple,routine examination of a cow is as follows:

1. Note its general appearance, fatness, sleekness, and attitude.

2. Note the presence of visible sores, swellings, or other defects.

3. Note the manner of breathing and the presence of a cough.

4. Note the elasticity of the skin by pinching and stretching it. The skin of a healthy animal is soft and elastic.

5. Feel under the jaw for enlarged glands.

6. Feel the udder for lumps and other evidences of inflammation.

7. Draw a few streams of milk from each teat into the hand and note any abnormal appearance.

8. Note the presence of diarrhea or abnormal discharges.

The tuberculin reaction is the most valuable health test, for tuberculosis is the most common bovine disease with which a dairyman has to deal, and the reaction will reveal it in its incipiency (page 353).

The food and drink of cows has a direct effect on their health and on the wholesomeness of their milk. The New York State Agricultural Law, Section 30, defines one form of adulterated milk to be that "drawn from animals fed on distillery waste or any substance in a state of fermentation or putrefaction, or on any unhealthy food," but the next section exempts ensilage. Water containing the specific bacteria of bovine diseases, especially those of the colon bacillus type, is often the cause of intestinal diseases among cows. A pure water-supply for a dairy herd is as important as one for human beings. A health officer may properly condemn a dairy water-supply that is polluted with the discharges of cattle.

Stables.—Housing conditions affect the health and milk production of cows in about the same way that they do the health and working efficiency of persons. A dark, tumble-down house is as bad for a cow as for a human being, and milk produced in such a house is likely to be unprofitable to the producer and unwholesome to the consumer.

A health officer will consider the drainage of a stable and yard. When the manure is removed from the yard, some of the earth is removed with it until a depression is often made which becomes filled with water after each rain. A health officer will note whether or not the yard is kept graded, and provision made for carrying off the surface water.

The health officer will look for contaminating surroundings near the stable, such as privies, pig-pens, hen-roosts, manure piles, and garbage heaps. All these things may be sources of contamination on account of their drainage, dust, and odors, and also because they may be the breeding-places for flies and vermin. A horse stable in the same stable with cows, or directly connected with the cow stable, is to be condemned.

There is no standard material for stable floors. Earth becomes muddy or dusty, and will be scored zero. Wood may be scored perfect if it is kept in good repair. Cement is the most sanitary material, and is also usually the cheapest.

Sanitary stables are now built on the standard plan of open interior construction with as few partitions and obstructions as possible. The floor is of smooth cement with a shallow trough in front of the cows for a manger, and a deep, square gutter behind them to receive their droppings. There are no partitions between the cows, and the only raised structure above the floor is a row of stanchions in which the cows are held or tied. Each stanchion is hung on swivels so that a cow may lie down or turn her head freely, and yet it confines her so closely that she cannot soil the bedding and platform on which she stands.

It is essential that the side walls and ceilings be smooth and tight, and that there be no projecting ledges to catch dirt. A hay loft above the cows with poles or loose boards for a floor will be scored zero, for it allows quantities of dust and dirt to fall into the stable.

The reasons for lighting a stable are the same as those for lighting a human dwelling. A health officer is expected to measure the windows and the size of the stable, and to estimate the amount of light and space per cow with a considerable degree of accuracy.

Bedding is necessary for the comfort and cleanliness of the cows. The best bedding is probably sawdust or wood shavings because of their freedom from dust. Moldy hay and dried manure are to be condemned for bedding.

Ventilation and heating are to be considered together and in connection with the window space. The old-fashioned barn with open cracks between the boards was often ventilated too much, and in winter was as cold as the outside air. It is not economic to use feed in order to keep a cow warm when a stable may readily be built and ventilated in such a way that its temperature remains at about 50° F., even on cold nights. A new stable with tight sides of matched boards and few windows is likely to be poorly ventilated, and too warm and close for comfort. If a health officer finds the sides of a stable to be wet with condensed moisture, he may be sure that the stable is poorly ventilated. An excellent method of securing ventilation without cold drafts is to remove some of the window sashes and tack muslin over the openings.

A standard space of 500 cubic feet per cow is found to give the most satisfactory balance between ventilation and temperature. If the space is larger, the temperature will be too low, and if it is smaller, the air will either be too close or cold drafts will be formed.

A system of ventilating flues with separate intakes and outlets will work well provided the sides of the building are tight and the dairymen use good judgment in operating the flues.

Utensils.—A health officer will give particular attention to the dairy utensils, for they have a great effect on the cleanliness and wholesomeness of the milk. It is important that the inner surfaces of the pails and cans be smooth and polished, and free from dust and rust, and from open seams in which dirt and dried milk may collect.

An abundance of water and facilities for heating it are necessary in cleansing the pails and bottles. If a health officer finds that a dairyman has only two wash-tubs for washing a hundred milk bottles daily, and has only an oil stove or two for heating the water, he may properly score the dairy zero and condemn the whole outfit. If one hundred or more bottles are to be washed daily, it is necessary that a boiler be installed for heating the water with steam, and keeping it hot during the whole process.

A small-top milking pail is one whose opening measures 8 inches or less. The large score of 5 is assigned to this kind of pail, for only a small amount of dirt will fall through the small opening. Experience shows that the change from a large-top pail to a small-top one is followed by a great reduction in the number of bacteria in the milk. One of the best pieces of advice that a health officer can give to a dairyman is to use a small-top milking pail.

A milk cooler is a most valuable utensil if it is properly handled. It may be a source of danger if it is unclean, or out of repair, or exposed to dust and flies. The ordinary type of cooler is one in which the milk flows in a thin film over a large can filled with cold water or ice. A great objection to it is that it is exposed to dust and flies. A better form of cooler is a thin, flat one which may be enclosed.

Dairymen talk a great deal about what they call the animal heat of the milk, and the supposed danger if it is retained. The health officer will often find it necessary to explain that animal heat is the same as any other heat, and that the objectionable conditions of animal origin which a cooler removes from milk are the tastes and odors. The health officer will often need to instruct the dairyman in the proper use of a cooler.

The cleanliness of the milkman's clothes may affect the quality of the milk, especially if they are covered with dust and loose dirt which may fall into the milk. A health officer, for example, will advise a farmer coming from a dusty field to put on a clean coat and overalls before he milks. The milkers on farms producing certified milk are required to put on freshly laundered suits at each milking.

Milk Room and Milk House.—A health officer will condemn a milk room or milk house if it is located near a privy or manure pile, or beside a dusty road, or in any other place where dust or dirt or odors are likely to contaminate the milk. If a privy is used on a dairy farm, a health officer may well advise that it be fly-tight, and have the pail system of disposal of excreta.

A health officer will score a milk room zero if its floors, walls, and ceilings are rough and out of repair, or if it is not well lighted, ventilated, and screened from flies. He will give credit if the room for receiving and washing dirty utensils is separated from the room in which clean utensils are stored and milk is handled. If the milk room is located in the cow barn, the health officer will require that it either be completely separated from the stable, or be entered through an intermediate room in order to exclude the dirt and odors from the stable.

Cleanliness.—The second column of the score card relates to the manner in which a dairyman uses his equipment. The essential point which a health officer will have in mind is cleanliness. While it is possible to produce clean milk with a dilapidated equipment, yet a dairyman who has such an equipment will be careless in the way he uses it; and, on the other hand, a dairyman who is careful and clean will keep his equipment in good repair. The condition of the equipment is an excellent indication of the methods which a dairyman habitually follows.

Cows.—Cleanliness of the cows is given one of the highest of all the ratings on the score card. If the cows are dirty, some of the dirt is sure to fall into the milk-pail during milking. It is impossible for a cow to keep herself clean in an ordinary stable. Dried manure and loose hair in a cow's flanks are indications that the dairyman does not clean the animal regularly. A good dairyman will curry the coats of the cows daily, and will clip the long hairs from the flanks and udders on the side on which the milker sits.

Stables.—The total rating for the cleanliness of the stable and barnyard is large, but it is subdivided into ratings of the individual parts, each of which a health officer will note in his inspections. The drainage of the barnyard and the removal of the manure daily have a great effect on the cleanliness of the cows and on the bacterial count of the milk.

The cleanliness of the stable and the purity of the air at milking times are of greater importance than their condition at other times. A health officer will require that currying the cows, feeding hay, and preparing the bedding shall be done after milking in order to avoid dust in the air during milking time.

Milk Room.—The cleanliness of the milk room is of greater importance than would seem to be indicated by its low rating, but a dairyman does not deserve credit for being decently clean. A health officer may properly condemn a milk room if it is not kept up to the modern standard of cleanliness of a kitchen.

Utensils.—Much of the bad taste of milk comes from bacteria growing in decomposing milk that is left in the corners and seams of the utensils. The minute remnants of milk that remain after careful cleansing will provide food for an abundant growth of bacteria unless the bacteria are killed. The cleanliness and sanitary condition of the utensils will depend largely upon the quantity of boiling water or steam that is used in washing them. A temperature of at least 180° F. is necessary in order to sterilize the utensils. A tea-kettle full of boiling water poured into a milk can may be merely warm after it has been in the can for a few seconds.

A test of the efficiency of the processes of washing and sterilization is the odor of the utensil after it has been closed for some time. Cover a milk can, or pail, or bottle for an hour, and then open it and test its odor. If the odor is unpleasant, the milk that is put into the utensil will acquire a similar odor and an unpleasant taste. Dairymen frequently leave the covers off the washed cans in order to avoid the unpleasant odor which they suppose must necessarily develop in a closed container. A health officer can demonstrate the effect of sterilization on the odor by washing a container in warm water and boiling a similar one, and then carrying out the odor test on both.

An accurate test of the sterilization of the utensils is afforded by a bacteriologic examination of the drops of water that are left in the cans after washing. Samples for a bacteriologic examination may be taken by shaking a small quantity of cold, boiled water in the container and sending a sample to the laboratory. Samples may also be taken by rubbing a swab moistened with sterile water over the inner surface of the container and inoculating a culture-tube.

Milking.—Cleanliness of milking is given the highest of all the ratings on the score card, for the time when milk is the most likely to be contaminated is during milking. The necessary movements of the milkers' hands and of the udders will dislodge epithelial scales if nothing else. While it is sometimes possible to draw a few streams of milk in a sterile condition, yet milk always contains bacteria when it is drawn into a pail in which it remains under a cow for a few seconds. But the number of bacteria may be kept extremely low by careful methods of cleanliness during milking.

Clean hands are as necessary for a milker as for a cook who handles the milk in the kitchen. A dairyman who wishes to produce a high grade of milk will require the milkers to wash their hands before milking each cow. Some milkers have a habit of wetting their hands with milk. This is an uncleanly practice, for it is almost impossible to milk with wet hands without dropping some of the soiled liquid into the pail.

If the udders and flanks of the cows are clean, there will be little or no dirt to fall into the pail. Three methods are in common use for cleaning them: first, washing them and drying them with a clean towel; second, wiping them with a damp cloth; and third, wiping them with a dry cloth. Cleaning with a dry cloth may raise dust and do more harm than good. A health officer will inquire into the cleanliness of the cloths used in cleaning the udders.

Handling the Milk.—Dairymen who are careless or lazy frequently pour the milk into an open can which stands in the barn where it collects dirt and absorbs odors. A health officer may properly require the milkers to remove the milk to a protected place immediately after milking each cow, and that those who work in the stable shall change at least their shoes if they handle the milk in the milk room.

Cooling Milk.—The only allowable means of preventing the growth and multiplication of bacteria in milk is coldness. The degree of temperature that is necessary will depend largely on the length of time that the milk is to be kept. The milk of New York City is at least three days old when it reaches the customers, and a temperature of 40° F. is required in order to preserve it. Milk need not be cooled at all if it is sold by a farmer from the kitchen door to a neighbor for immediate use. A health officer usually deals with milk that reaches the customer within twenty-four hours after it is drawn from the cow. A temperature between 50° and 60° F. is usually satisfactory for this milk.

The usual method of cooling milk in rural districts is to set the cans in freshly drawn water from a spring or well, or into the spring itself. The water usually has a temperature between 50° and 55° F. If this method of cooling is used a health officer may know that the milk has not been cooled below about 55° F.

There is often difficulty in keeping milk at a low temperature during transportation when its quantity is small. A health board may remedy this condition somewhat by passing an ordinance requiring that milk be delivered within a certain period unless it is kept below a specified temperature. A health board may also pass an ordinance specifying the maximum temperature of milk which may be allowed on delivery wagons. A health officer has the right to take the temperature of milk in dairies and on delivery wagons in order to make a proper scoring.

Some communities require a health officer to score a milk producer and issue a permit even when a farmer keeps only one cow and sells only a few quarts from his kitchen door. A health officer in such a case would consider the kitchen to be the milk room, the kitchen pump to be the water-supply, and the kitchen stove to afford the facilities for heating the water.

CHAPTER XXXIII

FOOD SANITATION

MILK is a food that is in a class by itself, owing to its liability to undergo changes, develop unwholesome products, and become a spreader of disease germs. It may endanger public health to such an extent that the supervision and control of its production and distribution is exercised by boards of health without question. But the same kinds of changes and infections that affect milk may affect other foods also. Various departments of national and state governments are undertaking certain phases of food supervision largely on economic grounds; and the departments of health of the larger cities are extending the work for sanitary reasons. The control of the sanitary conditions of foods, drinks, and confectionery that are offered for sale is under the jurisdiction of a local board of health, and the details of the supervision are within the scope of the activities of health officers and public health nurses. The word "food" is used in the general sense to include drinks, confectionery, and other substances which are ordinarily taken into the stomach.

The conditions which may affect the wholesomeness of food may be considered under four headings: 1, the state of the food itself; 2, the methods of preserving the food; 3, the health of persons who handle the food; and 4, the sanitation of the places in which foods and drinks are sold.

The conditions of food itself which may affect health are (1) its purity or freedom from adulteration, (2) its state of freshness or decomposition, and (3) the presence of poisons or disease germs.

Adulteration.—If a food has a composition different from that which it is purported to have, it is called an adulterated or sophisticated food. The conditions which are considered to be adulterations or sophistications are set forth in the Federal Food and Drugs Act of June 30, 1906, and are as follows:

1. Foods containing substances which are added in order to reduce their quality or strength, as, for example, watered milk.

2. Foods in which cheap substances are substituted for more expensive articles, as, for example, cottonseed oil for olive oil.

3. The meat of diseased animals, or foods containing filthy, decomposed, or putrid substances or products, as, for example,

oysters contaminated with sewage, and eggs on the verge of decay.

4. Foods from which any valuable constituents have been removed, as, for example, skimmed milk. But the sale of such foods is permitted provided their actual nature or composition is stated on the labels or is told to the buyers.

5. Foods colored or otherwise treated in order to disguise damage or inferiority, as, for example, old meat colored red to resemble fresh meat.

The principal ground on which adulterations are condemned is that of fraud. A health department has no jurisdiction over adulterations on the ground of fraud alone, unless it is specifically authorized by law to act; but it may properly take action when the adulterations have an effect on public health.

Freshness.—Many foods readily undergo changes in their physical state which render them undesirable as food without directly affecting their wholesomeness. Examples of loss of freshness are the wilting of vegetables, the softening of hard crackers during moist weather, and the lumpiness of old cornmeal due to the action of the oil of the corn. A department of health has little or nothing to do with this group of foods.

Decomposition.—The word "freshness" is also applied to the chemical state of food. A chemical change in food is usually called decomposition, and is nearly always caused by the growth of micro-organisms in the food. Decomposition is not necessarily a harmful process, and it is often applied in the manufacture of foods. Butter, cheese, and other dairy products are made with the aid of bacteria; bread is made light by the growth of yeast plants; sour bread is made by the action of yeast and bacteria; sauer kraut and pickles are products of bacterial action; and meat is improved in texture and flavor by the bacterial growth which takes place while it is hung in a cool room for a few days.

The processes of decomposition in foods may be divided into two main groups: 1, fermentation, or the change of sugars and starches to acids and gases, such as lactic acid in milk; and 2, putrefaction, or the change of proteins to alkaline products, many of which are offensive to the senses and poisonous. The products of the fermentation of sugars and starches are seldom harmful in themselves, but they are often associated with products of the putrefaction of proteins. When souring takes place in a food in which the production of acids is not a normal process, it may properly be considered to be an indication of unwholesomeness.

The ordinary decomposition or putrefaction of proteins gives rise to a class of poisonous products called ptomains. The usual symptoms of poisoning by the ptomains of decomposed food are abdominal pain, vomiting, diarrhea, fever, and weakness, and develop within a few hours or a day after the food has been eaten. The products of ordinary decomposition are not usually poisonous when their offensive odors and tastes first begin to be apparent, or when the process of decomposition is far advanced toward the final end-products. They are more frequently poisonous during the intermediate stages of decomposition, but their offensiveness is then so apparent that one instinctively shuns the food. A trace of the peculiar odors and tastes which are associated with putrefaction may be considered to be danger signs of approaching unwholesomeness, and a food in which they are present may properly be condemned.

Specific Bacteria of Food Poisoning.—The severe forms of food poisoning are usually caused by specific bacteria which are not usually present in and around food, but which are transmitted by the contact of one parcel of food with another, or with a diseased person or animal. Food containing these organisms may be considered to be infected in the same sense that a culture-tube is infected when it is inoculated with diphtheria bacilli; or that a person with typhoid fever is infected with typhoid bacilli.

The specific bacteria of food poisoning belong to the paratyphoid group, and consist of many varieties, some of which are peculiar to human beings only, while others are peculiar to cattle, or to pigs, rats, mice, or other lower animals. Two characteristics which are common to all varieties of the bacteria are (1) the production of toxins and (2) the ability to grow in meat and other foods. The symptoms of poisoning in man may be caused either by the toxins that developed in the food before it was eaten, or by the growth of the bacteria themselves after they have been introduced into the human body. The bacteria may be present in an animal that was sick before it was killed, or they may be introduced into meat or other food by a human carrier or by contact with infected meat, or the infected dirt of slaughter houses or butcher shops. The bacteria which are peculiar to lower animals seldom grow in human beings, but their toxins may produce the abdominal symptoms of food poisoning. The bacteria which are peculiar to mankind produce paratyphoid fever when they are introduced into the human body. (See page 263.)

The bacteria of food poisoning are usually associated with putrefactive organisms which are present almost everywhere; but the substances produced by the specific bacteria are not usually unpleasant to the senses, and they may be present in dangerous amounts while the food is apparently fresh and in good condition. Most foods of animal origin are likely to become infected or to undergo natural decomposition much more readily than those of vegetable origin. The following is a list of the ordinary classes of foods arranged in the order of their liability to become infected or decomposed:

1. Milk.
2. Crustaceans (lobsters, crabs, etc.).
3. Shell-fish (oysters, clams, etc.).
4. Fish.
5. Meat.
6. Fruit.
7. Vegetables.
8. Cereals.

Investigation of Food Poisoning.—Since food poisoning often has the nature of an infectious disease, the investigation of cases is a duty of a department of health. It may be suspected when its symptoms suddenly occur in a group of persons who have used a particular article of food or have eaten together. The sanitary code of New York State requires that the existence of a group of cases shall be reported to the health officer and also to the state commissioner of health (Chapter 2, Regulation 41). When cases are reported, the procedures that a health officer is to take are as follows:

1. Search for a common article of food that has been used by all the affected persons.

2. Obtain a sample of the food, place it on ice, and send it to a laboratory for a bacteriologic examination and a determination of the type of its organism, if any be present.

3. Search for the primary source of the infection, which will probably be either a human carrier, or an unclean shop or store, or ice-box, or the carcass of a diseased animal.

4. Take the necessary steps for the control of the carrier, or the disinfection of the infected places, or the destruction of the diseased meat.

Sausage Poisoning.—A special form of food poisoning is that known as botulismus, or sausage poisoning. It is caused by the Bacillus botulismus. The bacilli do not grow in the living body, but grow readily upon many kinds of foods, especially the ground meat of which sausage is made, for the grinding will distribute the bacilli from a small focus through the whole mass. The bacteria produce a toxin which is extremely poisonous when it is taken into the stomach, but it is destroyed by the heat of cooking. The sources of the bacilli are unclean and infected shops and utensils. The disease may be prevented by cleanliness in food handling and by thoroughly cooking the food. While it is a rare disease, the possibility of its occurrence is an argument for the sanitary control of places for the sale of foods.

Preserving Agents.—The decomposition of food may be prevented to a great extent by the use of chemical preservatives. These substances are antiseptic, and often have a poisonous action upon the human body. Their use constitutes a form of adulteration which is forbidden by the Federal Pure Food and Drugs Act (page 372).

The feeding of civilized people could not be done according to modern standards unless large amounts of perishable food which are produced in seasons and places of plenty are preserved and transported for use in seasons and places of scarcity. The efficient methods of preserving food in a wholesome state are: 1, drying; 2, canning; 3, salting; 4, pickling; 5, smoking, and 6, cold storage.

The wholesomeness of preserved foods depends principally upon four factors, as follows:

1. Their conditions when they are preserved.
2. The cleanliness and care with which they were handled during their preparation.
3. The method of their storage.
4. The period of time during which they are kept.

The processes of preservation may conceal the true nature of foods to a great extent, and give many opportunities for fraud. There is a great temptation to preserve food of an inferior quality and that which is about to spoil, and to keep the preserved products for long periods of time until a profitable sale can be made. But if the preserving is done honestly, the products will be as wholesome as the fresh foods.

Cold Storage.—The process by which foods are preserved in their most natural condition is that of cold storage. The business is highly specialized, and each section of a warehouse is fitted for a single class of food. The temperatures vary from a few degrees above freezing, for fruit and eggs, to 10° F. or lower for meat and fish. The periods of time during which foods will keep fresh and wholesome are known with considerable accuracy. Some kinds of bacteria and molds will grow at temperatures below freezing, and some evaporation of water continually goes on. A year is about the limit of time during which the freshness and wholesomeness of cold storage food can be guaranteed.

When foods that have been properly preserved in cold storage are removed for sale, they are in the same state that they were when they were put in storage. Food about to decompose will quickly decay after it it removed from the warehouse, and food that is infected will remain infected. But food which is fresh and of good quality when it is put in cold storage will remain fresh and wholesome while it is in storage, and will keep fresh for a reasonable length of time after it is removed. The people of cities could not be fed without cold storage.

Canned goods are usually sold in tin containers. A can is sealed while hot, and on cooling a vacuum is formed and the ends of the can are forced inward by the pressure of the air. When fermentation or decomposition occurs, gas forms and relieves the vacuum or makes pressure within the can. The test for the freshness of foods in sealed tins is the degree of vacuum or pressure within the cans. An inspector divides abnormal cans into four classes: 1, swellers; 2, springers; 3, flippers; and 4, leakers.

An inspector will first notice the ends of a can. If they are convex, gas is present under pressure, and the can is a sweller and is to be condemned.

The inspector will press upon the end of a can. If the opposite end bulges out with a snap, the can is a springer and its contents have undergone some degree of fermentation or decomposition.

The inspector will strike the end of a can flat upon a table. If there is a small amount of gas in the can, the blow will cause the bottom of the can to bulge out and remain convex. If the convex end is pressed, it will spring back with a snap. A can that reacts to this test is a flipper and its contents are in the beginning stage of fermentation, although they may not necessarily be harmful to health.

A can that is evidently leaking is always to be condemned.

A health officer or housewife can readily apply these tests in detecting canned foods which are presumably unfit for food.

Disease Germs in Food.—Foods may transmit diseases to man by means of disease germs which either were in an animal before its slaughter or were introduced into the food.

Most diseases of lower animals do not affect man, but a few may be transmitted to human beings, among them being anthrax, glanders, vaccinia, rabies, tetanus, foot-and-mouth disease, trichinosis, tapeworm, and tuberculosis. Paratyphoid fever in cattle is of importance because of its relation to food poisoning. The principal animal diseases which have a relation to human food are trichinosis (page 311), tapeworm (page 309), and tuberculosis.

Tuberculosis is common among cattle and pigs. It may be detected by an inspection of the carcass and internal organs of the slaughtered animals. The signs of the disease are enlarged lymph-glands, tubercles, and abscesses. The enlarged glands are usually seen in the neck and around the lungs and the intestine. Tubercles are white bodies like pin-heads scattered through the affected tissues, especially of the lungs. Abscesses are the result of a breaking down of the glands and tubercles.

Meat Inspection.—The inspection of meat at slaughter houses by trained inspectors is a necessary measure for the protection of public health. The departments of health of the larger cities require that animals to be used as food shall be slaughtered at licensed slaughter houses in the presence of trained inspectors, but in rural districts animals intended for local consumption are often slaughtered without an inspection of the meat or of the houses.

An inspection is made of the living animals and also of their carcasses and internal organs. Living animals are condemned when they are evidently diseased or show signs of sickness. When a slaughtered animal shows signs of disease, its body and internal organs are laid aside and examined in detail later. If the disease is localized, the affected parts are removed, and the remainder of the carcass is usually allowed to be sold. There seems to be no sanitary reason for condemning any healthy edible part of an animal, since a thorough cooking will prevent the transmission of disease by the meat.

Food Infection.—The infection of foods with the bacteria of human diseases is of special importance when the foods are to be eaten raw. There are three principal sources of infection: 1, sewage; 2, contaminated water; and 3, human carriers. The foods which are most likely to become infected are shell-fish and green vegetables.

Oyster Infection.—The most prolific oyster and clam grounds are located in shallow bays and estuaries where the water is likely to receive sewage from houses and villages. These waters nearly always contain colon bacilli which are derived from the banks of rivers and creeks which flow into them. Oysters feed by extracting bacteria and other microscopic plants from the water which passes over their gills. The kinds of bacteria that are in the water will usually be found in the liquor which surrounds an oyster in the shell. Colon bacilli are nearly always found in this liquor, and the presence of a few is not considered to be abnormal or to indicate contamination.

A few outbreaks of typhoid fever have been caused by eating raw oysters and other shell-fish taken near the mouths of sewers or in water that is heavily contaminated with sewage. The likelihood of the infection of oysters with typhoid bacilli is in direct proportion to the contamination of the water with colon bacilli. The principal cause of the infection with typhoid bacilli has been the practice of placing oysters in the mouths of fresh-water creeks which often contain sewage. This was done in order to make them appear plump because of the entrance of fresh water into the salt flesh of the oyster by the process of osmosis; but the practice is no longer legal, for the plumping simply dilates the flesh with water, and it may produce contamination of the oyster.

While the temperature of the water is below 40° F., oysters keep their shells closed and remain in a state of hibernation. During this period they soon digest the bacteria that lie within their shells, and remain sterile until the temperature of the water rises above 40° F. Since oysters are usually on the market during the cold months only, their hibernation is a great protection against infection.

The sanitary standard of oysters is based on the presence of colon bacilli in various amounts of their liquor. Five oysters are chosen from a lot, and three cultures are made from each. One c.c. of the liquor is taken for the first culture, $\frac{1}{10}$ c.c. for the second, and $\frac{1}{100}$ c.c. for the third. If colon bacilli are found in the $\frac{1}{100}$ c.c. sample, the score of the oyster is 100. If they are found in the $\frac{1}{10}$ c.c. and not in the $\frac{1}{100}$ c.c., the score is 10; and if in the 1 c.c. only, the score is 1. Allowance is made for the chance that colon bacilli might be found in a $\frac{1}{100}$ c.c. sample when there are only one or two present in each cubic centimeter of the liquor. A maximum total score of 50 is allowed for the five oysters. This practically means that oysters are considered wholesome when colon bacilli are found in each $\frac{1}{10}$ c.c. of their liquor if they are not found frequently in $\frac{1}{100}$ c.c. samples.

Cooking is an efficient preventive of infection from eating contaminated oysters.

Vegetables which are eaten raw may become infected with typhoid bacilli when they are fertilized with sewage or human excretions, or are washed in contaminated water, or handled by a carrier.

Infection from Food Handling.—Persons who are afflicted with communicable diseases, or are carriers of disease germs, may introduce disease germs into foods which they handle. Foods may be divided into three classes according to their likelihood to transmit infection from those who handle them to those who eat them:

1. Foods which are to be cooked before they are eaten are not likely to transmit infection.
2. Foods which are to be eaten raw are possible sources of

infection, but are not likely to be dangerous provided they are properly cleansed.

3. Foods in kitchens and those which are ready to be served at table are likely to transmit infection from infected cooks, waiters, and clerks. Soups, meat broths, stews, and boiled potatoes are similar to the culture-media used in laboratories, and when they are infected, bacteria of disease may grow in them readily. Lunch counters, restaurants, delicatessen stores, and other places in which food is sold ready to be eaten spread diseases far more readily than butcher shops, groceries, and similar food stores in which most of the foods sold are cooked or cleansed before they are eaten.

Fig. 36.—The back door of a restaurant that needs a visit from the health officer.

The principal diseases which are transmitted by means of foods are those of the intestine, especially typhoid fever. Cooks have been known who have been spreaders of typhoid fever for years, and have produced cases in nearly every place in which they work. These carriers may be detected by modern methods of laboratory examinations of their excretions.

Diseases of the throat and respiratory organs may also be transmitted by means of foods which are handled by infected persons or carriers. The best known examples of diseases which are food-borne are septic sore throat, diphtheria, and scarlet fever by means of milk; but any other cooked food may also transmit the diseases.

Prevention.—The prevention of food infection and of food-borne diseases consists in:

1. The education of the public.
2. The inspection of places in which food is prepared and sold.

Public education regarding food-borne diseases may be conducted along two general lines:

1. Instruction regarding the preparation of foods so as to destroy whatever infection that may be in them.
2. Arousing the public to demand cleanliness and sanitary methods of handling foods in places in which foods are sold. Financial loss from lack of trade is an effective means of influencing food dealers to adopt sanitary methods of food handling.

Food Inspection.—An ideal system of food inspection will embrace every stage of the production of a food from the crude article to its delivery to the consumer. The most practical system for an ordinary board of health to adopt is that of inspecting foods when they are ready for delivery to the customers. The inspections will include restaurants, lunch counters, ice-cream parlors, soda-water fountains, oyster houses, candy shops, delicatessen stores, and other places in which foods, drinks, or confectionery are sold.

Inspector's Score Card.—An outline of the items to be noticed during an inspection is contained in a score card, called the United States Standard Score Card, a copy of which is found on page 381. The card was designed for the use of the officers of the United States Public Health Service, and is similar to that used in inspecting dairies. The figures on the score card may be criticized on the ground of the impossibility of assigning fixed values to conditions which are variable; but the items constitute a standard guide for the inspection of any place in which foods, drinks, or confectionery are sold. An inspector is also to note the surroundings of an eating or drinking establishment, and to condemn those which are located near a stable or open cesspool, or privy, or other gross source of infection.

Examination of Food Handlers.—It is important that no person who is afflicted with a communicable disease, or is a carrier, be allowed to work as a cook or kitchen helper, or waiter, or to serve foods, drinks, or confectionery. While carriers are few in number, yet the danger from them is so great that extensive investigations for their detection and exclusion from eating houses are justifiable. Those who are grossly affected, or have open lesions, may be discovered by a physical examination; and

Sanitary Inspection of Places Where Foods are Prepared for Sale or Sold

Owner or Manager …

Trade Name …

Street and No. …

Registration No. … **Date of Inspection** …

Equipment	Score: Perfect	Score: Allowed	Methods	Score: Perfect	Score: Allowed
Plant			Plant		
Construction 10			Cleanliness 20		
Floors and Drainage..	7	....	Floors	5	....
Walls..............	2	....	Walls..............	3	....
Ceilings..............	1	....	Ceilings	1	....
Arrangement............7			Doors	1	....
Proper Rooms..........	4	....	Windows	1	....
Convenience	3	....	Good Order..........	1	....
Light	5	....	Free from Odor	2	....
Ventilation	5	....	Freedom from Flies...	6	....
Screens..............	5	....	Equipment (Cleanliness).. 30		
Cellar..............	3	....	Ice Boxes	10	....
Plumbing..............20			Tables..............	5	....
(Kind, quality, location and condition)			Sinks	5	....
Water Closets	10	....	Utensils	10	....
Sinks..............	10	....	Employees' Cleanliness.	5	....
Equipment............*25			Foods.............. 30		
(Kind, quality, arrangement)			Conditions	10	....
			Storage	10	....
Ice Boxes	15	....	Handling	5	....
Tables..............	5	....	Cleanliness	5	....
Utensils	5	....	Garbage Receptacles..15		
Water for Cleaning......20			Adequate..........	5	....
Hot..............	15	....	Location..........	5	....
Cold	5	....	Condition..........	5	....
	100			100	
Additional Deductions for Exceptionally Bad Conditions.			Additional Deductions for Exceptionally Bad Conditions.		
....		....	....		....
....		....	....		....
....		....	....		....
Total Deductions		....	Total Deductions		....
Net Total			Net Total		

Score for equipment … multiplied by 1 …

Score for methods … multiplied by 2 …

Total to be divided by 3…

Final Score …

REMARKS. (To cover such unusual conditions as sleeping accommodations, or the presence of domestic animals in or about work room, etc.)

…

…

… Inspector

Fig. 37.—The United States Standard Score Card.

those who are carriers may be detected by a bacteriologic examination of their excretions. Boards of health are beginning to require a medical examination and certificate of freedom from communicable diseases from workers in restaurants; and boards in the larger cities are requiring a bacteriologic examination of their excretions.

Sterilizing Dishes.—Dishes in which foods are served to patrons and the utensils with which they are eaten are contaminated with the excretions from the hands, mouths, and noses of the customers. The only practical method of sterilizing them is by the use of boiling water. A simple method of sterilizing them is to wash them in the ordinary way in soap and hot water, and then place them in a wire basket and dip them into a large kettle of boiling water which is kept on a stove for that special purpose. Dishes which are dipped in boiling water require no

Fig. 38.—Dish-washing—a simple, efficient method of sterilizing the dishes.

wiping, and thus they escape contamination from extra handling and from soiled towels which are often used in drying them. The economy of help required more than compensates for the expense of the fire.

The glasses and dishes at soda-water fountains and ice-cream parlors are often cleansed by placing them over upright brushes through which cold water flows. These brushes cannot be kept sterilized, or even clean, and are often sources of gross contamination unless the utensils are afterward dipped in boiling water. The use of paper containers is an economic sanitary method of serving cold drinks and ice-cream.

Food Regulations.—The presence of large camps of laborers engaged in building army cantonments has aroused the civil population to the necessity of food regulations similar to those which are adopted in armies. A simple code is as follows:

No food or drink, or material for making food or drink, shall be sold unless it is kept and dispensed in clean, closed, sanitary containers, and is handled in a clean and sanitary manner.

No food or drink shall be sold or exposed for sale unless it is kept covered in such a manner that it is protected against flies and dust.

No person whose hands or clothes are in an unclean condition shall handle or dispense food or drink that is exposed for sale.

No food or drink shall be sold or exposed for sale in stores, stalls, or wagons which are in an unclean or unsanitary condition.

No food or drink shall be sold, or offered for sale, or dispensed in dishes which have been previously used, unless the said dishes shall have been adequately cleansed with boiling water.

CHAPTER XXXIV

FOOD VALUES

THE scientific principles of feeding have long been applied to domestic animals. Agricultural papers discuss the diets of cattle, and tell what foods and how much are required to produce a 150-pound calf or to support a working horse. The same principles may be applied to produce a 150-pound boy who has the natural vigor and grace of a healthy calf, or to maintain a workingman with the strength and activity of a sleek working horse. Feeding human beings is becoming an exact science, whose elementary principles are few and may be readily understood. Writings on human diets are often bare statements of advice like dogmatic rules in arithmetic without explanations of the reasoning on which the rules are founded. When the foundation principles of dieting are understood, an intelligent person can apply them in the choice of food and the manner of feeding. It is necessary that a health officer should know and understand the scientific basis of food values, for nutrition has a direct bearing on physical and mental vigor, and on immunity to diseases.

Food substances are divided into three classes:

1. Building foods.
2. Fuel foods.
3. Regulative foods, or those which have a direct influence on the process of tissue building and the utilization of fuel foods.

Building Foods.—Every kind of living matter consists of a mixture of protein, water, and minerals. These three substances compose the flesh, blood, and bone of the human body. Building foods are required for two purposes: 1, for growth, and 2, for the repair of worn-out parts.

Protein consists of carbon, hydrogen, and oxygen, together with nitrogen and sulphur. It is a complex substance, and exists in various forms in the human body. Examples of protein are lean meat and the white of an egg. The body needs about 3 ounces of protein daily.

Minerals are the ashes that are left after a substance is burned. They consist of such material as lime, soda, potash, and iron. They are found in nearly all kinds of foods, and are intimately joined to the proteins in organic combinations.

Minerals added to food cannot take the place of those which are naturally there. We usually get sufficient mineral-building material when we eat the proper amount of other substances. They also have important uses as regulative foods (page 394).

Water enters and leaves the body unchanged in its form or composition. Its quantity in the flesh or blood may vary considerably from time to time. It is a vehicle in which all other body substances are dissolved. There is only one kind of water, and little need be said about it in a discussion of food values.

Fat is also found in the body, but little or none of it consists of fat that is eaten. It is manufactured principally from protein which the body does not need for other purposes.

Fuel Foods.—The food which a grown person takes into his blood in a day would weigh about 1 pound if it were dried, and yet it disappears and the body does not gain in weight. The explanation is that it is burned, or oxidized, in the body. The second great class of foods consist of those which the body uses as fuel. The oxygen which the body uses in oxidizing its fuel food weighs about $\frac{1}{2}$ pound more than the food, excepting water.

The process of oxidation in the body has two uses: 1, to produce heat for warming the body, and 2, to produce power for doing muscular work. A person doing muscular work burns food rapidly, and becomes warm. The body is a heat engine, and is run by means of the heat of its burning food. Only one-quarter of the total amount of the heat produced by the food can be used in developing power in the body. But the body engine is twice as efficient as the best steam engine, for the steam engine can turn only about one-tenth of its heat into power.

The fuel foods are starches, sugars, and fats. They are composed of carbon, hydrogen, and oxygen, with no nitrogen or sulphur. Starches and sugars are often called carbohydrates. Nearly all the fuel foods are oxidized soon after they enter the body.

The worn-out parts of the body consist principally of protein which has been oxidized. A grown person needs protein for the purpose of replacing that part of his living flesh which has been oxidized. We may, therefore, call protein a fuel food as well as a building food.

Composition of Foods.—Foods may be divided into those derived from animals and those derived from vegetables. Animal foods are rich in protein, and so also are peas and beans. These are popularly called building foods. They usually contain considerable amounts of fat, and are, therefore, fuel foods also. No animal food, except milk, contains carbohydrates in important quantities. Cereals, potatoes, and some fruits have a large proportion of sugar or starch and are, therefore, called fuel foods. But nearly all contain some protein, and are, therefore, to be classified as building foods also. Garden vegetables and the juicy fruits contain little protein or carbohydrates, and their value for building or fuel is small. Their principal value is that they contain regulative substances which are essential to health and growth.

The value of foods for building or fuel may be estimated from tables of their chemical composition. The tables usually give the proportion of protein, carbohydrate, fat, and mineral matter in the various foods, but they afford little basis for estimating their content of regulative foods. The following table is a general summary of the composition of the various classes of foods:

ANIMAL FOOD.

	Per cent.
Protein	10 to 30
Fat	10 to 75
Sugar or starch	Practically none.

CEREALS, POTATOES, BEANS, ETC.

	Per cent.
Sugar or starch	5 to 50
Protein	2 to 20
Fat	0 to 10

FRUIT AND GARDEN VEGETABLES

	Per cent.
Sugar or starch	1 to 10
Protein	1 to 5
Fat	Practically none.

Oxidation of Food.—The oxidation of food in the body is similar to the oxidation of wood in a stove. Food unites with oxygen in the body, and becomes smoke and ashes and produces heat. The oxidation of the carbon of either protein, carbohydrates, or fats produces carbon dioxid, and the oxidation of hydrogen produces water. These are the principal substances in the smoke of a burning fire. Neither of them is harmful to the body unless it is present in excessive quantity. Each is excreted from the body by an easy and simple process.

The oxidation of the nitrogen and sulphur of protein produces an ash which has an acid reaction. A certain degree of alkalinity of the blood and tissues is necessary for health, and when it is reduced, the body suffers in health and vigor. A diet containing a large proportion of meat, or eggs, or other animal food is harmful on account of the acid ash left after the oxidation of its protein. The excretion of the acids overtaxes the liver and produces what the older physicians called biliousness;

and the acids circulating in the blood produce gout, rheumatism, and pains in the joints and muscles. The more remote effects of an excessive protein diet are kidney troubles, hard arteries, and premature old age.

The ash left by cereals and most other vegetable foods is strongly alkaline, and is beneficial to the body. Its alkalinity is due to the small proportion of protein in the foods, and also to the large proportion of alkaline minerals in them. One of the fundamental principles of dieting is to eat no more protein than is needed to replace the worn-out protein of the living flesh. This may usually be accomplished by eating sparingly of meat and other animal foods, and using cereals and vegetables in their place. Milk and milk products are exceptions to this rule, for they contain protein and alkaline minerals in a proper combination for health.

We recognize two types of men in the relation of their food to oxidation. A stout man has a large stomach and fuel capacity, and small lungs and oxidizing ability. His stomach can supply fuel faster than his lungs can furnish oxygen to oxidize it. He will be likely to be short of breath and asthmatic, and to have trouble with his liver, kidneys, and arteries. He will probably be benefited by living on coarse, unnutritious food. His stomach can usually extract sufficient nutritive matter from coarse foods, such as spinach, turnips, and cabbage. If he lives on such foods as these, he may safely satisfy his hunger and appetite without exceeding his oxidizing capacity.

A lean athlete has large lungs and a small stomach. His digestive power is small and is constantly overtaxed in supplying sufficient food to replace that which is oxidized by the large lungs. This man will thrive on a concentrated diet. He can take an excess of protein with little harm, for he can oxidize it well. His worst troubles are likely to be indigestion and dyspepsia.

The relation of the stomach to the lungs will explain many of the contradictory observations about dieting. The lungs and the oxidizing capacity of the body must always be considered in discussing a person's food.

Caloric Value.—One standard of the value of various foods is the proportion of protein in them; another is their mineral composition; and another is their content of regulative substances; but the standard of the broadest application is their fuel value. The heating capacity of foods is the standard of their value which is usually given in tables of food composition. About nine-tenths of the subject of dieting concerns the fuel value of foods. The body must oxidize a certain amount of fuel food in order to do a given amount of work. These quantities have been determined by observing men who live for days in a closed chamber which is provided with means for analyzing the air, the food, and the excretions, and for measuring the quantity of heat that the man produces and the amount of physical work which he performs. The results may be applied accurately in providing food for armies, exploring expeditions, and institutions. They also give accurate results in feeding individuals.

The fuel value of a food is found by burning a weighed quantity of dried food in a piece of apparatus called a calorimeter. The case containing the food is surrounded by water. When

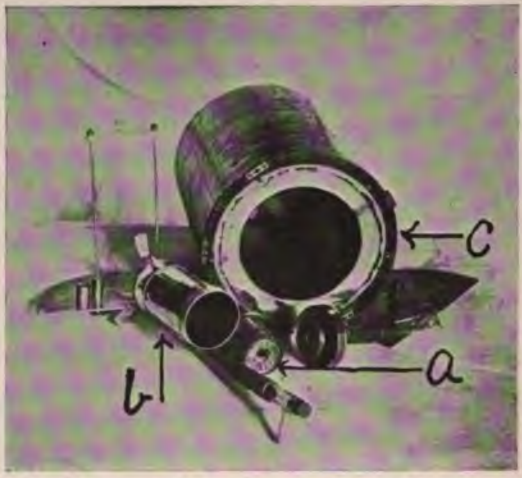

Fig. 39.—A simple form of calorimeter: *a*, Inner cell in which food is burned; *b*, cylinder in which *a* is enclosed; *c*, water container in which *a* and *b* are immersed. The number of calories is estimated by the change in temperature of the water.

the amount of food, the quantity of water, and the increase in the temperature of the water are known, the amount of heat produced by a unit of weight of food may be easily calculated.

Quantities of heat are measured in calories. One calorie is the amount of heat that will raise 1 kilogram of water 1° C. This is nearly the amount that will raise 1 pint of water 1° F.; 100 calories will raise a quart of ice-cold water nearly to the boiling-point; 2500 calories will raise 75 quarts of water, which is nearly the volume of the body, from a freezing temperature to that of the normal body. A person doing light work needs to produce about 2500 calories daily, and one at heavy work, 3500 or 4000 calories.

The adult human body produces heat at about the same rate as two burning candles of tallow or paraffin. An ordinary candle weighs 1 ounce, will burn four hours, and will produce 240 calories of heat. Two candles burning continuously for twenty-four hours will, therefore, produce 2880 calories of heat.

Balanced Diet.—The body is designed to oxidize food elements in certain proportions. The protein which it is designed to oxidize is that which forms a part of the living flesh of the muscles. Protein is a poor fuel food, and is oxidized with difficulty. It is also much more expensive than the proper fuel foods—starch, sugar, and fat.

Fat enters the blood-stream just as the blood is approaching the lungs. Most of the fat is probably oxidized in the lungs. Starch and sugar enter the blood-stream in the intestine, and are carried to the liver. The best health is maintained when oxidation in the muscles, the lungs, and the liver is maintained in the proper balance. A diet containing protein, fat, and carbohydrate in the proper proportions is called a balanced diet. A standard proportion is that one-sixth of the calories shall come from protein, two-sixths from fat, and three-sixths from carbohydrate.

The effects of an unbalanced diet may be illustrated by candy eating. When an excess of sugar is eaten, oxygen will combine with it more readily than with protein. The protein will then be imperfectly oxidized, and will harm the body in the same manner that an excess of protein in the diet would. The rapid oxidation of alcohol in the body, and its effect in robbing the protein of oxygen, account for many of the evil effects of strong drink.

The subject of balanced diet is also concerned with the regulative substances that are found in foods (page 394).

The body has an immediate and frequent need for fuel food. It can go only a few hours without requiring a new supply of fuel; but it can go a few days without sufficient building food; and it can go for possibly a month without regulative foods. Fuel foods are used up rapidly and a new supply is normally required three times a day. Protein for building is used only one-sixth as rapidly as fuel food; and regulative foods are used still more slowly. The subject of the caloric value of foods is fundamental, and must receive first consideration in the estimation of the value of every diet. A dietitian must think in terms of calories, and deal with figures which are fairly accurate and uniform.

Calories in Food.—One ounce of protein, or starch, or sugar will produce 120 calories of heat; and 1 ounce of fat will produce 240 calories. If we know the composition of a food, we may easily calculate how many calories it will produce. For example, how many calories will a pound loaf of bread produce?

The composition of bread is approximately 50 per cent. carbohydrate and 10 per cent. protein.

16 oz. × 0.50 = 8 oz. carbohydrate; × 120 = 960 calories.
16 oz. × 0.10 = 1.6 oz. protein; × 120 = 192 calories.
960 + 192 = 1152 calories.

The 100 Calory Standard.—The greater part of the study of dieting consists in becoming familiar with the number of

Fig. 40.—Number of calories in a simple breakfast.

calories that are produced by various dishes as served at table. The subject is much simplified by the possibility of adopting a simple rule of almost universal application. This rule is as follows:

A rather small portion of food as ordinarily served at table will contain about 100 calories.

This rule is broad and general, but is a standard from which to begin the estimation of the value of any particular food, and the results of its application are found to be fairly accurate in actual practice. The following amounts of various foods each contain about 100 calories:

Bread—a rather thick slice.
A biscuit or bun.
Flour—a heaping tablespoonful.
Four Uneeda Biscuits.
Three graham crackers.
A shredded wheat biscuit.
Two or three pancakes.
Two lady fingers.
One large cooky.
A small helping of layer cake.
One-sixth or one-twelfth of a pie.
A potato of ordinary size.
A small sweet potato.
Beans, boiled or baked, one or two tablespoonfuls.
Oatmeal, cornmeal, hominy, rice, macaroni, farina, as ordinarily cooked, three or four tablespoonfuls.
A small lamb chop.
A small helping of bacon, beefsteak, pork, or chicken.
A small codfish steak.
An ordinary glass of milk.
Cream, 3 tablespoonfuls.
Butter, an ordinary helping.
Olive oil, one tablespoonful.
One large egg.
Sugar, 2 or 3 heaping teaspoonfuls, or 4 cubes.
Maple syrup, 1 or 2 tablespoonfuls.
One large apple.
Apple sauce, 2 tablespoonfuls.
Six cooked prunes with their juice.
A large fig.
Three peaches.
A banana.
A small bunch of grapes.
Three large dates.
An ear of green corn.
Thick vegetable soup (purée)—one plateful.
Ordinary soups and broths—2 or 3 quarts.

The garden vegetables, such as tomatoes, string beans, tur-ps, cabbage, and carrots, and those used as salads, have very tle value as fuel or as building foods. They will be discussed der regulative foods.

Fat has twice the caloric value of protein or carbohydrates. ything containing a large proportion of fat will, therefore, luce a large amount of heat. What are popularly called foods usually contain much fat.

The caloric value of a food will depend also upon the concentration of the oxidizable elements. Most pies and cakes have a high caloric value on account of their richness in fat and sugar. Desserts are usually eaten after a full meal of other foods, and the result often is that an excessive amount of fuel food is taken, and the oxidizing capacity of the body is exceeded.

Candy, ice-cream, soda water, and the more solid fruits are foods. They are often eaten between meals under the impression that they have no effect on nutrition. They usually have a considerable caloric value, and when they are eaten between meals, the calories which they produce are to be added to those of the regular meals.

Milk is also to be considered as a food rather than a drink. A pint will produce over 300 calories, and 8 pints or 4 quarts a day will supply all the food needed by a person doing light work. A glass or two of milk at the end of a meal or between meals supplies a considerable amount of fuel food which must be oxidized.

Tea, coffee, and cocoa in themselves have little or no food value, but when the drinks are prepared with milk and sugar, each cupful will supply about 100 calories.

If we know the caloric value of the various typical foods, we can readily arrange a bill of fare to supply the required number of calories. Since the daily requirement for a person at light work is 2400 calories, each meal must supply about 800 calories. There are two methods of ordering a meal which shall contain the required number of calories. The first is to look over a list of foods and their calories, and choose a sufficient amount to produce 800 calories. This method involves a considerable amount of skill in figuring and planning, and the results are not satisfactory unless one is an expert. Eating by rule is usually irksome, and does not work well in practice. The second method is to choose a meal according to our desires, just as folks did before calories were known. We can then reckon the number of calories in a meal and increase or diminish the quantity of certain dishes as is necessary.

Utilization of Foods.—The utilization of foods which are eaten consists of two processes: 1, digestion, or the preparation of foods for their entrance into the blood-stream; and 2, assimilation, or the uses to which they are put by the living tissues throughout the body.

Human foods are second-hand materials which have previously formed a part of the body of a lower animal or of the substance of a plant. Proteins, carbohydrates, and fats are complex substances, and are composed of simpler elements which may be compared to the bricks and boards of which a house is made. Foods as eaten are in the condition of a house which is to be torn down in order that its simple materials may be recovered. The object of digestion is to tear the elements apart and reduce them to a condition resembling that of the individual bricks and boards of a wrecked building. Only the simple elements can pass through the lining of the intestine and enter the blood-stream.

The assimilation of food after it has entered the blood consists either in the oxidation of the simple food elements or in rebuilding the protein elements into new combinations in the tissues of the body.

The digestion of a carbohydrate consists of its reduction to a simple form called maltose. Carbohydrates are divided into three groups of substances: 1, the celluloses; 2, the starches; and 3, the sugars. Cellulose is the fibrous parts of a plant, such as cotton and wood. Man cannot digest cellulose, although cattle may do so. Man digests starch imperfectly when it is raw, but he digests it readily when it is well cooked and the cellulose wrappings of its grains are burst. The valuable portion of a food is that only which is utilized by the body. The proportion of cellulose, and the method of preparing or cooking a food, must be considered in judging the value of a food of plant origin.

Fat of vegetable origin is not digested in the body so readily and well as that of animal origin. A large proportion of olive oil and other kinds of vegetable oils passes through the whole length of the intestine unchanged when considerable amounts are fed. This effect may often be desirable, but the vegetable oils are to be considered medicines rather than foods. The principal source of fat must be food of animal origin.

Utilization of Building Foods.—The digestion of a protein consists principally in its reduction to amino-acids; and its assimilation consists in building the amino-acids into the proteins which exist in the body. About eighteen kinds of amino-acids are required to maintain the body in health. The protein of each kind of food is composed of particular amino-acids. If there are more of any kind than the body needs, the excess will be wasted, and their presence in the blood or intestine may be a source of trouble. What is called indigestion is often due to an excess of unused products of digestion, and may be remedied by a proper combination of food which will supply the various amino-acids without an excess or deficiency of any.

If there is a deficiency of any kind of amino-acid, the nutrition of the body will suffer. If there is a lack of a single element that is normally present in the body, growth and repair will cease, just as the lack of a certain kind of nails may prevent the erection of a building. If a diet is deficient in an amino-acid, the addition of that acid may enable growth and repair to proceed at a rapid rate. New discoveries regarding specific protein deficiency are constantly being made as the result of experiments in feeding domestic animals. They shed light on the causation of rickets, scurvy, and the malnutrition of infants fed on condensed milk and patent foods.

A great problem in feeding is to choose such a combination of foods that the quantity of the various amino-acids will exactly meet the needs of the body. Two broad principles underlying the choice are now recognized.

1. About one-fifth of the protein of food must be of animal origin. It may be meat, or milk, or dairy products, or eggs, or fish, or shell-fish, or any other kind of animal food.

2. A variety of food is necessary in order to insure a supply of all the various amino-acids that are needed. There need not be a variety at each meal, or even each day, for there are great reasons for having only two or three dishes at a meal; but a monotonous diet of a very few things can seldom be kept up for many weeks at a time without impairment of growth and nutrition. A variety is especially desirable for those children who from choice or force eat only one or two articles of food.

Regulative Foods.—The regulative food elements are those which supply little or no material for fuel or building, and yet are absolutely necessary for growth and repair, and for maintaining the body in health and vigor. They consist of mineral salts and vitamins. The bulk, or volume, of a food, and its taste are also elements which have a regulative effect on the nutrition of the body.

Inorganic Mineral Salts.—The inorganic salts are the substances which are left as ashes when a food is burned. They have at least three important uses: 1, they maintain the alkalinity of the blood (page 387); 2, they supply building material for all the tissues, particularly the bones and teeth; and 3, their presence is necessary for the action of the heart and for nerve activity. A deficiency of foods containing the salts is an element in the cause of scurvy.

The mineral salts must be in the form of their natural combinations with other food elements. If a food is deficient in them, the addition of the ashes of a food will not supply the body with the missing elements. Some are found in nearly all natural foods, but they are present in the proper forms and proportion in milk. They are also especially abundant in juicy fruits, leafy vegetables, and salads. Some of these articles of diet are necessary in order to supply an abundance of inorganic salts. There seems to be no danger in taking foods containing an excess of the salts.

Vitamins.—The vitamins have become known chiefly from feeding experiments on animals. They exist in only minute quantities in any food. Their chemical composition seems to be similar to that of a protein. Their presence cannot be detected by a chemical analysis, and they are known only by their effects. If a diet that is perfect except that it has no vitamins is fed to young animals, the animals do not grow, but if the vitamins are added, growth becomes normal at once.

If an adult animal is fed on a diet free from vitamins, it slowly becomes weak and diseased, and finally dies.

There are two vitamins—one, called A, is soluble in fats, and the other, called B, is soluble in water.

The fat-soluble vitamin, A, is abundant in milk, butter, and cheese; in the yolks of eggs; in livers and kidneys; and in the leafy vegetables, greens, and salads. It is less abundant in muscular tissue or lean meat. Its quantity is deficient in cereals and potatoes. It is almost absent in peas and beans, and is entirely absent in lard, tallow, and the vegetable fats. The effects of its absence from the diet of lower animals are a cessation of growth, progressive weakness, and death. A growing child needs milk, butter, and eggs in order to obtain an abundance of this vitamin. The good effects of cod-liver oil upon poorly nourished children is probably due to its content of fat-soluble vitamin, but cod-liver oil is no better than butter in that respect. Children who are poorly nourished are greatly benefitted by fresh milk and eggs on account of their content of the fat-soluble vitamin. A lesser proportion of this vitamin is required by adults than by children; but adults require an extra amount after a wasting illness in order to stimulate the production of lost tissue.

Alfalfa contains the fat-soluble vitamin in large proportions, and on this account it has a high value in promoting the growth of domestic animals. Alfalfa flour also has a considerable proportion of protein and carbohydrates, and can be readily digested by human beings. Almost the only hindrance to its use in bread is its bitter taste. The development of a variety of alfalfa that is palatable to human beings would be a great achievement in human feeding.

The water-soluble vitamin, B, is widely distributed through most common foods, but it is deficient in some. It is abundant in seeds and cereals, but it is unevenly distributed through each individual kernel. It is absent from the interior of a kernel.

but is concentrated in the layer just beneath the outer husk. The rice and hominy which is commonly sold in stores is what is called polished, meaning that the husk and outer layer of each kernel has been removed by friction. When polished rice is the principal article of diet, those who eat it are subject to a fatal form of neuritis called beriberi, but if a patient eats the whole kernels, or drinks the water in which the whole kernels have been soaked, he quickly recovers.

The concentration of the water-soluble vitamin on the outer layers of grain kernels is one of the principal arguments for the use of unpolished rice and hominy, and of flour made from whole wheat. Another argument for the use of the whole grain is that protein and mineral salts are also more abundant in the outer layers than in the interior of the kernel. There is not a great difference in composition between whole wheat flour and the white flour made from the interior portion of the wheat grains. The difference can scarcely be noticed when a varied diet is eaten, but the deficiency in the vitamin may lead to poor nutrition when white bread is the principal article of diet.

Neither of the vitamins are affected by ordinary cooking. Boiled greens and cooked dairy products will supply them in as good form as raw salads and fresh milk.

Bulky Foods.—Foods that contain considerable indigestible matter have two important uses. In the first place they assist the process of digestion by distending the intestine and helping the flow of food along the digestive tube. A cow needs coarse food, such as hay and straw, for its digestive tube is large and its intestinal muscles require a considerable amount of substance on which to act. A dog has a small intestine that is adapted to a diet of meat and other concentrated foods. The plan of the intestine of man is intermediate between that of the cow and of the dog. Man requires some bulky food which is supplied by such foods as fruit, the green garden vegetables, and the coarse coverings of the kernels of grain.

A second use of bulky foods is to satisfy the appetite without exceeding the oxidizing capacity of the body. The feeling of hunger is satisfied when the stomach is filled with tasty food. A stout person will thrive on coarse food which satisfies hunger without supplying an excess of fuel or building food.

Taste and Enjoyment of Food.—The pleasant taste of food is important in promoting its digestion and assimilation. When a food is put into the stomach without the person's knowledge, the digestive juices do not flow, and the muscles of the digestive tract are slow in their actions; but the sight or smell of pleasant food causes the digestive juices to flow and the muscles to act even when the stomach is empty. We need such tasty foods as juicy fruits, turnips, cabbage, and cheese in order to promote digestion.

Racial habits of eating and individual preferences must be considered in dieting.

The body demands a variety of food in order to obtain all the necessary food elements, especially the vitamins; but the variety need not be great at each individual meal. There may even be a grave objection to having a variety at every meal. A person eating a dinner of many courses satisfies several appetities. If he eats hearty soup, and a fish course with bread, he obtains about all the protein and fuel food that he needs. His appetite for soup, fish, and bread is satisfied, and he desires no more of them at that meal. This satisfaction of his appetite is a sign that the need of his body for fuel and building food is satisfied. But when he sees the meat course, the chicken, and finally the dessert, he has a new appetite for each; and if he takes them, he satisfies a number of appetites, and eats too much of all kinds of foods, especially the proteins. An excellent rule is to make a meal out of only two or three kinds of food, and to vary them from meal to meal.

Our appetites and tastes are given to us in order that we may judge what foods to choose. They are reliable guides if we do not have a great variety of foods at any one meal. We are usually safe in satisfying an appetite for any two or three things at a meal. Our natural appetites will usually lead us to choose the foods which our bodies require.

Choosing a Bill of Fare.—One of the first objects to be considered in choosing a bill of fare is to satisfy the peculiar taste and desires of the person who eats the food. Certain nationalities and certain families prefer their own peculiar dishes. It is usually possible to satisfy individual preferences and yet supply a person with a scientific diet. An excess or deficiency of any element in one dish can be counteracted by another dish either at the same meal or at another.

The second element to be considered in a bill of fare is to provide the proper number of câlories produced by the food. The caloric value of a food is a very different matter from its weight or volume. Between 800 and 1600 calories will be needed for a meal. The number will depend principally on the muscular activity of the person who eats the meal.

The third element to be considered is to include a proper quantity of protein. A person requires about 3 ounces of protein daily, or 1 ounce at each meal. After choosing foods which yield the required number of calories, a dietitian will estimate their content of protein or building material. If there is an excess or deficiency of protein, it may be corrected by changes in the kinds of foods that are chosen. It is a good rule to avoid two dishes rich in protein, as, for example, beefsteak and chicken at the same meal. A common fault of a bill of fare at a banquet is its great excess of protein.

A dietitian will make constant use of tables giving the composition of the various foods and the calories which they yield. It is not necessary that every meal should constitute a balanced diet. A few meals may contain an excess or deficiency of an element, provided the defect is corrected within a week.

A fourth element to be considered in choosing a bill of fare is to include the proper kind and amount of regulative materials. If there are children to be fed, nothing can take the place of milk or other dairy products. These foods are the best sources of the fat-soluble vitamin, and all their food elements are in forms which are readily and completely utilized by the body. Adults require fruits, vegetables, and salads on account of their mineral salts, their vitamins, and their content of indigestible cellulose.

A balanced ration for a day will contain at least one article from each of the following groups of foods:

1. Foods rich in protein, such as milk, cheese, meat, fish, eggs, beans, or peas.
2. Food containing starch and sugar in available form, such as cereals and potatoes.
3. Foods containing animal fats, such as butter and fat meat.
4. Foods containing mineral salts and vitamins, such as fruits, fresh vegetables, greens, and salads.

CHAPTER XXXV

SANITARY ENGINEERING

Public health work may be divided into the environmental and the personal. The original work was principally environmental, and was along the lines that are now known as *sanitary engineering*. It consisted in the control of the grosser forms of uncleanness, and embraced such activities as street cleaning, plumbing inspection, the removal of sewage and garbage from public sight, the improvement of grossly polluted water-supplies, and the abatement of offensive nuisances. These activities required the construction of extensive public works, the supervision of laborers, and the operation of mechanical systems. The knowledge and skill that were required were not those of a physician or health officer, but of a civil engineer. The profession of sanitary engineering is now recognized as co-ordinate with that of medicine.

The work of the sanitary engineer is largely the mechanical removal of human wastes, and their purification and destruction by physical, chemical, and biologic means; while the work of the physician and health officer is principally the control of human beings themselves and their education regarding their personal duties in preventing diseases and promoting health. A health officer requires the assistance of a sanitary engineer as frequently as that of a medical consultant or epidemiologist. Universities give the degree of Doctor of Public Health in sanitary engineering as co-ordinate with the same degree in medicine. The position of sanitary engineer ranks with that of an epidemiologist in the knowledge and skill that are required and in the honor that is associated with the office. One of the most important divisions in the department of health of a state or city is that of sanitary engineering. It is necessary for a health officer to be familiar with the scope of the activities of a sanitary engineer, and to recognize the problems that are to be referred to him.

Activities.—The lines of public health work which are under the supervision of a sanitary engineer are as follows:

1. Water-supplies.
2. Sewage disposal.
3. The pollution of streams and public waters.

4. Plumbing.
5. Garbage disposal.
6. Drainage.
7. Nuisances.
8. Milk pasteurization.
9. Ventilation and heating.
10. Lighting.
11. Housing.
12. Food sanitation.
13. Industrial hygiene.
14. Vital statistics, to some extent.
15. Sanitary survey.

Water-supplies.—Giving advice regarding installing and maintaining public supplies of pure water is one of the principal duties of a sanitary engineer. A health officer may look to him for instruction regarding the following points:

1. The quantity of water needed and the amount available.
2. Planning, constructing, and maintaining the plant.
3. The purity of the water, and its liability to future contamination.
4. Its adaptability to industries (boilers, laundries, etc.).
5. A sanitary survey of the watershed or source.
6. Cost of constructing and operating the plant.
7. The conditions, or so-called diseases, which render water unwholesome or undesirable.
8. The mechanical operation of the plants.
9. The filtration of unsafe water-supplies.
10. The emergency chlorination of water, especially during an epidemic of a water-borne disease.

Sewage Disposal.—The removal of household water after it has been put to use is one of the duties of a sanitary engineer. The points which he will consider are:

1. The composition of the sewage.
2. The degree of purification that is needed.
3. Planning and constructing sewer systems and disposal plants.
4. Operating disposal plants.
5. The protection of water-supplies.
6. Organizing sewer districts.
7. Abating nuisances arising from sewage, cesspools, and privies.

The prevention of the pollution of streams, lakes, and other bodies of water with sewage and trade wastes is a problem with which a sanitary engineer must deal. A difficulty in its solution is the legal plea of riparian rights of those who pollute the water. When the amount of foreign material was comparatively small, and the effects of the pollution were not appreciated, the disposal of the waste substances in the water was legal, and the use of the water for disposal purposes had a financial value. It is often claimed that the public cannot take away a right which has been legalized by years of usage. New York State met the problem in 1903 by legalizing the existing pollution under certain conditions, but forbidding the discharge of an increased amount of polluting material (Public Health Law, Section 76).

The supervision and inspection of plumbing was an important duty of sanitary engineers and health officers in the days when the fixtures and pipes were crude and their working principles were not understood. Since efficient methods of construction have been developed and the fixtures standardized, plumbing has become a minor problem in public health. But a sanitary engineer must give particular attention to the plumbing in designing a large building or a camp.

The protection of plumbing against freezing has an important bearing on public health. An epidemic may result when a spring thaw releases a large amount of infectious sewage that has flowed upon the surface from a frozen waste-pipe.

Garbage Disposal.—The disposal of garbage in cities requires a considerable degree of engineering skill. Some of the problems which a sanitary engineer must solve are:

1. The regular collection and transportation of the garbage.
2. The recovery of grease and other useful substances.
3. The suppression of fly-breeding and odors at the reduction plants.
4. The management of piggeries in which the garbage is used as food.

Drainage.—A sanitary engineer is often required to do drainage work, especially for the prevention of mosquito breeding. This work is of great sanitary importance in connection with the suppression and prevention of malaria and yellow fever. It is also of economic importance in the vicinity of salt marshes and stagnant swamps.

Nuisances.—The establishment of factories and transportation lines in residential districts frequently gives rise to claims of their injurious effects on health. The determination of many of these nuisances is a matter for the expert knowledge and judgment of a sanitary engineer. The rule is that every business must be conducted with due regard for the health and comfort of other persons. Nuisances are often supposed to be inseparable from many lines of business; yet it is possible to suppress the nuisances connected with most occupations, provided the cost is paid. A sanitary engineer is the expert adviser who devises the means for preventing the nuisances.

The common nuisances with which a health officer deals are under the control of the division of sanitary engineering of the state department of health.

Milk Pasteurization.—The pasteurization of milk requires considerable skill in the manipulation of the apparatus, and an expert knowledge of mechanical engineering. The supervision of pasteurizing plants is one of the activities of a sanitary engineer.

Ventilation and Heating.—The ventilation and heating of buildings constitute a single problem. A building can be ventilated readily if its heating is disregarded; or kept warm easily if ventilation is ignored. Satisfactory ventilation and heating depend on many conditions which vary in buildings that are apparently similar. While the systems are somewhat standardized, a ready-made one that works well in one building may be a failure in a similar one owing to differences in their locations, prevailing winds, or other essential conditions. A system must be adapted to the particular building in which it is put. Unsatisfactory ventilation and heating often follow a failure to employ an expert sanitary engineer in designing and constructing the ventilating and heating systems of large buildings.

Lighting.—The lighting of schoolrooms, lecture halls, factories, and other assembly places is a problem for a sanitary engineer. Uneven and improper lighting produces glares, eyestrains, and headaches, and is a great contributing cause of fatigue. A competent sanitary engineer can arrange the lights so that a room is illuminated softly and evenly, and with due regard for the comfort and efficiency of its occupants.

Housing.—A health officer frequently has housing conditions brought to his attention. Among those which affect health are the following:

Cubic feet of space per person.
Window area.
Toilet facilities.
Water-supply.
Plumbing.
State of repair of the rooms.
Trades and occupations followed in the rooms.
Rooms in the building used for immoral purposes.

There are few housing laws or restrictions except in the larger cities, although there is a great need for them. The housing problems that come before a health officer are comparatively simple, and the remedies are usually evident; but in difficult cases the source from which the health officer would seek advice is the division of sanitary engineering of his state department of health.

Food Sanitation.—The supervision and control of food sanitation in homes, stores, and eating houses is within the scope of the knowledge and experience of the average health officer, but the transportation of food from the farm to the retail store, and from the store to the consumer is a sanitary engineering matter which has an important effect on public health. The nutrition and activity of many people are largely dependent on an abundant supply of food at moderate cost and the co-ordination of supply and demand largely through proper transportation facilities. Among the food transportation problems which a sanitary engineer will aid in solving are:

1. Providing facilities to transport food supplies from areas of abundance to places of scarcity.
2. Preservation of food during transportation.
3. Excessive cost of transportation.
4. Duplication of delivery routes, as, for example, a dozen milk wagons delivering milk on a city block when one wagon is sufficient.

Industrial Hygiene.—Accidents, occupational diseases, and many other health conditions associated with trades and occupations frequently come to the attention of a sanitary engineer. Among the industrial conditions with which the engineer has to deal are the following:

1. The collection and elimination of harmful dust, fumes, and gases.
2. The construction of guards for dangerous machinery.
3. Devices for stopping machinery quickly or automatically in case of accident.
4. The substitution of machinery for hand labor.

Vital Statistics.—A sanitary engineer must be familiar with the vital statistics of his district in order to know the diseases and causes of death with which he has to deal. A number of deaths from typhoid fever, for example, would be suggestive of impurities in the water-supply; an excess of pneumonia cases would require an investigation into housing conditions; and an excess of industrial accidents and occupational diseases would call for an investigation of factory conditions.

Sanitary Survey.—One of the duties of a health officer is to make a sanitary survey of his district and record it in an intelligible manner. If he does this, a sanitary engineer can readily obtain the elementary data which he can use in his work in water-supplies, sewage disposal, and other activities.

Relation to Public Health.—All the activities of a sanitary engineer have an effect on public health that is direct and immediate. Extensive epidemics have been caused by polluted drinking-water, sewage contamination, deficient drainage, and unclean milk-supplies. The suppression of the great public sources of infection may be credited to sanitary engineers. But the indirect and remote effects of sanitary engineering are also of great importance. The work of a sanitary engineer may be called civic housekeeping. A good housewife has a standard of order and cleanliness which is higher than that which is required for the protection of the health of her family. She is trained to detect unsanitary conditions in their incipiency, and to correct them before they develop into menaces to health. The condition of her house is an index of her consideration for the health and comfort of her family. Civic housekeeping is an equally sure indication of the attitude of a people toward public health matters. Public carelessness regarding water-supplies, sewage, garbage, and other environmental conditions is associated with indifference and carelessness in all matters relating to public health; and, on the other hand, a civic pride in matters of sanitation and public decency is associated with a high standard of public health in all its phases.

A clean-up week campaign affords an opportunity for a health officer to apply the principles of sanitary engineering to individual homes. Heaps of refuse and filth are often allowed to accumulate because there are no facilities for their disposal. House-to-house inspections and public meetings call the people's attention to the need of co-operation in the disposal of household wastes. The activities of a clean-up week are frequently the first steps which lead to the establishment of public dumping grounds, incinerators, sewer systems, and the public collection of garbage and rubbish.

Relation of the Health Officer to the Sanitary Engineer.—Problems in sanitary engineering, like those in epidemiology, vary from simple conditions for which the ordinary health officer can devise a remedy, to complex problems requiring a high degree of technical skill. A health officer is expected to be educated in the elementary principles of sanitary engineering so that he may recognize the existence of an unsanitary condition, diagnose its nature, and suggest practical means by which it may be corrected. If an unsanitary condition is difficult and complex, he will refer the matter to the engineering division of his state department of health. His further duty will then be to promote the adoption of the plans for the correction of the condition. Much of his work will be political in obtaining the co-operation of his board of health, and in securing a favorable vote for the plan and appropriation when the matter comes up at an election.

Relation of the Sanitary Engineer to the Public Health Laboratory.—The natural environment of the fields and woods is sanitary and healthful. The soil, water, and air are naturally favorable in their effects on human health, and the principal dangers which may be called public are those from wild beasts, insects, and poisonous plants. Unhealthful conditions are usually of human origin, and the first ones to develop when a district is settled are the pollution of water with human excretions, and the introduction of insect-borne diseases such as typhus fever and malaria. The problem of a sanitary engineer is to keep the soil, water, and air of a settled community as pure as they are in the woods and open fields. He must detect the polluting material before it is evident to the senses or produces a disease. He can do this by means of chemical, bacteriologic, and biologic analyses. A public health laboratory is a necessary adjunct to the office of a sanitary engineer. The special work which the laboratory will do for the sanitary engineer is the examination of water, sewage, milk, and air, and the identification of disease-bearing insects.

Legal Duties.—A sanitary engineer must give due consideration to the legal phases of his work. The proof of the existence of unsanitary conditions which are not evident to the senses must be in legal form, and sufficient to convince a judge or jury if the matter should be brought to court. Laboratory samples must be collected by competent persons, and their identity in the laboratory established. The correction of many unsanitary conditions, the establishment of water and sewer districts, and the construction of public works must all be done strictly according to law. A sanitary engineer is expected to advise the health officer regarding these legal matters, and to see that all the forms of law are observed.

CHAPTER XXXVI

NUISANCES

CONDITIONS and things which affect health and life vary from those which are merely annoying to those which are deadly. Those whose influence on health is slight or imaginary are called nuisances.

Progress in public health knowledge has led to great changes in the subjects on which emphasis is placed. The air and the ground were formerly supposed to be the natural breeding-places of epidemics. The causes of disease were believed to be the weather and the soil during the first quarter of the nineteenth century, and as long as this belief in uncontrollable sources of infection prevailed, there could be no science of preventive medicine. The development of the science of bacteriology during the last quarter of the nineteenth century led sanitarians to ascribe the causes of disease to the products of fermentation and decay, such as sewer-gas, emanations from decaying matter, and filth of all kinds. It was supposed that dirt and decaying substances in themselves bred diseases, and sanitarians, therefore, placed the emphasis of public health work on outward cleanliness. Sewers were constructed, modern plumbing was installed, and pure water-supplies were secured. The surroundings and environments of man and every unclean condition were supposed to be the principal causes of disease.

Standards and opinions which were new and up to date during the last quarter of the nineteenth century are now matters of common knowledge, and civic cleanliness is as much expected as personal cleanliness, and the popular standards in both are so high that they more than meet the requirements of public health. Boards of health and health officers would have little to do if public health work consisted principally in maintaining cleanliness, for plumbers and policemen and the great majority of people themselves have both the knowledge and the desire to make their environment sanitary to such a degree that further efforts in that direction would usually have only a minor effect on health.

The new public health is founded on the principle that the source of communicable diseases is man himself, and that things outside of the human body are dangerous only when they have been polluted by man himself. Dirt and decaying substances are seldom dangerous unless they come from man, and even then they are not dangerous unless the person from whom they come has a communicable disease. This new conception may be illustrated by diphtheria. The principal cause of diphtheria was formerly supposed to be sewer-gas and other emanations from decaying substances, but now it is known to be transmitted almost entirely by direct contact of a person with one who carries the germs.

Influence of Environment.—The importance which a health officer assigns to an unpleasant or annoying condition is often at variance with that which the public ascribes to it, for the popular beliefs regarding hygiene today are those held by average sanitarians a generation ago. One of the most troublesome problems of a health officer is how to make a complaining public consider the things of man's environment in their true relation to health. The environmental things which commonly have a major effect on the health of man are milk, food, water-supplies, sewage, flies, and mosquitoes. Most other things in man's environment have only a minor effect on health, and are nuisances rather than poisons. A fair estimate is that 90 per cent. of the influences which affect health are those which one person has upon another, and only 10 per cent. are those of the environment upon man. Sanitarians no longer place the major emphasis on cleaning up the environment of man. Carting away rubbish, ashes, and tin cans, disposing of waste-water from kitchen sinks, and suppressing odors from pig-pens and hen roosts are spectacular acts which produce a deep effect on a community, but they have only a slight effect on the health of the people. The effective protection of the public depends principally on a quiet medical inspection and supervision of individuals, such as the discovery of diphtheria carriers, and the detection of mild cases of contagious diseases. There is nothing spectacular or sensational in this work. It is not discussed in the public press, and people, judging its importance by the publicity given to it, often rank its value below that of the suppression of nuisances which are evident to the eyes and noses of the public. The fact that a skilled health officer devotes less than 10 per cent. of his time and energy to the suppression of nuisances does not mean that he is neglecting them. Nuisances are now receiving more attention from departments of health than ever before, and the comparatively low value that is placed upon their suppression is due to an increase in the rating of the direct influence of one man upon another. The detection and suppression of nuisances is properly the work of unskilled assistants of the health officer, while the really effective work of protecting the public from diseases is the work of the health officer himself and of his expert superiors.

Definition of a Nuisance.—A great difficulty in dealing with nuisances is that there is no standard definition of the word. Blackstone's definition is, "That which worketh harm, injury, or damage." A health officer may consider anything to be a nuisance if it causes sickness, suffering, or annoyance; but there can be no standards of what constitutes suffering and annoyance. Each nuisance must be considered by itself, both in its intrinsic importance and also in the importance which is popularly ascribed to it.

The law recognizes as nuisances many things and conditions which offend customs, decency, or morals, or are damaging to property rights. A health officer is concerned only with those which have a direct effect upon health.

How Nuisances Affect Man.—The nuisances with which a health officer has to deal may be divided into those which affect the body physically and those which affect it through the senses. Those which have a direct physical effect upon the body may be divided into those which may produce a communicable disease, as, for example, a garbage heap containing typhoid germs; and those which may produce a non-contagious sickness by chemical action, as, for example, irritating gases from a chemical factory. Those which affect the body through the senses may be divided into those which may indirectly produce a physical effect, as, for example, by producing loss of sleep or appetite, and those which are merely annoying. The manner in which nuisances act is indicated by the following diagram:

Nuisances.
- 1. Offend customs, decency, or morals.
- 2. Affect the body.
  - 1. Physically and directly.
    - 1. Produce a communicable disease.
    - 2. Produce a non-contagious sickness.
  - 2. Through the senses.
    - 1. Produce a physical effect indirectly, as by loss of sleep.
    - 2. Cause merely an annoyance.

Bases of Classification.—A health officer must classify nuisances on two fundamental bases: first, their effect on health, and second, the number of persons affected.

Relation to Health.—Section 1530 of the Penal Code of New York State calls anything a public nuisance when it "Annoys, injures, or endangers the comfort, repose, health, or safety of any considerable number of persons." When a health officer receives a complaint of a nuisance, his first problem is to determine whether it affects health or not. Some nuisances are always dangerous to health; some may be dangerous under certain conditions; and others do injury solely on account of the nervous temperament of the person affected. Whatever annoys, injures, or endangers the comfort and repose of a person may injure his health if the annoyance is considerable in degree and is continued for a considerable period of time. The health officer must usually make a decision whether or not a nuisance is of sufficient importance to produce an effect on health. If a nuisance does not affect health, the health officer usually has no further responsibility concerning it, unless the law or local custom places it under his jurisdiction. A health officer is expected to know how to deal with every kind of nuisance that commonly arises, and to advise both the complainants and the offenders regarding the proper action to take in abating it. The health officer of a rural district is often the only official to whom a complainant can go. If he refuses to discuss an evident nuisance which does not come directly under his jurisdiction, the nuisance is likely to go unabated. He can have a great influence as an adviser regarding these classes of nuisances.

Nuisances which are annoying through the senses are often on the borderline in their effect on health. A nuisance which a strong laboring man would disregard may cause great suffering to a refined, delicate lady. Nuisances which operate through the sense of sight seldom affect health or come under the jurisdiction of a health officer, and a person who is annoyed by them can usually avoid them readily. Nuisances which operate through the senses of smell and hearing are often extremely annoying. They may have marked effects on health, and a person who comes within the range of their influence cannot readily escape their effects. The principal minor nuisances with which a health officer has to deal are odors and sounds.

Public and Private Nuisances.—Nuisances are also classified as public and private. A public nuisance is one that may affect a considerable number of persons, as, for example, the kitchen drainage from a house in which there is a case of typhoid fever. This drainage might affect many persons even if it is located in a thinly settled, rural district. A private nuisance is one that may affect only a few persons, as, for example, a henroost which a person maintains near his neighbor's house in a thinly settled community. The roost would not produce a communicable disease, and it would be merely an anoyance to only one family. The only nuisances in which a health officer is authorized to act officially are those of a public nature.

If a health officer decides that he cannot act on a nuisance because it does not affect a person's health to a degree which is evident to others, or because it affects only a few persons, anyone who is affected by the nuisance may bring a private suit to recover damages from the person who maintains it.

Nuisances Per Se.—When a health officer proceeds to abate a nuisance, he must usually prove, first, that a certain condition or thing exists, and second, that it actually constitutes a nuisance. But there are some things and conditions of which a court will take what is called *judicial notice,* meaning that, if the condition or thing is proved to exist, the court will consider it to be a nuisance without proof. Those conditions and things which have been adjudged to be dangerous or unlawful under all circumstances are called *nuisances per se,* or in themselves.

The first class of nuisances per se is composed of those which are universally held to be dangerous both by experts and by the public. Examples of this class of nuisances are: 1, a glandered horse watered at a public trough; 2, diseased meats offered for sale; 3, dangerous or vicious animals kept where they may endanger the public; 4, offensive trades conducted in a public place; 5, water dammed up and made stagnant; 6, drainage from cesspools flowing into a stream in a village; and 7, dead animals on or near a public highway.

A second class of nuisances per se consists of those which have been held to be such by court decisions. An example is the nuisance of dense smoke.

Nuisances per se of a third class are those declared to be such by statute law. Examples of nuisances of this class in New York State are stagnant water in which mosquitoes breed, and depositing noisome substances on or near a public road.

A fourth class of nuisances per se are those which exist in violation of a local code or ordinance. There are many conditions and things about which there is usually a difference of opinion whether or not they constitute nuisances, and a health officer is often in doubt whether or not the board of health and public opinion will sanction his attempts to abate them. If these nuisances are specifically mentioned in the local code, they become nuisances per se, and the health officer may proceed against the offending persons on the ground of violating a local ordinance. Moreover, a community which desires to have a high standard of civic cleanliness may declare almost any undesirable condition to be a nuisance which a health officer may abate without proving the condition to be detrimental to health. The local sanitary code of a community often deals with conditions which public opinion holds to be nuisances in that place, and which may not be considered to be nuisances in an adjoining town.

Legalized Nuisances.—There are trades and occupations and branches of municipal work in which nuisances cannot be avoided. Many of these nuisances are legalized by decisions of the courts or by statute laws. Examples of legalized nuisances are railroad trains operated at night, village dumping grounds, garbage disposal plants, and contagious disease hospitals. The rule in these cases is that every reasonable attempt shall be made to render the nuisances as slight as possible. But even if a nuisance is legalized, an individual may maintain a private suit at law for damages. This principle was established by the suits brought against the elevated railroads of New York City for damages caused by the noise of the trains and the interference with the access of light and air to the houses adjoining the tracks.

Necessary Nuisances.—When a health officer investigates a nuisance, the defense is often made that it cannot be helped. Examples of necessary nuisances are livery stables, gas houses, slaughter houses, iron foundries, and noisy factories, especially those located in villages and cities. People who come to crowded centers of population must expect to find the nuisances multiplied as well as the conveniences, for noises, odors, and dust accompany the advantage of easy transportation, accessible markets, and social life. The noises and dust which accompany certain trades and occupations constitute nuisances which must be endured if factories are to produce the modern necessities of life. Necessary nuisances are on a par with those which are legalized. Many of them would be nuisances per se if they were maintained in a residential section of a village or city, but they are tolerated when the people who live near them are workmen who choose to live near their places of work.

Necessary nuisances are by no means beyond the control of the health officer. He may require a person to conduct his business with a due regard for the rights of others, and to take all reasonable measures to prevent his business from becoming a nuisance to anyone. If any phase of a necessary business or occupation becomes a nuisance as a result of neglect, the offender is liable to punishment for maintaining an unnecessary nuisance.

A nuisance is not to be excused because it has existed for years without protest. A pig-pen is a necessary nuisance on a farm, but if a village springs up around a barnyard, the farmer may be compelled to remove his pig-pens and stables. He cannot maintain them on the ground that he had them first and that hundreds of people settled around him voluntarily, knowing the condition of his yard. Every new regulation of a board of health places a restriction on the established customs of some persons, and unwillingness to change old habits does not excuse anyone for maintaining what a majority of other persons consider to be a nuisance.

Lack of intention to annoy anyone is no valid excuse for escaping the penalty of maintaining a nuisance. If a dog persistently barks through the night, and continually annoys a number of persons, the plea of the owner that he too is annoyed and wishes the dog would keep quiet, does not excuse him from liability. The health officer may require the owner either to keep the animal quiet or to get rid of it.

The plea of unequal damage to a number of persons does not constitute an excuse for maintaining a nuisance (New York State Penal Code, Section 1531). Some persons are not annoyed by an unpleasant odor, while others are greatly annoyed. If a nuisance annoys a considerable proportion of the persons who are subject to its influence, a health officer may proceed against the offender.

Kinds of Nuisances.—Nuisances are of such varied nature that any classification of them would be incomplete. Those which affect public health may be considered under twelve heads: 1, decaying matter; 2, offensive odors; 3, drainage; 4, stream pollution; 5, stagnant water; 6, unsanitary food shops; 7, unnecessary noises; 8, smoke; 9, dangerous occupations; 10, diseased animals; 11, housing conditions; and 12, public conveniences.

Decaying Matter.—Decaying substances are considered to be nuisances principally because they are offensive to the senses. Almost the only grounds on which a health officer may consider them to be harmful to health is that they may be the breeding-places for flies (page 329).

Privies, uncovered cesspools, and other incomplete systems for the disposal of excretions in rural districts are nearly always offensive nuisances to some degree. If they do not pollute water-supplies, the health officer will usually be able to abate the nuisance connected with them by requiring that the contents of privies shall be kept covered and inaccessible to flies, and that sewage shall be conducted in tight plumbing and closed outdoor pipes to its final disposal place under ground.

Garbage is in a class with sewage when it contains human excretions. A health officer may properly condemn any garbage heap that is likely to undergo decay or putrefaction, or is located on or near a public place or street. The refuse of slaughter houses, butcher shops, and fish markets comes under the jurisdiction of the health officer.

Stables, pig-pens, and hen-roosts contain the fermenting excretions of animals. If these excretions were dangerous in themselves, ordinary milk and eggs would be poisonous foods. The grounds on which a health officer may control stables, pens, and roosts is that they may be the breeding-places for house-flies, or offensive to smell. He may require that they be kept clean and dry. A board of health may establish standards of their cleanliness. It may specify the manner and frequency of the removal of their contents, and may require the use of substances, such as borax, which will prevent flies from breeding. The boards of health of some cities and villages are allowed by law to establish restricted areas where animals and chickens may not be kept.

A health officer is often puzzled over the disposal of the bodies of large dead animals that have been left on the property of some one not their owner. The rule in law is that the owner of the land is liable for any nuisance that is on the land. If the animal is on a public street, the health officer may order the body buried at public expense.

Offensive Odors.—The gases which excite offensive odors are popularly supposed to be deadly emanations and nuisances which produce communicable diseases. Coal-gas, illuminating gas, and the gases of certain chemicals, such as chlorin, may be dangerous to health or life because of their direct chemical action when they are inhaled in large quantities; but there is no gas that can produce a communicable disease. Gaseous products of decay may accumulate in a closed cesspool in such quantity that they explode when a lantern is lowered into the pit, but scavengers who breathe the offensive gases of cesspools in a concentrated form are not subject to sickness more frequently than other persons. The leading sanitarians from 1880 to 1890 taught that sewer-gas would cause diphtheria and puerperal septicemia, but proof was soon developed that it did not contain the specific bacteria of the diseases. Sewer-gas is as free from bacteria as the wind.

The principal way in which offensive odors affect health is through the mental suggestion of their origin. They are often signs of decaying matter and filth which are not to be tolerated in any community. But their offensiveness is sufficient grounds to authorize a health officer to take action to suppress them. A health officer is justified in suppressing any offensive odor whether it comes from decaying matter or not. Examples of such odors are those from soap making, chemical fertilizers spread near dwellings, and fish markets in residential districts.

Offensive Drainage.—The drainage of dirty water and offensive liquids near dwellings or in public places is rightly considered to constitute a nuisance with which a health officer may deal. Sewage, the overflow from cesspools, and the drainage from privies are obviously dangerous, for they contain the excretions from human beings. The drainage from kitchens and laundries is on the borderline of danger, for it may sometimes contain small amounts of human excretions. The drainage from barnyards, stables, manure piles, and slaughter houses may give rise to offensive odors, and may be a breeding-place for flies. The question sometimes arises whether or not a health officer shall consider that the drainage from a person's house or barn upon the yard of another constitutes a public nuisance. He is safe in deciding that it may, for infective material and flies may spread to considerable distances, even if the odors are local.

Stream Pollution.—The pollution of streams frequently occurs both by the natural downhill flow of surface drainage and also by the wilful use of streams for getting rid of offensive material. The degree of offensiveness and danger of the pollution will depend on several factors. If the drainage contains sewage or other human excretions, it will obviously constitute a nuisance which may affect public health. Substances which may putrefy also constitute public nuisances which may affect health. Substances which merely discolor the water may affect property rights only. A health officer must also consider the effect of the foreign substances on fish and plants, and the secondary nuisance which may result from their death and decay.

The danger from polluted water will depend also on the uses to which the water is put. The danger will obviously be great when the stream is used as a source of water-supply, or for harvesting ice, or for bathing, or for watering cattle. The relation between the amount of polluting substances and the quantity of water in the stream must also be considered. Streams polluted with trade wastes, such as those from gas works, tanneries, and paper mills, constitute a special class of nuisances which often involve damages to property rather than to health. The intricate legal question of riparian rights is often invoked when a health officer tries to abate the pollution of a stream.

Stagnant Water.—A health officer frequently receives complaints about stagnant water in ponds, marshes, and swamps, in pools formed by the waste water of ice plants and other factories, and in muddy areas of marsh land recently filled in. It is popularly believed that the green scum which often forms on stagnant pools is detrimental to health. The scum is composed of green plants which absorb carbon dioxid and give off oxygen like green trees. They may give off slight odors when they die. It is also supposed that stagnant water gives off a deadly emanation, especially at night; but this theory has been disproved by the proof that malaria is caused by mosquitoes which breed in stagnant pools. This relation of mosquitoes to stagnant water justifies a health officer in considering stagnant water to be a public nuisance. The nuisance does not usually consist in the water itself, but in the mosquitoes which breed in the water, and the action which a health officer may take in abating the nuisance is directed against mosquitoes. A health officer may require the owner to cover the water with a film of oil, or stock the water with fish which will eat the young mosquitoes, or to abolish the water altogether if there are no practical means of preventing mosquitoes from breeding in it.

Sale of Food.—Local health departments are rightly assuming more and more control over food stores, such as bakeries, grocery stores, meat markets, candy shops, and fish stalls. A health officer will take note of at least three conditions about them: first, their cleanliness, especially of their ice-boxes and cellars; second, protection of the food from flies and other vermin; and third, the exposure of the food to street dust, flies, and dogs on sidewalks and in open stalls.

The dishes, cups, and spoons in which ice-cream and soda water and other soft drinks are dispensed may be contaminated with the mouth discharges of persons who use them, unless they are sterilized with boiling water. A local health board may properly require the owners of ice-cream parlors and soda-water fountains either to wash the used utensils in boiling water before they are used a second time, or to use paper containers and spoons which are to be discarded after being used once.

The control of restaurants might well be assumed by local boards of health. Minimum requirements are that kitchens, ice-boxes, cellars, and store-rooms shall be kept clean; that flies be excluded from the kitchens and dining rooms; and that all dishes shall be washed in boiling water.

There is great need for educating the public regarding the sanitation of food stores, and the cleanliness of dishes in which foods and drinks are served in public places. A health officer cannot enforce high sanitary standards in the sale of foods and drinks until the average man who sits on a jury understands the elementary principles of the transfer of infection from mouth to mouth, and by flies.

Unnecessary Noises.—Noises affect health only indirectly by disturbing comfort and repose, especially at night during the hours which are customarily given to rest and sleep. They are usually controlled by police officers on the ground of being a disturbance of the peace, but a health officer sometimes receives complaints about noises and requests for information how they may be controlled. Some of the noise nuisances which may require his investigation and control are howling dogs, crowing roosters, bellowing cows, the exhausts of automobiles and motor boats, whistles and bells, flat wheels on trolley cars, and noisy occupations in a residential district. A noise is not a public nuisance that requires action by a health officer unless persons from several different families are affected by it.

Smoke consists of unburned particles of carbon, and is not directly detrimental to health. It has been supposed to produce tuberculosis, but coal-miners are no more subject to tuberculosis than workers in other trades, although the particles of carbon which they inhale are more irritating than those of smoke. The smoke nuisance with which a health officer has to deal is usually a private one and affects only a few persons who live immediately beside the source of the smoke. The proper official body to deal with a smoke nuisance is the board which has charge of the ordinary political administration of a community. A health officer may properly act in an advisory capacity. Smoke is usually caused by the cooling of burning gases before they are completely consumed, and it may usually be prevented by proper methods of feeding and firing furnaces and boilers. The smoke of boiling tar and that from gas plants and chemical works may contain irritating fumes which are harmful to health, and which may require action by a health officer.

Objectionable Occupations.—Occupations that are offensive or dangerous may be public nuisances with which a health officer has to deal when they are located in a residential district. Examples of this class of occupations are duck raising, slaughtering animals, fat rendering, soap making, fish-oil extraction, and the manufacture of explosives. These occupations are necessary, and the ground of calling them public nuisances is their location. The objectionable occupations with which a health officer usually has to deal are those carried on by individuals in small shops in their own back yards.

Diseased Animals.—The smaller domestic animals which are diseased, especially stray cats and dogs, may be public nuisances which may affect health. Few animal diseases may be communicated to man, but dogs, cats, and rabbits may have rabies, and cats may possibly have diphtheria. A health officer may properly authorize some laborer to kill and bury a diseased animal that is wandering on a public street. The board of health may properly employ a dog catcher to seize and kill all homeless dogs and cats, and it is the duty of the board to do so when a case of rabies is found in a community.

Housing Conditions.—Dwelling houses which are in a dilapidated condition, or which lack toilet facilities or proper drainage, may be public nuisances, but the laws are inadequate to enable a health officer to improve them except in a few of the larger cities. Every state has need for definite housing laws which will enable a health officer to prevent persons living in unsanitary houses, and to condemn dwellings for other reasons than that they harbor the germs of contagious diseases.

Public Conveniences.—It has been proved that bacteria from the mouth adhere to the edge of a drinking-cup that has been grasped by the lips, and to a towel on which the lips and nose have been wiped. Drinking-cups and towels that have been used in common by several persons are also likely to convey disease germs from one person to another. The sanitary code of New York State forbids the maintenance of common drinking-cups and towels in public places when they are to be used by more than one person without being adequately cleansed. A health officer may consider a common drinking-cup or common towel to be a public nuisance. Pencils that are distributed daily to scholars in a school promiscuously also constitute a public nuisance, since children often bite them and wet their points with their lips.

When expectorated matter dries, bacteria from the mouth and nose may rise as dust and be inhaled by those who breathe the dusty air. If the matter dries quickly, the bacteria may remain alive in the dust. Tubercle bacilli, streptococci, and other germs of infectious diseases may be found alive in the dust that rises from expectorated matter. Spitting on floors and sidewalks in a public place constitutes a public nuisance which may affect health, and which is forbidden by many sanitary codes. Ordinary spittoons that are maintained in an uncleanly state may also be considered to be public nuisances.

A health officer may find an unclean barber or his shop to be a public nuisance. Shaving cups and brushes, razors, and hair brushes may collect bacteria from a person on whom they are used. An instrument may pick up pus germs from minute pimples on the face and transfer them to another person. The germs of ringworm or barber's itch may be thus transferred.

The sanitary code of New York State has a section requiring barbers to cleanse their hands and instruments before serving their customers.

Investigation of a Nuisance.—Custom and law charge the health officer with the control of nuisances that affect health. He must act whenever an alleged nuisance is brought to his attention either by a complaining citizen, or through official inspection, or in any other manner. His first action is to visit the scene of the supposed nuisance and investigate its nature and extent. It is well for the health officer to take written notes on the spot, describing the condition exactly and taking measurements and samples for analysis, if necessary. He can use the notes as evidence if it is necessary for him to go to court in abating the nuisance.

A health officer receives many complaints that are the outcome of quarrels between neighbors, and on investigation finds that the conditions of which complaint is made are not much worse than the average in that locality. When a health officer investigates a complaint, it is well for him to investigate the property of the neighbors, including that of the complainant, both for comparison and to avoid the appearance of being partial. If one nuisance is abated, it is well to abate all similar nuisances in the neighborhood while the people are talking about them.

Decision.—The second duty of a health officer is to render a decision based upon his investigation. The possible decisions that he might make are indicated in the following scheme:

1. It violates a { (*a*) statute law, or / (*b*) sanitary code; } or
2. Affects health { (*a*) directly or / (*b*) indirectly } and is a { (*a*) public or / (*b*) private } nuisance; or
3. Does not affect health.

A health officer may often be in doubt regarding the proper decision to make. He will save himself and his board much annoyance, and will establish a reputation for wisdom and fairness, by being consistent in his various decisions, and by making them according to the standards of the community. For example, a condition which would be regarded as an intolerable nuisance in a community of well-to-do commuters might be disregarded in a settlement of coal-miners.

Action to be Taken.—If a health officer finds a condition which does not affect health or which constitutes a private nuisance, he will have no further official connection with it; but he may properly give advice regarding its correction.

If a public nuisance which affects health is found to exist, the health officer must take immediate action, which will include the following four steps:

1. Inform the party against whom the complaint is made of the decision.
2. Explain to him the exact nature of the nuisance.
3. Suggest a remedy and discuss it with the offending party, or with his plumber, engineer, or other expert adviser, if necessary.
4. Obtain an answer from the offender whether or not he will abate the nuisance.

The formal information which a health officer gives to an offender had best be in writing so that no excuse can be made that the notice had not been given. The following printed form may be used:

Board of Health, ——————— (Place) ——————— (Date)

Mr.———————

A condition affecting health exists on your premises as follows:

———————————————————————

———————————————————————

You are advised to remedy the condition within———days.

Signed——————— (Health Officer).

This form may be printed with stubs on which the health officer may keep a record of his inspections and notices. A supply of these forms bound in pads is a necessary part of a health officer's outfit. When an offender fails to abate a nuisance, the procedure which a health officer is to follow is outlined in Chapter VIII.

A health officer has no power to enforce any particular method of abating a nuisance. If he should order a particular remedy, and it should prove to be insufficient, the offender might claim that he has obeyed the order, and is therefore relieved from further liability. But it is the health officer's duty to give an offender advice regarding various remedies that may be applied, and to leave the decision of choosing the remedy to the owner. For example, if a cesspool is overflowing, it would be unwise for a health officer to order the installation of subsurface irrigation pipes from the cesspool, but it would be his duty to advise the owner of that and of other methods of remedying the condition, and to indicate the comparative value of the various methods.

Over 90 per cent. of all nuisances are remedied by offenders voluntarily as a result of inspections and notices given by health officers. If a health officer is sincere, honest, and tactful, he can usually persuade an offender to abate a nuisance. If an offender is angry and obstinate on the first visit of a health officer, he will usually calm down and comply with the advice after he has thought the matter over. If a health officer is unable to persuade an offender to follow his suggestions voluntarily, he has three means of enforcing action: first, by summary abatement; second, by a suit at law; and third, by an order of his board of health.

Summary abatement means entering upon an offender's property and abating a nuisance at public expense. The New York State law provides that the cost of the summary abatement of a nuisance may be recovered from the owner of the premises by a suit at law, and that the judgment shall constitute a first lien upon the property. It also authorizes a board of health to use public funds or to borrow money, if necessary, in abating a nuisance.

The method of summary abatement is to be used only when the danger to health or life is immediate and considerable. Examples of nuisances which may require summary abatement are articles, or sewage, or drainage which are known to contain disease germs; stray dogs which are vicious or rabid; and dead animals on property whose owners are unable to bury them.

It is the intent of the law that the health officer shall not abate a nuisance summarily except on the order of his board of health, for the power is too wide and dangerous to be entrusted to one person. A health officer who employs the method is personally liable for the costs, and also for possible damages, unless the board of health approves his action. The health officer is expected to use the method on his own initiative only when the emergency is urgent.

Suit at Law.—If a person neglects to abate a nuisance, the usual method of compelling him to act is a suit at law. This is a slow method, for the suit is usually a civil action, and several days must elapse between the service of the summons and the trial of the case—in New York State at least six. The direct object of the suit is to recover a penalty, but the effect of a suit nearly always is to convince the offender of the wisdom of abating the nuisance.

Injunction.—Another court proceeding for the abatement of a nuisance is the injunction. An injunction is an order of court that an offender shall cease from doing an act until its legality can be determined. It is a slow and costly method, and is to be used only in conditions of great importance when there is no immediate danger to health or life.

All court proceedings are legal actions which require the assistance of a lawyer. A health officer may properly refuse to take a case to court unless the board of health will employ a lawyer to represent him.

Order of a Board of Health.—A third legal method of abating a nuisance is by an order of the board of health issued after a formal investigation of the condition. The members of the board may inspect the conditions themselves or they may hold a hearing and summon witnesses. The board makes an investigation, forms a judgment, and issues a notice in practically the same manner that a health officer does. The principal difference is that the board of health is governed by the rules of court proceedings, and its decisions have the force of court orders.

CHAPTER XXXVII

THE DISPOSAL OF HOUSEHOLD WASTES

Household Wastes.—The substances which are discarded as waste matter from households are usually classified as garbage, ashes, and rubbish. Garbage consists of substances which are likely to undergo decay. Ashes and rubbish in themselves have no bearing on public health, but if they are mixed with garbage, they come under the control of the health officer.

Decay.—One of the principal problems with which a health officer has to deal is the disposal of waste matters which naturally decompose into harmful or offensive substances. These waste matters consist of dead animals, table scraps, meat, slops, human excretions, filth, grass, manure, and all other wastes that decay or rot. The decomposable substances are dead materials which were manufactured by living things out of liquids, gases, and minerals that are found in the soil and air. When their life ceases, a process called decomposition, or decay, or rotting sets in, and finally returns the substances to the soil and air in their original forms as liquids, minerals, and gases. Decay is necessary in order that life may continue, for it unlocks the substances which were contained in living things, and which would otherwise remain bound up in dead substances until the earth would be covered with dead matter, and all the available food substances would be exhausted from the soil and air.

The processes of decay are performed principally by bacteria, molds, yeasts, and fungi. They or their spores are scattered everywhere and are ready to grow wherever they find the proper food. Living things are immune to the organisms of decay, but as soon as a living substance becomes lifeless, it is susceptible to them and begins to decompose.

The bacteria of decay may be divided into two classes: first, the *aërobes*, or those which grow in the presence of oxygen; and second, the *anaërobes*, or those that grow without oxygen. The substances produced by anaërobic bacteria are often extremely offensive, and the process by which they are produced is called *putrefaction*. The substances produced by aërobic bacteria are usually only mildly offensive, and the products are not likely to constitute a nuisance.

Putrefaction is likely to take place when a mass of decaying substance is so large that oxygen cannot readily penetrate every part of it. For example, a pail of house slops will soon become putrid and offensive, but if they are poured upon porous soil, every drop comes in contact with oxygen, and the decay that takes place is not offensive. A dead animal undergoes putrefaction because oxygen is unable to penetrate beneath its surface. Putrefying substances first become softened and then liquefied. When the liquid flows away or soaks into the soil, it comes in contact with oxygen and then is acted on by aërobic bacteria. The final result of the process is to oxidize the decaying substance and to change it to the same substance that would be formed if it were consumed in a fire.

Decomposition of Carbohydrates.—Decomposable matter, like living things, is composed of three classes of substances: first, carbohydrates; second, fats; and third, proteins. Carbohydrates consist of sugars, starches, and celluloses, such as wood, cotton, and the fibrous parts of grass. Sugars and starches are decomposed by molds and yeasts into alcohol and carbon dioxid; and by bacteria into water and acids, such as acetic and lactic acids. Cellulose is decomposed by fungi, molds, and bacteria, and is finally changed to carbon dioxid, marsh gas, and other simple substances. Cellulose is very resistant to air-borne bacteria, but it is readily decomposed by the organisms which are especially abundant in the soil, and this fact accounts for the rapid decay of wood, cotton, and other forms of cellulose when they are in contact with the ground. Carbohydrates do not usually decompose to offensive and harmful products, and their disposal seldom gives trouble to a health officer.

Decomposition of Fats.—Fats and oils are very resistant to decay. They do not become offensive or harmful in themselves, but they are likely to clog sewer systems and prevent the disposal of other substances. The disposal of grease in waste-pipes and cesspools is often a difficult problem which a health officer is often called upon to solve. It is probable that the greater part of fatty substances which reach the soil are eaten by earthworms, insects, and other forms of animals.

Decomposition of Proteins.—Protein substances undergo decomposition and decay with great readiness. The decomposition is usually produced by bacteria, but also by fungi, molds, and yeasts. If the decomposition is caused by anaërobic bacteria, some of the products may be offensive gases, such as sulphureted hydrogen and ammonia, which are produced through putrefaction. If the decomposition is produced by aërobic bacteria, the substances that are formed during the course of the process are only slightly offensive. Aërobic bacteria also cause oxygen to unite with the decomposing substances, and the final products of the decomposition are carbon dioxid, water, nitrates, sulphates, and other completely oxidized substances. A decomposition that begins with putrefaction may finally end in complete oxidation of the substance. There is no definite dividing line between the two processes. The offensive odors of decaying substances come principally from proteins. The odors from proteins of animal origin are usually more offensive than from those of vegetable origin.

Products of Protein Decomposition.—A health officer is especially interested in the three final products of protein decomposition—ammonia, nitrites, and nitrates. These three substances contain the nitrogen of the protein. Ammonia is produced in comparatively early stages of decomposition, and its presence indicates that active decomposition is going on. The oxidation of ammonia results in the production of nitrites and nitrates. This change is produced by nitrifying bacteria which are abundant in the soil, especially in the upper few inches where air has ready access. The ammonia is oxidized to nitrites and then to nitrates. The nitrifying bacteria are of great importance to the farmer in the fertilization of the soil, and to the health officer in the disposal of household wastes and sewage. The disposal of household wastes in rural districts depends largely upon the nitrifying bacteria of the soil.

Filtration.—When a liquid containing solid particles passes through a porous substance, such as the soil, the solid particles are held back while the liquid passes through. This process is called *filtration*. The proportion of suspended solid matter that is removed from the liquid will depend on the size of the solid particles and of the pores of the filter. The process of filtration will not remove substances that are dissolved in the water.

The disposal of liquid household wastes depends upon the co-ordinated action of the processes of filtration and nitrification. When a small quantity of liquid waste is thrown upon the ground, it filters through the soil slowly. Its solid particles are held back and are brought into contact with the oxygen of the soil and with the nitrifying bacteria. The substances that are dissolved in the liquid are also acted upon by the oxygen and bacteria, and the liquid that finally reaches the deeper layers of the soil is pure water.

The processes of filtration, oxidation, and nitrification cannot go on constantly and with no interruption, for when the ground is completely soaked with waste matter, its oxygen is soon exhausted and the nitrifying bacteria cannot act. If household waste is thrown upon one spot of ground frequently in such quantity that it forms a pool, little or no purification takes place. But the solid matters which are filtered out lie on or near the surface and putrefy, owing to the absence of oxygen. Also the substances that are dissolved in the liquid remain unchanged and are likely to pass down through the deeper layers of the soil and into the ground water. After a quantity of liquid has been emptied upon the soil, it is necessary that the ground should remain unused for several hours in order to allow a new supply of oxygen to penetrate the soil.

Grass and plants growing in the soil utilize waste substances as food, and thus promote their destruction.

Source of Danger from Household Wastes.—Decomposing wastes of houses and barnyards may be harmful to health for three reasons: first, because of the poisonous products of their decomposition; second, because they may contain the germs of human disease; and third, because of their relation to house-flies.

Ptomains and other liquid or solid products of decomposition are seldom harmful to human beings unless large quantities reach their food- or water-supplies. But if food or water becomes contaminated with decomposing substances in sufficient quantities to do harm, they would be so offensive to smell and taste that few persons would use them.

All manner of communicable diseases have formerly been ascribed to the gases of decomposing substances. But it has been proved that the gases do no harm. Scavengers who inhale the odors in concentrated forms do not have communicable diseases more frequently than other persons, and disease germs are not found in the air of places that are filled with decaying substances. The ground on which a health officer may condemn garbage heaps or manure piles is not that they or their odors may produce disease, but that they are annoying to those who breathe them, and that they may be the breeding-places of house-flies.

The principal ground on which a health officer may require the proper disposal of household wastes is that they may contain the germs of human disease. A health officer divides decomposable substances into two classes—those which contain human excretions and those which do not. The excretions from normal human beings are not more harmful than those from lower animals, but excretions from those who are diseased, or who are carriers, will contain the germs of the disease. Any collection of household waste is likely to receive the excretions from someone who is discharging disease germs from the body. Since the germs in excretions are surrounded by the substance in which they naturally grow, they may remain alive for a considerable time and be a menace to those who live near them.

The two methods by which disease germs are usually transported by household wastes to persons are: first, by means of drinking-water containing drainage from the wastes; and, second, by means of house-flies. The principal diseases that may be spread by household drainage are typhoid fever and other intestinal diseases. Drinking-water polluted with household wastes was the cause of much sickness in the days when little care was taken of house wastes, and when open springs and shallow wells were the usual sources of drinking-water. A general clean-up of back yards and the proper protection of water-supplies has reduced the amount of sickness remarkably, but if a considerable number of people in a town should return to the old standards of the disposal of wastes, there would doubtless be a return of the former prevalence of sickness.

House-flies.—One of the greatest arguments for the proper disposal of household wastes is that house-flies crawling over them may pick up disease germs and may carry them to food on which they alight. The prevalence of typhoid fever and other intestinal diseases to a greater degree in summer than in winter is explained by the presence of fly-carriers in summer. But if flies could find no human excretions on which to alight, they could not transmit diseases from one person to another.

Household Wastes.—The decomposable household wastes with which every health officer has to deal are: 1, kitchen drainage; 2, garbage; 3, human excretions. These waste substances are produced in all dwelling houses, even those of the humblest and most ignorant laborers. Their disposal by every family is done according to some system, even though it be a system adopted merely by habit or convenience. Inspections of these systems and giving advice regarding their control are among the most common duties which every rural health officer has to perform.

Four requirements which are necessary for the disposal of household wastes are: 1, that they shall not remain exposed on the surface of the ground; 2, that they shall be placed at a safe distance from a dwelling or source of water-supply, usually at least 50 feet distant; 3, that they shall be protected from flies; and 4, that they shall be kept free from odors or other objectionable features.

These requirements may be met in extremely simple ways, or costly and elaborate systems may be adopted. Whatever system is adopted, it will require care; but the attention required is no more than the poorest and most ignorant person can readily understand and give.

Kitchen Drainage.—In ordinary homes where no plumbing exists the kitchen is the place where all the members of the family wash their faces and hands and do their laundry work, as well as wash dishes and cook. The waste water from these kitchens will, therefore, contain waste matters from the human body. It will also contain much protein matter, and will readily decompose and putrefy. If a member of the family has a communicable disease, the kitchen waste water may contain germs of the disease. The disposal of waste water from kitchens properly comes under the supervision of the health officer.

A primitive method of disposing of kitchen drainage is to toss it out of doors upon the ground. This may be sanitary if the quantity is so small and scattered that it soaks into the ground at once; but it is not sanitary when the quantity is large or when the ground is frozen. If a pool of dirty kitchen water can be seen around the kitchen door, the health officer may properly condemn it.

A safe method of disposing of kitchen drainage is to pour it into a pail and to empty it upon the back part of the yard, first on one spot and then on another, in order that no part may receive more than will readily soak away.

The simplest improvement that is usually installed in a kitchen is a sink with a waste-pipe extending through the side of the house with possibly a trough or pipe extending from the house. If no attention is given to the system, there will be an offensive pool at the end of the pipe. Two simple remedies for this condition are to have a movable distributing trough and move its outer end daily in order to distribute the water over a large area; or to receive the water in a pail or barrel and empty it on the back yard.

A so-called improvement that is often attempted is to conduct the water into a headless barrel sunk into the ground forming a tiny cesspool. This contrivance soon becomes clogged with grease, and the contents become putrid. If a person cannot afford to build a good-sized cesspool, he had better have none at all, but use pails for carrying away the kitchen waste by hand.

If a yard is small and is in a congested section of a village, a health officer may properly require the owner to build a large cesspool to receive the kitchen drainage. A round cesspool 4 feet in diameter and 4 or 5 feet deep is large enough to receive the drainage of a large family. It is desirable to have also a smaller cesspool to receive the water first and act as a grease trap in order to remove the fatty and soapy substances before the water passes into the main cesspool. It is necessary to place a cover on a cesspool in order to prevent flies and mosquitoes from entering it and breeding.

Garbage consists of scraps of food from the table, and kitchen refuse such as scraps of meat and potato peelings. It also contains other waste substances, such as dirty papers, boxes, and tin cans. It seldom contains disease germs or has a direct effect in producing diseases. But a health officer is justified in supervising its disposal because it may ferment and become the breeding-place for house-flies. Ordinary garbage contains a large percentage of sugar and starch. The fermentation of the carbohydrates produces acetic and other acids which restrain the growth of anaërobic bacteria and prevent putrefaction. Garbage seldom putrefies, but it readily becomes sour and gives off a peculiar odor which is offensive to most persons.

The disposal of garbage ought not to be a difficult problem for a rural health officer, for it has a high value as food for animals, and householders can either feed it to their own animals or they can usually find neighbors who will take it away. There is no excuse for throwing it on an ash heap in the back yard since anyone can dispose of it properly with very little effort. If only a small quantity is produced, it may be buried in the back yard or burned. In villages it may be collected by scavengers or by the municipality at public expense.

The laws of New York State permit the formation of districts in which garbage is collected at public expense. The districts are formed by petition, as a sewer or lighting district is formed (Town Law, Sec. 477a).

Garbage in larger cities is usually collected under municipal control. Grease is extracted from it, and the residue is utilized as fertilizer. The sale of these two products often meets the cost of the collection and treatment.

Woodruff Pit.—An excellent device for the disposal of garbage is the Woodruff pit. This consists of an excavation about 12 feet in diameter and 3 feet deep, whose sides are lined with brick or stone. A solid mound about 3 feet high is built in its center, leaving a circular space about 4 feet wide between it and the side walls of the pit. The bottom is the natural soil. The finished pit looks like a shallow cellar with a mound in its center. Garbage and rubbish are dumped into the pit and set on fire. The material usually contains enough boxes, paper, and other combustible substances to burn the whole contents. What is not burned will dry out, and may be burned a day or two later. The ashes may be removed when the pit becomes partly filled. A pit may be constructed for less than $100. A community may construct and operate one at public expense.

Human excretions consist principally of proteins that are already partly decomposed. They readily putrefy and produce the same kind of offensive products that the original proteins produce when they putrefy.

Human excretions often contain disease germs, and their disposal is one of the most important problems with which a health officer has to deal. The lack of proper disposal of human excretions in the past has produced more sickness and a greater number of deaths than almost any other cause. It is now the principal cause of hookworm disease, and is frequently the cause of typhoid fever. It is also one of the principal causes of the summer diarrhea of infants.

Disease germs are transmitted from human excretions in three principal ways: 1, by water-supplies containing the excretions; 2, by house-flies which have alighted on the excretions; and 3, by contact of persons with the excretions. The danger from contact with them is indicated by the prevalence of hookworm disease in those parts of the United States in which there are few provisions for the disposal of human excretions. The young hookworms live in soil polluted by the excretions and gain access to the body through the skin of barefooted persons.

Privy.—The most common method of disposing of human excretions is by means of an outdoor water-closet or privy. A health officer will consider the following points in judging its sanitary condition:

1. Location. Is it located where its contents cannot reach a household water-supply; and where it is not offensive to the senses of those who live near it?

2. Construction. Does it confine its contents so that they do not flow over the surface of the ground? Is it tightly enclosed against house-flies? Are its contents readily accessible for removal?

3. Maintenance. Is it maintained in a decent, odorless, and sanitary condition; and is it kept in repair?

Location.—A health officer frequently has to decide the question of the proper location for a privy. It is important that a privy shall be located on the downhill side of a dwelling or source of water-supply in order that the natural flow of liquids shall be away from the house or water-supply. This is especially important when the ground is frozen. It is also necessary to consider the slope of underground strata of rock or clay in order to make sure that they do not incline toward the water-supply.

Locating privies so that they are not offensive to the sight or smell of the neighbors is one of the most common problems of a health officer. It is frequently a practice in villages for a householder to place the privy close to the back fence, thus bringing its rear opposite a neighbor's kitchen. This is a matter in which a health officer needs definite rules and regulations of his board of health to govern his decisions and actions.

Construction.—A health officer who condemns a privy is often asked to give a plan for a privy that he can approve. The following are the specifications for a sanitary privy of the minimum size: The building is 3½ feet square. Its front is 7½ feet high, and its rear 6½ feet. It has a sloping roof. The door is 28 inches wide, and opens outward. The seat is 16 inches high and 20 inches wide. The hole in the seat is 8 x 10 inches. A cover for the opening is hinged to the back part of the seat. The rear wall of the building is cut away at the height of the seat, and is made into a door which may be opened for cleaning the contents of the receptacle.

The seat and the rear door are made with tight joints, and the building is set closely upon the ground or upon a tight raised foundation in order to exclude flies. Tight construction of the seat and back is a most important point. If the vault is dark, flies are not likely to try to enter it.

An excavation a foot or two in depth is made under the seat to receive the excretions. If it is too deep, the contents cannot be easily removed, and if it is too shallow, they overflow upon the ground. An elaborate receptacle consisting of a water-tight box of cement or brick may be built. Its disadvantage is the difficulty of removing its contents in a sanitary manner.

It is desirable that the privy be at least 4½ feet square in order that the door may open inward. It is also desirable that it be ventilated. A 4-inch ventilating shaft may be built in one corner, extending from the vault up through the roof. It is also desirable to have screened windows on opposite sides of the building.

Earth Closet.—A privy is least objectionable when its contents are kept dry. A simple method of doing this is to keep a box of dry earth or ashes in the privy and to throw a shovelful into the vault each time it is used. This is an imperfect method, but it is a great aid in lessening the offensiveness of the excretions. An ordinary privy cannot be kept in a sanitary condition if house slops are emptied into it.

Pail System.—A privy in which the excretions are received in a pail or can is a great improvement over one in which they are deposited in the ground. The advantage of a pail receptacle is that it is easy to build and to keep clean, and that the pails may be readily carried away without danger to the person who handles them. The disadvantage is that it requires attention every few days. The pail system can be used wherever ordinary privies are used. In congested sections of villages where there are no sewer systems, the pail system with municipal collections is almost a necessity for those houses which are not supplied with running water and cesspools.

The privy described on page 430 may be adapted to the pail system by extending the floor under the seat and placing a can or pail under the opening. A garbage can 15 inches in diameter and 15 inches high makes a good receptacle.

Maintenance.—A privy requires attention like everything else that is in constant use. It requires cleaning at least as frequently as its receptacle is filled to the surface of the ground. A flimsy building soon falls to pieces, and a health officer must decide whether or not it is fly-proof and tight. A tenant moves out and leaves the receptacle full, and the health officer is then called to determine whether the landlord or the tenant shall clean it. These are largely legal questions which a belligerent householder may contest in court. A health officer's success in securing the proper maintenance of the privies in his jurisdiction will depend largely on the standards which the board of health specifies in its rules and regulations.

The removal of the contents of privies is a troublesome problem in villages. There is difficulty in getting intelligent, reliable persons who will do the work, and who will dispose of the cleanings properly. There is grave danger of spreading disease germs if the cleanings are spilled on the ground or along the street. It is necessary that the work shall be regulated by ordinances and orders of the board of health.

Final Disposal.—The method of the final disposal of privy contents and of cesspool cleanings is of great importance. One method is to bury them. Disease germs usually die soon when they are buried, for the conditions under the soil are unfavorable for their survival. House-flies that were breeding in the buried matter when it was buried may burrow to the surface through a foot of soil. The eggs of hookworms and tapeworms may survive for months in the soil. Still, the burial of the contents is a reasonably safe method of disposal if they are covered out of the reach of chickens and dogs. Burial is the most practical method of final disposal that a rural health officer can usually advise.

Cesspool cleanings and privy contents are often used as fertilizers. This method of disposal may be dangerous if they are used for growing vegetables which are to be eaten raw, or crops such as potatoes, which require workmen to handle the soil with their bare hands. It may be safe when they are used on such crops as wheat and hay, in which the part that is harvested does not come in contact with the soil. If the privy contents are used as fertilizer, they must be plowed under or buried promptly in order to remove the danger of disease germs as soon as possible.

The treatment of privy contents with chemicals, such as chlorid of lime, in order to kill the disease germs, is too costly and uncertain for practical use.

Boiling human excretions in order to kill the disease germs in them is about the only sure method of rendering them harmless. This method was used in the camps of laborers who built the Catskill Aqueduct for New York City's water-supply. It was found to be the cheapest, the least troublesome, and the surest method of disposing of human excretions on a large scale. In these camps the excretions were poured into boilers and evaporated to dryness, and the residue was burned.

Licensing Scavengers.—A method of controlling the disposal of household wastes in villages is by the licensing of scavengers by the municipality. The license is given for permission to cart the wastes over public streets. It is necessary that the municipality should provide a place for the disposal of the wastes, and to appoint inspectors to see that the work is properly done. The cost of the disposal place and of the inspectors may be met by charging a small fee for each load that is carried away. The good behavior of the scavengers may be insured by requiring each one to give a small bond for the proper performance of his work.

If the licensing of scavengers is adopted, the board of health will be likely to require that all householders shall dispose of their wastes in a sanitary manner. The scavengers themselves will be benefited by the increased work which the system brings, and by the monopoly which the licenses give to them. They can afford to buy the proper equipment and to serve each householder cheaply and efficiently.

Sanitary Code.—A great difficulty that a health officer meets in controlling the disposal of household wastes is that the lack of definite standards requires that he must assume to set his own standards, and if the offender defies him, he must prove that his standards are right. But if the standard requirements are specified in a sanitary code, the health officer can simply refer to the code for his specific authority. For example, suppose a privy is not fly-tight, and a health officer has the offender arrested. If there is no provision in the code requiring it to be fly-proof, the health officer must prove that a particular one is dangerous to health, and he might have great difficulty in doing so. But if the code requires it to be fly-proof, all that he has to prove is that flies might easily enter its receptacle.

The requirements of the code relating to the disposal of household wastes may vary in different districts according to the nature of the soil and the social and educational condition of the people. It is the duty of the health officer to advise his board of health regarding the specific regulations that are needed in his district, and of the board of health to adopt them.

Education.—There is great need of educating the people of country districts in the proper methods of the disposal of household wastes, and of arousing a public demand that the methods shall be adopted throughout the community. A health officer is naturally the leader in this educational work. He can distribute copies of the sanitary code throughout his district, and can explain the requirements when he makes inspections. He can enlist the influence of civic leagues, village improvement societies, and other public organizations. He can start a few prosecutions with the intention of impressing the public as well as of punishing the offenders. He can induce physicians to approve his work and to recommend it to their patients. He can influence school trustees and boards of education to build and maintain a model privy at each school house.

There is a possibility that a health officer may become too enthusiastic, and may attempt to enforce measures for which public sentiment is unprepared. The disposal of household wastes is often a matter of decency rather than of public health, and a health officer must distinguish between the two conditions. The complaints of one neighbor against another are often the results of petty quarrels, and are not prompted by any desire to promote health conditions. A health officer can be misled in the disposal of household wastes more readily than in almost any other matter. In dealing with these conditions he has need of a double portion of good sense, sound judgment, and self-control.

CHAPTER XXXVIII

SEWAGE DISPOSAL

Composition of Sewage.—When a house is supplied with running water, the ordinary method of disposing of most household wastes is to transport them by flowing water to a disposal plant. The mixture of household wastes and water is called *sewage*. The amount of sewage that is produced in a house is nearly equal to the quantity of water that is used in the house.

Sewage consists of the waste water from kitchens, laundries, and bath-rooms, and of human excretions mixed with a large quantity of water. Each 1000 parts of sewage contains only about 1 or 2 parts of solid matter, of which about one-half is suspended in the water and one-half is dissolved. Somewhat more than one-half of the solids of sewage is decomposable organic matter, and the remainder consists of substances (such as minerals) which will not decompose. There is not much difference in the average composition of samples of sewage from various sources, whether they are taken from a large public sewer or from the discharge pipe of a small house.

Sewage contains 1,000,000 or 2,000,000 bacteria in each cubic centimeter. About 10 per cent. of the bacteria are colon bacilli from the human intestine. Some may be disease germs that were discharged from the bodies of human beings. Most of the bacteria are the ordinary ones of decay and putrefaction.

Dangers from Sewage.—Sewage is dangerous to health principally on account of the disease germs which it contains. The principal danger is that the sewage may convey the disease germs into a well or stream or other source of water-supply. The danger is not proportional to the number of germs that enter the water. A few in a glass of drinking-water are almost as dangerous as large numbers. The great volume of water with which human excretions are mixed in sewage makes it probable that disease germs will be carried into a water-supply from an elaborate sewer system more readily than they will from the undiluted excretions of a primitive disposal place. The conveniences of plumbing and of a sewage system are accompanied by an increased responsibility for care in the final disposal of the sewage.

Sewage flowing into a body of water is a menace to the health of those who bathe in the water. There is a possibility that oysters taken from sewage-laden water may contain disease germs. The pollution of salt waters at seaside resorts may affect the health of visitors from inland towns, and of people of communities in which oysters are received from polluted waters. The sewage disposal system of a community may have an influence on the health of people living far away from the community.

Another danger from sewage is that house-flies may transmit disease germs from it to food or to the mouths and eyes of persons.

An argument for the proper disposal of sewage is that it is offensive to sight and smell, and is a nuisance that is not to be

Fig. 41.—Sewage in the interior of a village block that needs a public sewer system.

tolerated in respectable communities. Cesspools overflowing on the ground are among the principal nuisances with which a rural health officer has to deal.

Disposal Systems.—The problem in sewage disposal is to remove the decomposable organic substances and the bacteria from the water, and to destroy them so that they will not be offensive to the senses or dangerous to health. An unsuccessful disposal method that has been thoroughly tested is that of holding the sewage in a tank and treating it with chemicals, such as copperas or alum, which will coagulate the solids so that they will either float on the surface or settle to the bottom. The clarified liquid may then be drawn off. This system is expensive, uncertain, and impractical, and a health officer will seldom need to give it consideration.

Another system is the distribution of the sewage over the surface of farm lands. This, too, has been thoroughly tried, and has nearly always proved unsuccessful. The sewage has very little fertilizing value; a large area is required for its disposal; the cost of labor makes the system expensive; and the presence of disease germs renders the crops dangerous for human food. A health officer will do right if he condemns a system of surface disposal because of danger to health and of expense.

A third system of sewage disposal is to discharge the sewage into a lake, or river, or bay, or other body of water. This is a

Fig. 42.—Surface disposal of sewage—a crude system.

dangerous method of disposal, especially if the body of water is used as a source of water-supply. The natural purification of the water depends largely on the oxidizing action of the oxygen that is naturally dissolved in the water. If the proportion of sewage to the water into which it is discharged is as 1 to 200, the quantity of oxygen in the water will be decreased to such a degree that some kinds of fish cannot live in the water. If the proportion of sewage to water is as 1 to 50, the quantity of oxygen will be decreased to such a degree that putrefaction may take place. But disease germs may remain alive in the water even though the water does not become offensive to the senses. One of the great problems with which departments of health have to deal is the prevention of pollution of bodies of water with sewage.

Nearly every system of sewage disposal with which a health officer has to deal depends for its action on bacterial decomposition, with a further purification by oxidation or by filtration through the soil. If the purification is complete, the organic substances in the sewage will either be removed or completely oxidized to carbon dioxid, water, and nitrates, sulphates, phosphates, and other minerals which are naturally found in ground water; and the water which flows away will be free from bacteria. It is possible to purify sewage to such a degree that it is fit for use as drinking-water.

The devices which are commonly used for purifying sewage are: 1, a collecting tank; 2, subsurface irrigation pipes; 3, a contact bed; 4, a sprinkling filter; 5, a sand filter; and 6, a chlorinating apparatus. These devices are often used in various combinations, as, for example, a collecting tank, a sprinkling filter, and a chlorinating apparatus.

Fig. 43.—Two settling tanks—one empty and one filled.

Settling Tank.—Every efficient system of sewage disposal makes use of a collecting tank in which the raw sewage is received. A collecting tank is not filled and then emptied before it receives more sewage, but the sewage flows through it continuously. It is made of sufficient size to hold at least the quantity of sewage that is produced during twelve or twenty-four hours. The sewage therefore remains in the tank for from twelve to twenty-four hours, and during that time it undergoes two processes: 1, sedimentation, and 2, putrefaction. While sewage is flowing slowly through a collecting tank, the heavy particles of solid matter sink to the bottom, and the lighter ones float on the surface. For this reason a collecting tank is often called a *settling* tank or *sedimentation basin*. An efficient tank will usually remove somewhat less than one-half of the solid matters that are suspended in the sewage.

An active bacterial action also takes place in a collecting tank. The action is one of putrefaction, and for this reason the receptacle is often called a *septic* tank. The result of the putrefaction is to liquefy some of the solid bits of matter that float in the sewage, and to decompose some of the substances that are dissolved in it. The action is rapid during the first few hours that a particular mass of sewage remains in the tank, but after that period of time the action is slow. There is no advantage in retaining the liquid part of sewage in a septic tank for a longer time than a day. A septic tank will remove about half of the decomposable substances which are contained in sewage, and the effluent will undergo further offensive decomposition unless it is subjected to a greater degree of purification.

Cesspool.—The cesspool is the type of sewage disposal plant in which a health officer is especially interested, for it usually constitutes the entire disposal system of houses which are not connected with a public sewer system. A cesspool is an underground septic tank from which the liquid slowly escapes through the soil. The actions which take place in it are sedimentation and putrefaction. The liquid which escapes is slowly filtered through the soil, and its organic matter is slowly oxidized by the oxygen which penetrates the soil. The effluent finally reaches the underground water. The degree to which it is purified will depend largely on its quantity, the character of the soil, and the depth at which the ground water is reached. Fine sand makes an efficient filter. Coarse gravel, or a fissure in rock, allows the liquid to pass through almost unchanged. If the quantity is considerable, the purifying capacity of the soil may be exceeded. If the ground water lies near the surface of the soil, the purifying action will be slow, and the effluent will not soak away from the cesspool.

Safety of a Cesspool.—The safety and efficiency of a cesspool will depend principally on: 1, the capacity of the soil to absorb the effluent; 2, its nearness to a well or spring or other source of water-supply; and, 3, the care with which it is maintained. If houses are near together, the soil may be saturated with sewage to such a degree that all the ground water is polluted. Under these conditions cesspools may still be safe if all the wells are closed and only a public water-supply is used. If the soil has not sufficient capacity to absorb the effluent, the installation of subsurface irrigation pipes will often solve the problem of the final disposal of the liquids (p. 440).

Construction of a Cesspool.—A cesspool is usually constructed with circular sides and arched top, and is built of brick or stone laid without mortar. No bottom is laid in it, and perforations are sometimes left in its sides to allow the liquid to soak away readily. A standard size for a cesspool of an ordinary house is 7 feet in diameter and the same in depth.

It is necessary to provide a cesspool with a cover which fits tightly enough to exclude flies and mosquitoes. Uncovered cesspools breed a large proportion of the mosquitoes which annoy the people of villages. It is not necessary that the cover should be perforated for the escape of gases.

It is economic to construct two connected cesspools. The outlet pipe of the first cesspool is provided with an elbow which extends downward about 2 feet in order to draw off only the portion of the liquid which is comparatively clear. The bottom of the first cesspool soon becomes clogged with sediment, but the bottom of the second cesspool should remain porous for years. The expense of frequently cleaning a single cesspool will soon exceed the cost of a second one.

Maintenance of a Cesspool.—A cesspool that is acting properly will act continuously for months and years. About a foot of sediment will collect on the bottom, and a foot of scum will float on the surface. This quantity of sediment and scum will not increase, for the processes of putrefaction will go on continuously, and will slowly reduce the solid matters to gases and liquids. The perfect action of a cesspool requires that the bacterial action shall be as active as possible. Some persons put chlorid of lime or other antiseptics into their cesspools, expecting to lessen the offensiveness of the sewage. About the only effect of the antiseptic is the undesirable one of restraining the liquefying action of the bacteria, thus increasing the quantity of sediment and clogging the cesspool until it overflows. Antiseptics in a cesspool do more harm than good.

When the bottom of a cesspool becomes clogged, the proper remedy is to pump out the liquid contents and remove a few inches of the earth until clean soil is reached, and replace it with clean sand. If the bottom soil is simply turned over, the mud which clogs the soil remains, and the condition of the cesspool is soon as bad as ever.

Large quantities of gases, such as marsh gas, are produced during the process of putrefaction. The mixture of these gases with air is explosive, and serious accidents have resulted from lowering a lantern into the cesspools too soon after they were opened.

The final disposal of cesspool cleanings is considered on page 431.

Subsurface Irrigation.—When the capacity of the soil to dispose of liquids is limited from any cause, such as the nearness of the ground water to the surface or the close texture of the subsoil, a system of subsurface irrigation is often used as an accessory to a cesspool. It is also well adapted as the main feature of the disposal plant of a large country house or a small institution. The system consists of small pipes of agricultural tiling laid with open joints in rows 3 to 6 feet apart a foot or two beneath the surface of the soil. The pipes receive the effluent from a cesspool or septic tank, and distribute it into the upper layers of the soil where the oxidizing and nitrifying bacteria are especially abundant and active.. The pipes may be laid in a front yard with benefit to the lawn. An acre of subsurface irrigation tiling will take care of from 15,000 to 25,000 gallons of sewage effluent daily. The heat of the sewage will prevent the soil around the pipes from freezing even when the ground elsewhere is frozen.

Construction of a Subsurface Irrigation Bed.—The tiling of a subsurface irrigation bed is laid with a slope of about 4 inches in 100 feet in order that the in-flowing sewage will not rush to the outer end of the system, but will distribute itself uniformly through all the tiling. The joints are wrapped with a thin layer of excelsior, and their upper surfaces are covered with tarred paper in order to exclude sand and yet allow space for the escape of the liquid.

The raw sewage from a house is received into a dosing tank whose capacity is equal to that of the subsurface pipes. An automatic device discharges the contents of the filled tank suddenly in order that the whole pipe system may be flooded. While the tank is refilling, the liquid in the pipes soaks away, oxygen penetrates the ground, and the soil becomes prepared for a new dose of sewage. The service of a sanitary engineer is usually required in constructing a subsurface irrigation system.

When irrigation tiling is laid in order to increase the capacity of a cesspool located in a low area, it is usually impossible to construct a dosing tank. The effluent then drains into the tiling constantly, and there is a probabliity that a sediment will collect in the joints and finally clog them. One remedy for this condition is to build the cesspool above ground, sufficiently elevated to allow the construction of a dosing tank.

Elements in a Disposal Plant.—It is not economic to dispose of large quantities of sewage effluent by direct absorption into the soil. The plan that is usually adopted by a large institution, or a village, or a city is to subject the effluent to purification to a degree that it may be safely discharged into a stream or other body of water. Four processes of purification that are commonly employed are: 1, sedimentation in a septic, or settling, tank; 2, oxidation by aërobic bacteria; 3, filtration; and 4, chlorination. A septic or settling tank is nearly always used in every system for the preliminary treatment of the sewage.

Fig. 44.—The sprinkling pipes and underdraining tiling of the stone bed of a sewage disposal plant ready to be covered with stone.

Imhoff Tank.—When a large quantity of sewage is treated in a septic tank, there is a considerable accumulation of sediment called *sludge*. An Imhoff tank is a special form of receiving basin that is designed to liquefy the maximum amount of sludge, and to require the removal of the sludge with the least frequency. It consists of a deep concrete tank which is divided into an upper and a lower compartment. The bottom of the upper compartment opens into the lower by a narrow slit. The raw sewage is received into the upper compartment, and as it slowly flows along, its sediment falls into the lower compartment and there undergoes putrefactive decomposition. The action which takes place in the upper compartment is principally a sedimentation of the coarser solids with but little action by the anaërobic bacteria on the finer solids or the dissolved substances. The greater part of the purification of the liquid is accomplished later by aërobic bacteria to whose action the effluent is subjected either in a contact bed, or a sprinkling filter, or a sand filter.

Contact Bed.—A contact bed consists of a large tank about 3 feet deep filled with pieces of stone about the size of hen's eggs. The effluent from the sedimentation tanks is oxidized by aërobic bacteria which cling to the stones. After three or four hours the liquid is drawn off and the bed is allowed to lie empty for a few hours in order that a new supply of oxygen may penetrate the beds.

Fig. 45.—A sand filter bed ridged and furrowed for winter.

A contact bed will remove about two-thirds of the organic matter and bacteria that is in the liquid. One acre of beds will treat about 500,000 gallons of sewage daily or about the quantity that is produced by 5000 people.

Sprinkling Filter.—A broken-stone bed in which the sewage is sprinkled upon the surface is called a *sprinkling filter*. Oxidation in it takes place rapidly owing to the intimate contact of the liquid with the air, and to the thin sheets in which it trickles down between the stones. An efficient sprinkling filter will act about three times as rapidly as a contact bed, and will remove over 80 per cent. of the solids and bacteria from the sewage.

Sand Filter.—A sand filter consists of a bed of sand, usually about one-quarter of an acre in area and 4 feet deep, surrounded

Fig. 46.—Sprinkling sewage over the stone bed of a sewage disposal plant.

by an embankment, and underdrained. The effluent from the collecting tank undergoes oxidation and filtration in it, and if the

Fig. 47.—Sand filter of a sewage disposal plant.

bed is working properly over 90 per cent. of the solids and bacteria are removed. The effluent is discharged upon a sand filter

Fig. 48.—The distributing troughs on the sand filter of a small sewage disposal plant.

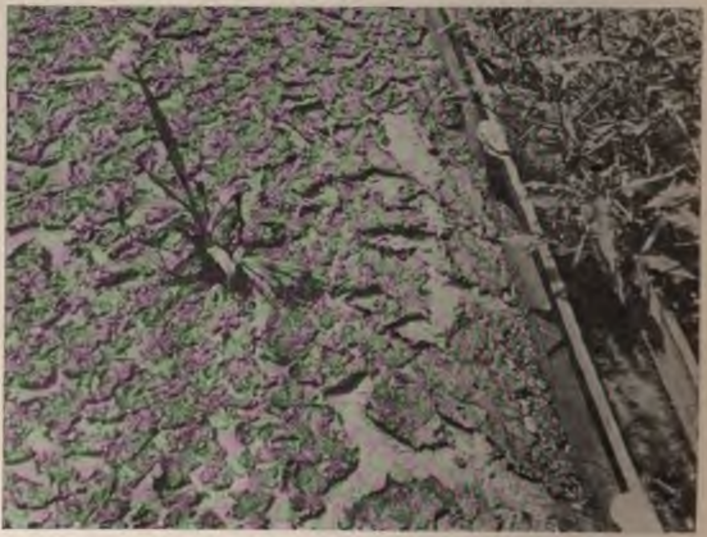

Fig. 49.—Dried sediment on the surface of a sand filter of a sewage disposal plant.

in a sudden gush only once or twice a day. The liquid soaks away quickly, and the nitrifying bacteria then act on the filtrate for some hours. If the bed is continuously soaked with sewage it will have little or no purifying action, owing to the impossibility of oxygen penetrating it. A sand filter is usually constructed in

Fig. 50.—Stone bed of a sewage disposal plant.

several beds, and the effluent is discharged upon each in rotation. An acre of sand filter will dispose of about 100,000 gallons of sew-

Fig. 51.—View of an attractive sewage disposal plant. The three low houses in the foreground cover the objectionable structures.

age daily, or about the quantity that is produced by 1000 persons. A sand filter is economic in sandy soils where land is cheap.

After a sand filter has been in use for some weeks, a scum of grease and fine solids forms on the surface and clogs the sand. It is necessary that each bed should be thrown out of use frequently and dried in order that the scum and an inch or two of the surface sand may be removed.

Late in the fall the surface sand of a filter must be deeply furrowed and ridged in order to prevent freezing. A layer of ice forms on the surface and is supported by the ridges. The ice protects the sewage and soil beneath it from freezing. A sand filter that is properly ridged will remain in good condition throughout a severe winter.

Chlorination.—The final process in the complete purification of sewage is the sterilization of the effluent with chlorin in the form of chlorid of lime or of liquid chlorin. The chlorin acts by combining with the hydrogen of the impurities, thus forming hydrochloric acid and liberating oxygen in an active form. The oxygen immediately combines with the organic matter and bacteria and oxidizes them. The quantity of chlorin that is needed will depend on the amount of impurities that are in the liquid. From 1 to 10 parts of chlorin in each 1,000,000 parts of sewage are usually required.

Tests of Efficiency.—A health officer can perform two tests to determine the efficiency of a sewage disposal plant. The first test is the determination of the stability of the effluent, or its liability to undergo further decomposition and putrefaction. If the coarse particles are removed from sewage and the total amount of organic matter is reduced to a quarter of its original amount, the effluent will usually be stable. The test may be performed by taking a jar of the purified sewage and setting it aside for several days in a room of ordinary temperature. If no turbidity or offensive odor develops, the sewage is stable, and will not undergo decomposition when it is discharged into a body of water or upon a filter-bed.

The effluent from a collecting tank or from a contact bed is seldom stable. That from a sprinkling filter or a sand filter is usually stable if the system is properly operated.

A second test of the efficiency of a sewage disposal system is the determination of the number of colon bacilli in the treated sewage. Intestinal bacteria are rather long lived in sewage, but they do not multiply in number. A disposal plant will reduce the number of colon bacilli in about the same degree that it reduces the quantity of organic matter. The reduction in the number of colon bacilli per cubic centimeter as the sewage passes through the disposal plant is therefore a reliable indication of the efficiency of the purification process, and of the destruction of disease germs which may be in the sewage. A health officer can have the test done by sending samples of the sewage to a laboratory in sterile 2-ounce bottles. A health officer must take a series of samples, one from the stream of sewage before it enters the collecting tank, one from the stream of effluent that flows from the tank, one from the effluent from the contact bed, or sprinkling filter, or sand filter, and one from the effluent after final sterilization. These samples will show a progressive diminution in the number of bacilli, and none will be found in the last sample if the system is 100 per cent. efficient.

Choice of a System of Disposal.—The system of disposal that is needed for a particular locality will depend largely on what disposition is finally made of the effluent. If the effluent is discharged into a large body of water, an Imhoff tank with chlorin treatment of the effluent will constitute an efficient system. If the effluent from a disposal plant is discharged into a small stream which is used as a source of water-supply, it may be necessary that the disposal plant shall consist of a collecting tank, a sprinkling filter, a sand filter, and a chlorinating apparatus. The disposal plant must be adapted to the particular locality which it serves.

Sewer System.—A sewer system consists of collecting pipes or sewers, and a disposal plant. A health officer has little to do with the sewers directly, except when they are broken or obstructed. The construction and maintenance of sewers are engineering problems with which an engineering department has to deal.

A health officer has very little power over a private sewer system, except to require that the disposal shall be done in a sanitary manner. He cannot require a householder or the managers of an institution to install any particular type of sewer system. But a health officer who understands sewer systems will often be asked to give advice regarding their installation and management. If a health officer condemns a sewer system at a private residence, or an institution, he should be able to advise the owners or managers what system to install in its place, where to locate the disposal plant, and how to manage the system.

Manufacturers and contractors often exploit patented systems which are merely complicated adaptations of well-known principles. A householder can usually get a practical plumber to design a simple, inexpensive system which is adapted to the soil of the locality. It is a good plan for a health officer to consult the plumbers regarding the costs of standard sewer pipes, cesspools, and disposal plants in his locality. A health officer can also promote public health by advising the plumbers regarding the standard methods of sewage disposal which are efficient and economic in his locality.

Public Sewer System.—When a city, village, or congested district needs a public sewer system, the health officer is the person from whom the people and officials naturally seek advice. The manner of establishing a sewer district is prescribed by statute law in some of the states. For example, the New York State law relating to sewers in towns is found in the town law, Art. 11, Secs. 230–248; and the law relating to village sewers is found in the village law, Art. 11, Secs. 260–278, and in the public health law, Art. 3, Sec. 21a; and the relation of sewage to stream pollution and potable waters is found in the public health law, Art. 5, Secs. 73–87. It is the duty of a health officer to know the laws relating to sewers and sewage in his district, and to advise the people and officials concerning them.

The question sometimes arises of the advisability of the construction and operation of a public sewer system by a private person or corporation who would charge for its use. It is not wise to make the use of a sewer dependent on money payments. If the water-supply of a house is cut off, the occupants can obtain a temporary supply from a neighbor without undue hardship or danger; but if a house is cut off from sewer connections, the resulting pollution of the house and soil may be dangerous to health.

Designing and constructing a public sewer system are problems of engineering and business which are under the jurisdiction of the business department of a municipal government. It is the duty of a health officer to give advice regarding the sanitary problems to be solved. But the decision regarding the solution of the problems does not lie with him or with the board of health, but with the engineering and business departments.

Operation of a Disposal Plant.—The operation of a disposal plant is under the control of the business departments of a municipal government, but it is the duty of a health officer to make inspections and take bacteriologic samples of the sewage in order to have records of the efficiency of the plant. The health officer of a rural community is the official who is best qualified to take samples and to secure their examination.

CHAPTER XXXIX

WATER-SUPPLIES

Pure Water.—By *pure* water a health officer means *wholesome* water, or water that is adapted for drinking, cooking, and laundry purposes. Water that is used for household purposes is not *pure* in the sense that it consists of water alone. It always contains dissolved substances, such as oxygen, carbon dioxid, and traces of minerals, but these substances usually improve the water rather than harm it.

Impurities.—The ordinary requirements for household water are that it shall be free from color, odor, taste, sediment, and disease germs. A water may be grossly contaminated with mud, decayed leaves, or other suspended matters; or with coloring-matters derived from swamps; or with putrefaction products derived from decaying substances in stagnant pools, giving the water unpleasant odors and tastes. Gross contaminations are plainly evident, and automatically give warnings of possible danger.

Water may contain undesirable substances which do not render it unwholesome, but which make it undesirable for certain household purposes. An excess of lime makes a water "hard" and unsuitable for laundry purposes. An excess of alkalies or salt may render water unfit for drinking or cooking. An excess of iron discolors clothes which are washed in it. A health officer receives complaints about these undesirable impurities more frequently than he does about the more dangerous ones.

The principal impurities which are dangerous to health are disease germs derived from human excretions. Water from lakes, rivers, and underground sources is naturally free from disease germs, and its use will not produce sickness unless it becomes polluted with disease germs of human origin. The disease germs usually enter the water with unpurified sewage. The sewage on farms and in rural districts usually comes from privies and cesspools which are located without reference to the underground drainage. The whole soil of the built-up portions of villages and cities is usually saturated with sewage, and the underground water is unfit for use. Rivers and lakes are often the receptacles for the sewage of villages and cities which have no sewage disposal systems. Water containing sewage and living disease germs may be clear and may taste pleasant. A slight amount of gas and mineral matter derived from sewage may improve the sparkling appearance and the taste of water, and may give rise to a false impression that the water is unusually wholesome.

The principal diseases which are spread by means of polluted water are typhoid fever, dysentery, cholera, and other intestinal disorders. These diseases are unusually prevalent in communities in which the water-supply is polluted with sewage; and a purification of the water is followed by a great reduction in the number of cases of typhoid fever in the communities. The number of deaths from typhoid fever per 100,000 inhabitants of a city may be taken as a rough indication of the purity of the water-supply of that city.

Sources of Water-supplies.—One source of water-supply is rain-water stored in underground cisterns. A source of its pollution is dust washed from the roofs on which the water is collected, but that dust is not likely to contain disease germs. Another is dirt which falls through the top of the cistern when its cover is out of repair. This dirt may contain disease germs. Cistern water is usually wholesome if care is taken to discard the first water which flows from the collecting roof after each rain, and if the cistern is kept in repair and is cleaned at least twice a year.

A spring of water gushing from the ground will usually be pure if there is no source of pollution near it and if surface water is directed away from it.

A well consists of a hole or shaft sunk through the soil to an underground source of supply. The underground water will be polluted with disease germs when the quantity of sewage which is deposited near the well is so large that the process of its filtration through the soil cannot remove its impurities. The old-fashioned type of well consisted of a broad, open hole lined with brick or stone laid without mortar. It permitted the entrance of dirt and surface drainage through its top and sides. The modern type of well consists of an iron pipe a few inches in diameter driven or sunk into the ground, and protected from surface drainage. Replacing open wells with wells consisting of iron pipe has greatly reduced the amount of typhoid fever on farms and in rural districts. No type of well is usually safe in the built-up portions of villages and cities, owing to the saturation of the soil with sewage.

Lakes and rivers are frequently used as sources of water-supplies, especially for cities and large villages. They are frequently polluted with the contents of sewers both public and private and with sewage from surface drainage.

Detection of Pollution.—A health officer is often asked to examine a water-supply in order to determine its purity. His examination will consist of two procedures: 1, inspecting the water-shed from which the water is taken; and 2, sending samples of the water to a laboratory for examination by an expert.

Examination of a Water-shed.—The sources of pollution of water-supplies are usually privies, cesspools, sewer outlets, and barnyards. They can readily be found and their condition determined. An inspection of the water-shed and drainage will also disclose the probable routes for the transmission of the impurities. A health officer will note the location of the sources of pollution with reference to the spring, or well, or the intake pipe of a pumping station; the slope of the surface of the land; the subsoil, and its filtering capacity; and the direction of the slopes of the strata of soil, and of the underground flow of water. He will also note the presence of barnyards and of cultivated fields, and their relation to the water. If a health officer is inspecting a private well, he will be likely to find the source of pollution within 100 feet of it. The pollution of the wells supplying the water works of a village will usually be found within a few hundred feet. If the water is taken from a pond or a lake, the inspection will include its whole circumference. It may be necessary to inspect both banks of a stream or river for miles up stream.

The effect of pumping must be considered in judging the probability of the pollution of a well. Underground water flows in a downhill direction along the strata of soil in which it is contained. The natural rate of flow is only a few feet a day. For example, it may be from 3 to 30 feet in fine sand. If a cesspool is located in an uphill direction from a well, the underground flow of water will be from it toward the well; but if it is located in a downhill direction, the underground flow will be away from the well.

Pumping a large quantity of water from a well makes a cone-shaped depression in the level of the water immediately around the well, and the water then flows toward the well from every direction. The area and depth of the depression will depend on the quantity of water that is withdrawn and on the rapidity of the pumping. Suppose, for example, 10,000 gallons of water are pumped from a well in an hour. This amount of water would fill an inverted cone 3 feet deep having a radius of 20 feet, but since the water is contained only in the interstices between the particles of soil, the area affected will extend more than 20 feet in every direction around the well. Water will then flow toward the well from every direction, and the drainage from a cesspool located within any part of the affected area might be drawn into the well.

A health officer must bear in mind the frequent practice of using abandoned wells as cesspools. Since they extend down to the ground water, no purifying action of filtration takes place in the effluent from them.

The fluorescin test is often valuable to determine the flow of sewage from a cesspool or sewer into a water-supply. Fluorescin is a coal-tar dye which in extremely diluted solutions imparts a greenish fluorescence to water. If an ounce or two of the dye is emptied into a cesspool or water-closet, the appearance of the characteristic fluorescence in a well or stream or other source of water-supply that is located near by is proof that sewage from that particular source has entered the water. A health officer can readily make use of this test to determine the flow of sewage from a cesspool to a well, or to locate the outlet of a suspected sewer-pipe.

Laboratory Examination of Water.—The laboratory tests of water for household purposes are chemical and bacteriologic. The impurities are usually present in extremely small amounts, and their detection requires the services of skilled investigators and the use of a well-equipped laboratory. An analysis that is not accurate is useless. Samples are frequently brought to a health officer with the expectation that he will examine them himself. The examinations which the ordinary health officer can make are useless.

Chemical Analysis.—When a sample of water is examined, its color, turbidity, and odor are first noted. A chemical analysis is then made to determine the quantities of the following substances in the water: total solids, minerals, ammonia, nitrites, nitrates, and chlorin. The hardness of the water and its iron content are often determined also. The amounts of the various substances in water are usually expressed as parts per million parts of water, and sometimes as grains per gallon.

Color.—Pure water is naturally colorless, but when a considerable depth is viewed against a white surface, as in a white-tiled swimming pool, it appears greenish blue. The water which has been stored in a cistern or swampy area sometimes has a brown color from the presence of vegetable dyes which are dissolved from leaves and wood. The color has no significance so far as the effect of the water on health is concerned. The color is determined by viewing the water contained in a deep glass tube of a standard size.

Turbidity is the loss of transparence due to solid particles suspended in the water. These particles are usually either clay, shreds of vegetable substances, or iron. They are usually harmless, but they are to be considered suspicious until their exact nature is determined.

Odor.—Whatever odor there may be in water is derived from the animal or vegetable substances which are dissolved in the water. Some of the odors are characteristic of certain kinds of pollution, as, for example, the odor of human perspiration in water polluted with laundry waste. The odor is first determined at room temperature by shaking a considerable quantity of water in a corked bottle and smelling it at the instant the bottle is uncorked. A sample is then heated nearly to boiling in a covered vessel and its odor is noted at the instant that it is uncovered.

Reservoir water often acquires unpleasant odors and tastes which are caused by harmless oils produced by algæ and diatoms growing in the water, or by the decay of the organisms.

Solids.—The total quantity of solid matter that is dissolved or suspended in water is determined by evaporating 100 c.c. of the water to dryness and weighing the residue, which consists of both organic matter and minerals. The residue is then heated to redness in order to burn the organic matter. That which finally remains is mineral matter, and when its weight is subtracted from that of the original residue, the remainder indicates approximately the weight of the organic matter in the water.

Water derived from sewage contains a considerable amount of organic matter. When any water passes through the soil, it comes in contact with decomposing organic substances and carries some of them along in solution. The quantity of organic matter, or of the characteristic products of the decomposition of organic matter, is an indication of the original degree of pollution of the water, and also of the degree of its purification. The organic matter consists of carbohydrates and proteins, and of bacteria and shreds of wood and leaves, all of which will burn. The presence of a large proportion of matter which will burn is an indication that the natural processes of oxidation and purification are incomplete, and that a considerable amount of organic impurities that may possibly be harmful still remain in the water. The identification of the organic impurities is determined principally by tests for the nitrogenous substances, which are ammonia, nitrites, and nitrates.

The greater part of the substances which are dissolved in water are usually minerals unless the water is grossly polluted. The quantity of mineral matter in water will vary widely from the large proportion found in mineral waters to the small amount found in water from sandy soil. A water containing 500 parts of total solids per 1,000,000 is not considered fit for household use. Water of good quality usually contains less than 100 parts of total solids per 1,000,000.

Nitrogenous Products.—Ammonia, nitrites, and nitrates are products of the decomposition of proteins, and contain the nitrogen of the proteins. Practically all the nitrogen that is found in water is derived from protein impurities, especially from sewage and decomposing animal matter. The amount of nitrogenous substances in a sample of water is an indication of the quantity of organic impurities which the water contains or has contained.

Ammonia.—The test for ammonia in water is performed in two stages: first, the determination of the amount of *free* ammonia, or of ammonia that has already been formed; and second, the determination of the *albuminoid* ammonia, or of the ammonia which may be formed out of the undecomposed protein or albuminous matter that is in the water.

The first stage of the test for ammonia is performed by distilling the ammonia from 500 c.c. of water, and adding the distillate to tubes of Nessler's reagent, which is a standardized solution of potassium iodid, mercuric chlorid, and caustic soda. The presence of ammonia is indicated by the appearance of a yellow color in the tube. The quantity of ammonia is determined by comparing the color of the sample with that of similar tubes containing known quantities of ammonia.

The second stage of the ammonia test is performed by adding potassium permanganate and caustic soda to the water which remains after the first distillation, and repeating the distillation and the test. The protein in the water is decomposed by the permanganate, and its nitrogen appears as ammonia.

Nitrites.—The test for nitrites in a water is a pink color which develops when a small quantity of a standard solution of sulphanilic acid and naphthalymin is added to a sample of the water. The quantity of nitrites is indicated by a comparison of the color with that of tubes in which the test is made with known amounts of nitrites.

Nitrates.—The test for nitrates in water is made by evaporating the water to dryness, treating the residue with phenoldisulphonic acid and an alkali, and diluting the mixture with pure water. A yellow color indicates the presence of nitrates, and the amount is indicated by a comparison of the depth of the color with the colors of tested tubes containing known quantities of nitrates.

Significance of Nitrogenous Products.—Albuminoid ammonia, free ammonia, nitrites, and nitrates form a series indicating successive degrees of the decomposition and oxidation of protein from the unchanged substance to that which is completely oxidized. Ammonia is produced during the first stage of decomposition, and is found almost as soon as decomposition begins. As the natural process of purification proceeds, the ammonia is acted upon by the nitrifying bacteria of the soil and by other oxidizing agents, and is oxidized first to nitrous acid and then further to nitric acid, both of which unite with minerals of the soil to form nitrites and nitrates.

Albuminoid ammonia represents protein which has not undergone decomposition, and its presence in any considerable quantity indicates that the drainage from sewage, manure, or other decomposing substance is entering the water by a fairly short and direct route.

Free ammonia is an indication that a water is receiving the drainage from substances that have undergone some degree of decomposition which is not far advanced. Some ammonia that is derived from the air may usually be found in rain-water, but any considerable quantity in ground water suggests the existence of a nearby source of pollution.

Nitrites are transient products that exist for only a short time just before the oxidation of ammonia to nitric acid is completed. They are not normally found in water, and their presence is an indication that organic matter is still undergoing decomposition in the water, but that the process of purification has advanced to a greater degree than is indicated by the presence of ammonia.

Nitrates are stable mineral products, and form a part of the ashes which are produced by the oxidation of protein. They are found in all soils and in all ground waters. Their presence in unusual amounts is usually an indication that a large quantity of organic matter has existed near the source of the water, but that it has been completely destroyed. If an excess of nitrates is found in water, it would be the duty of a health officer to search out the source of the decomposing matter from which they come, and to take steps to insure the future purity of the water.

Chlorin in the form of chlorid of soda, or common salt, is naturally found in nearly all water. Its quantity varies in different localities, but its natural amount in a given locality is fairly constant. A marked increase in its amount in water is an evidence of pollution with the excretions of human beings or of lower animals. Chlorin may persist in the water after all the organic matter from which it has been derived has been fully decomposed and oxidized.

The test for chlorin is made by adding a few drops of a solution of bichromate of potash to a sample of the water, and then adding a standard solution of silver nitrate drop by drop until the water begins to appear red. The silver of the silver nitrate unites with the chlorin of the sodium chlorid as long as any chlorid is present, and then it unites with the potassium bichromate, forming a red silver salt. The quantity of silver solution that is used before the red color appears, compared with the amount of water tested, is an indication of the proportion of chlorin in the water.

Bacteriologic Examination.—Water nearly always contains a few ordinary bacteria of fermentation and decay, but these kinds have little significance, for they are harmless to man. Thousands in each cubic centimeter of water would be unusual, and would indicate the presence of polluting material on which the bacteria are living.

Colon bacilli are the characteristic bacteria of the intestines of warm-blooded animals, including man. They are discharged in immense numbers with the excretions, and their presence in a water-supply is an indication of pollution with human excretions, sewage, or barnyard drainage, except in the rare instances of pollution with the excretions of wild animals and birds. It is almost impossible to detect and identify the bacteria of any human disease in water, but the detection of colon bacilli and the determination of their number is easy. If colon bacilli enter a water-supply, the germs of typhoid fever and other intestinal diseases may enter it also. The colon bacilli are longer lived and more resistant than the germs of specific diseases, and their absence from a sample of water is an almost sure indication that typhoid bacilli and all other bacteria derived from the human intestine are absent also.

An estimation of the number of bacteria in a sample of water is made by mixing a small measured quantity of water with a gelatin culture-medium that is liquefied with heat, pouring the mixture into a Petri dish, and counting the colonies that develop. Two series of plates are usually prepared, and one is incubated at the ordinary temperature of a room (20° C.) and the other at the temperature of the human body (37° C.). The ordinary bacteria of the soil do not grow well at the higher temperature, while colon bacilli and disease germs do not flourish at room temperature. The number of bacteria present in each cubic centimeter of wholesome water will usually vary from less than a score to over a thousand.

Estimation of Colon Bacilli.—When colon bacilli grow in the presence of certain sugars, such as lactose or dextrose, they produce gases and acids. In one test, a sample of water is mixed with a liquid culture-medium containing lactose in a tube which is arranged in such a way that it catches any gas that may be produced. The production of gas indicates the presence of colon bacilli. Ox bile is sometimes added to the culture-medium in order to restrain the growth of all bacteria besides those of the intestinal group. The test is usually made in a series with 1, 0.1, and 0.01 c.c. of water. The report which is made by the laboratory states the smallest amount of water in which the colon bacilli were found, and from this an estimation of the number of bacilli per cubic centimeter can be made. If, for example, they were found in 0.1 c.c. and not in 0.01 c.c., each cubic centimeter of the water contains 10 bacilli.

Another method of determining colon bacilli is to implant the water in a Petri dish containing a culture-medium to which alkaline or blue litmus is added as an indicator. If colon bacilli are present, their colonies may be recognized by their red color which develops as the result of the action of the acid of the bacteria. The number of red colonies indicates the number of colon bacilli that were in the sample of water that was implanted, and from this the number in each cubic centimeter may be estimated.

The presence of colon bacilli in a water-supply usually indicates that the water is polluted with sewage or the excretions of human beings or domestic animals, and that the source of the pollution is near by and is likely to make the water dangerous for household purposes.

Collection of Samples.—While a health officer is not expected to make a laboratory examination of water, he is expected to be able to take samples for the laboratory, and to have sufficient knowledge to understand the meaning of the laboratory report. At least a gallon of water is needed for a chemical analysis, and the container must be a glass-stoppered bottle in order to avoid contamination of the water. Laboratories and state departments of health will usually supply the containers for both chemical and bacteriologic examinations.

In taking a sample, be sure to obtain one that is representative of the true condition of the water. Take a sample from a river or lake at some distance from the shore in order to avoid stirring up a sediment. Be careful not to touch the lower part of the stopper or the inside of the neck of the bottle. If a sample is taken from a water-pipe, allow the water to run for at least five minutes before filling the bottle.

Samples for the bacteriologic examination of water are usually taken in sterile, 2-ounce, glass-stoppered bottles. The utmost care must be taken to get a representative sample and to avoid the contamination of the stopper. It is well to take both chemical and bacteriologic samples at each collecting station. Ship the samples by express by the quickest route in order that they may be examined before changes can occur in the water. If the weather is warm, pack the bacteriologic samples in ice.

Always send with the samples a detailed description of the location at which the samples were taken and of the source of the water-supply, whether from a lake, or river, or well. If from a well, describe its depth, and the character of the subsoil, and the existence of cesspools, barnyards, privies, and other possible sources of pollution near it. If from a lake or stream, describe the character of the land in its vicinity, the density of population, the drainage, and the possible sources of pollution.

Interpretation of Results.—A health officer must consider his inspection of the water-shed or of the surroundings of a well in forming an opinion of the wholesomeness of a water-supply. If the report which he receives indicates a possible pollution, it is his duty to find the source of the suspicious substances. If he has sent with the sample a full description of the drainage area around the source of the water-supply, the report of the analyst will probably contain a discussion of the sources of pollution and suggestions for the proper remedies. It often happens that a suspicious substance has no significance, as, for example, a considerable amount of chlorin in water near the seashore.

Typical Analyses.—The following tables are the results of the analyses of two samples of water taken on the same day. One sample was from the public water drawn from wells located on the outskirts of a village. The other was from a driven pump located near the congested center of the village. The subsoil is sandy and the ground-water level is 10 feet below the surface. The figures indicate parts per 1,000,000:

Public Water-supply.	*Private Water-supply.*
Color, trace.	Trace.
Odor, faint vegetable.	Faint vegetable.
Turbidity, slight.	Pronounced.
Solids, total, 69.	197.
Loss on ignition, 9.	40.
Mineral residue, 60.	157.
Iron, 1.80.	4.88.
Ammonia, free, 0.016.	0.156.
Ammonia, albuminoid, 0.014.	0.022.
Nitrites, 0.001.	0.010.
Nitrates, 0.060.	24.000.
Chlorin, 5.00.	25.75.
Hardness, 14.00.	67.40.
Bacteria per cubic centimeter, 25.	5.
Colon bacilli in 30 c.c. of water, 0.	0.

The water from the public works is pure and wholesome. The color and turbidity are caused by iron rust. The rather high percentage of chlorin is caused by the location of the village on the seashore.

The color and turbidity of the private water-supply are due to iron rust which had accumulated in the storage tank. The high chlorin content indicates that a great quantity of sewage and stable drainage had entered the ground water; and an inspection of the locality revealed many cesspools and two livery stables within a block of the well. The large amount of nitrates indicates pollution, but also that oxidation and destruction of most of the sewage had taken place. The increased quantity of ammonia and nitrites indicates that some of the sewage is incompletely destroyed. The increase in hardness is probably due to the minerals contained in the sewage. The absence of colon bacilli indicates that the pollution has not yet reached a degree in which intestinal bacteria may survive and produce sickness. The analysis shows that the water is polluted, and a consideration of the surroundings indicate that the well must soon be abandoned.

Periodic Examinations.—When there is reason to suspect a constantly increasing danger of pollution of a well, periodic analyses of the water will reveal the progression of the pollution. There will first be an increase of the nitrates and chlorin, next, of the nitrites, and then of the ammonia. Later, colon bacilli will occasionally appear, and finally will be present constantly. Periodic examinations are necessary, for example, when new houses are constantly being built near water works which are located on the outskirts of a village, for there will come a time when the increase of population will cause a dangerous degree of pollution of the water.

Prevention of Water Pollution.—One of the duties of a health officer is to give advice regarding the prevention of pollution of water, and how to secure a wholesome supply. If the water-supply for a farm or an isolated dwelling is a well, the preventive measures are to place the well in a location where the effluent from cesspools, privies, and barnyards cannot reach it; to construct the well water-tight from the surface to a depth of at least 3 feet; and to locate all places for sewage disposal at a safe distance and direction from the well. If a spring is used, the preventive measure is to remove all sources of pollution from its vicinity. If a cistern is used, the preventive measures are to clean it frequently, to keep it covered closely, and to see that the first water that runs from the collecting roof after a shower is discarded.

Household Purification.—Small filters are sometimes sold to purify water for household use. Nearly all of them are worse than useless, for they become dirty, and bacteria grow in them luxuriantly. The only ones that have any value are those of the Chamberlain or Berkefeld type which are made of porous earthenware similar to those used in bacteriologic laboratories. But even these require daily cleansing, and the slowness with which the water passes through them renders their use impractical.

Purification by Boiling.—The surest method which a health officer can recommend for purifying water at home is that of boiling it, for the heat will kill all bacteria of disease that may be in it. Boiling the water for some minutes expels the oxygen which is dissolved in it, and the water then has a flat, unpleasant taste. This taste may be prevented by removing the water from the heat just as it begins to boil, or by shaking the boiled water in a jar in order to restore the oxygen to it. If a health officer is suspicious of the quality of a water, it is his duty to insist that it be boiled before it is used for drinking, or for the preparation of food, or for washing dishes.

It is frequently the practice in rural districts to go to some trouble to secure safe water for cooking and drinking, and to use a polluted supply for the laundry and for scrubbing. This is by no means a safe or desirable practice, and it is the duty of the health officer to use every possible means to secure a pure supply for every purpose.

Purification of Public Water-supplies.—One of the most important duties of a health officer is to keep himself informed regarding the analysis of the public water-supplies of his district, and the possible sources of pollution of the water-shed from which the supplies are drawn. The duty and powers of remedying unsafe, threatening conditions lies with the board of health and the executive officers of the business department of a municipality; but the health officer's duty is to keep the officers and the public informed regarding the conditions, to advocate the proper remedies, and to call the state department of health to his assistance if necessary.

A great difficulty in securing action for preserving the purity of a water-supply is that judges and juries usually require legal proof that sickness has actually resulted from the use of that particular water, or that particular kinds of disease germs have actually entered the water. There is a great need of laws which shall fix the responsibility for remedying unsafe conditions of a water-supply, and which shall prescribe definite measures and legal proceedings to secure the remedy promptly.

Chlorination.—If a public water-supply is polluted, an efficient method of its purification is to add chlorin to it. The apparatus needed is the same that is used in chlorinating sewage (page 446). The object of the chlorination is to kill the bacteria, especially the disease germs, in the water. The quantity of chlorid of lime or of liquid chlorin required is usually 1 or 2 parts per 1,000,000, and is so small that it can scarcely be detected by taste or a chemical analysis of the treated water. An appraatus for applying liquid chlorin can be installed in a few hours, and there is no excuse for delaying its use when pollution becomes known. The Department of Health of New York State has a portable outfit for applying liquid chlorin which it sends out for use in emergencies.

Effect of Reservoirs.—Two measures which are used for purifying water on a large scale are storage in a reservoir and filtration.

When water is stored in a reservoir, its solid particles, including bacteria, settle to the bottom, and the bacteria are killed by the action of the sunlight. It is necessary that the water shall pass through the reservoir slowly and that the sediment shall not be disturbed.

The reservoir must have a capacity equal at least to a day's consumption of water, for at least a day is required to produce a great reduction in the number of bacteria. Storage in a reservoir does not produce complete purification, but it is of great value preliminary to further treatment.

Filtration through sand is the process that is usually adopted for the purification of water on a large scale. A sand filter consists of a bed of sand about 4 feet in depth contained in a covered tank of concrete, and underdrained to carry off the purified effluent. A filtration plant is usually built in units of small beds for convenience of operation and cleaning.

Filter beds are of two kinds, the slow type and the rapid. The principal difference between the two is in the method of operation.

Slow Filtration.—In the slow type of filtration the water is allowed to flow over the bed to a depth of about 1 foot and to sink away at the rate of about 4 inches per hour. This gives the bed a capacity of between 2,000,000 and 3,000,000 gallons a day per acre. The action of the filter is to remove solid particles, including bacteria, from the water. It has no action on substances dissolved in the water. The purifying action of the bed takes place principally in the upper 2 or 3 inches of sand, and is dependent on a gelatinous growth of micro-organisms which forms on the grains of sand. A filter-bed is inefficient until this growth has formed. It is the gelatinous matter, and not the sand itself, which catches the impurities and holds them back from the water which passes through the filter.

A slow sand filter will remain in action about a month, and then the gelatinous growth will obstruct the interstices between the sand grains and prevent the passage of the water. The filter must then be drained and an inch or two of sand removed from its surface in order to restore its permeability. After a few months of service the bed becomes reduced in thickness and the sand must be returned.

Rapid Filtration.—When water is purified by rapid filtration, alum or copperas is added to it in order to coagulate some of the dissolved substances. When the water passes through the filter-bed, the flocculent coagulum adheres to the sand grains, and acts in the same manner as the gelatinous micro-organisms in a slow filter. A rapid sand filter will act about ten times as fast as a slow filter, but the filter must be cleaned every day. The cleansing is done by forcing water backward through the sand in order to wash the coagulum from the sand grains. Chlorin is usually added to a public water-supply after it has been filtered.

The choice between the slow and the rapid systems of filtration is principally an economic and engineering problem. A filter of either type that is properly operated will remove 98 per cent. of the bacteria from a water. Sand filtration of the public water-supplies of cities which formerly had polluted water has produced a great reduction in the amount of typhoid fever in those cities. For example, Albany takes its water-supply from the Hudson River, which contains the sewage from Troy, ten miles up stream. Sand filtration was introduced in 1899. Albany's annual death-rate from typhoid fever before the water was filtered was 90 per 100,000 of population; after filtration it dropped at once to 21.

It is a question which is the more efficient and economic method for cities located on rivers to adopt, to render their sewage effluents completely pure and sterile, or to purify the water-supplies. It is probable that both methods will be required in the future.

Hardness of Water.—What is called hardness in water is caused principally by lime and magnesium dissolved in the water, mostly in the form of carbonates. When soap is mixed with hard water, it combines with the lime and magnesium and forms an insoluble scum—1 grain of lime will neutralize 8 grains of soap. There is a great waste of soap when hard water is used, and the scum which is formed is objectionable. A water containing 12 parts of lime or magnesium per 1,000,000 is considered to be hard; 50 parts per 1,000,000 indicates excessive hardness. The hardness has no effect on health, but a health officer ought to understand its principles in order to advise those who inquire about the condition.

A gallon of pure water will dissolve about 2 grains of carbonate of lime, but if it contains carbon dioxid, it will dissolve five or ten times as much. If hard water containing carbon dioxid is boiled, the gas will be driven off, and a part of the mineral matter will be separated from the water and will be precipitated as sediment, and some will be left in solution. The hardness caused by carbon dioxid is called temporary hardness, while that caused by lime dissolved in the water alone is called permanent hardness.

The test for hardness is to add a solution containing a known quantity of soap to the water drop by drop, shaking the bottle, and noting when a lather forms. The quantity of soap used indicates the amount of lime and magnesium that is in the water.

There is no practical method of overcoming the permanent hardness in water, but the temporary hardness may be overcome by boiling the water. It may also be overcome by adding freshly slaked lime which unites with the carbon dioxid. The removal of the carbon dioxid reduces the solvent power of the water, and the lime that was held in solution by the gas becomes insoluble and falls as a precipitate.

Iron.—A health officer is frequently consulted on account of iron in the water. Iron in laundry water stains the clothes red. It gives an unpleasant taste to water. If often forms an iridescent scum which looks like oil on the surface of the water. It unites with the tannin of the leather in the valves of pumps, and forms black ink, which may give the impression that some one has poisoned the water. When water contains an excess of iron, a micro-organism, called *crenothrix*, may grow in the water-pipes and form a gelatinous mass which may fill the pipes. Particles of the growth may break off and make the water turbid, or decay and give the water an unpleasant odor and taste. Driven pumps that are used in kitchens are often affected with the crenothrix. The effects of iron in household water simulate all manner of unsanitary conditions of the water, and yet the iron has no perceptible effects on health. A health officer is often perplexed in explaining the unpleasant conditions produced by iron in water, and in making sure that iron is actually the cause of the trouble.

Iron in water is usually that which has been dissolved from the soil. It is dissolved in a ferrous state in which it is soluble in water, but when it comes in contact with air, it is oxidized to a ferric state, in which it is insoluble and falls as a red precipitate of so-called iron rust. This is the usual manner of the formation of the red sediment in water pitchers in which water stands for a few hours, and of the red mud which often forms in the bottoms of storage tanks. Iron is likely to give trouble if more than ½ part per 1,000,000 is present in water. Little can be done to prevent trouble with iron in kitchen pumps. If a storage tank is used, the iron will become oxidized and will be precipitated after the water has stood for some hours. If the intake and outlet pipes are arranged in such a way that they do not disturb the sediment, storage in a broad, shallow tank will remove a large part of the iron.

Public water works often have trouble with iron-rust in the water. One method of removing the iron is to aërate the water by passing it over a grating, storing it in a reservoir, and filtering it if necessary. The aëration oxidizes the iron to an insoluble form in which it subsides to the bottom of the storage tank.

CHAPTER XL

VENTILATION

Definition.—The subject of ventilation embraces a study of the various conditions of the air of enclosed spaces in their effects upon human beings. The health officer is especially interested in the effects of air that is modified by housing, breathing, and occupations upon persons who breathe such an atmosphere. The principal conditions of the air which may affect health are its chemical composition, temperature, humidity, movements, dust, and living organisms.

The air affects the body chemically through the organs of respiration, and physically by contact with the skin. Many atmospheric conditions with which a health officer has to deal affect the skin much more than the lungs.

Composition of Outdoor Air.—The standard of purity of the air is that of the outdoor air of the fields and woods. Such air is composed of gases in about the following proportions:

	Per cent.
Oxygen	20.94
Nitrogen	78.09
Argon	0.94
Carbon dioxid	0.03
Helium, ammonia, nitric acid, etc.	trace

The proportions of the various gases of outdoor air do not vary appreciably in various samples, no matter from what locality the samples are taken, except in those taken in the immediate vicinity of sources of gross pollution. The weight of air over every square inch of the surface of the earth is 15 pounds, and that over each square foot is 1 ton. This amount is so great that whatever gases can be taken from the outdoor air are insignificant in comparison with the whole quantity of the atmosphere; and those which can be poured into the air are soon diluted to harmless traces. The only situations in which foreign gases are usually present in outdoor air in appreciable amounts are the immediate vicinity of volcanoes, chemical factories, and gas plants. The gaseous composition of the outdoor air of crowded streets of cities is practically the same as that of rural districts. Fresh, wholesome air is as available to city dwellers as to the people of the country. The healthfulness of the air of the seashore, the mountains, the forests, and the prairies depends on other factors than its chemical composition.

Temperature.—The body regulates its temperature by varying the elimination of its heat into the surrounding atmosphere. It is adjusted to live with comfort in air at a temperature of about 68° F., which is about 30 degrees cooler than itself; but it can adjust itself to air that is 100 degrees or more cooler. As the temperature of the air rises above that for the maximum comfort, the body has increasing difficulty in getting rid of its heat. Feelings of uneasiness, restlessness, dulness, sleepiness, and headache then develop, and there is a feeling of oppression in breathing. Later the temperature of the body rises, faintness comes on, and a heat-stroke develops.

The effects of an air temperature approaching that of the body depend largely upon the humidity of the air. The body eliminates its heat by radiation into the air and by the evaporation of perspiration. If the air is dry, the evaporation of perspiration may be sufficiently rapid to cool the body even when the temperature of the air is higher than that of the body.

Humidity.—The atmosphere always contains vapor of water. The quantity of water that it can hold depends principally upon its temperature. One cubic foot of air at 32° F. can hold 2.2 grains, while at 70° F. it can hold 7.9 grains, and at 90° F., 14.3 grains.

The humidity of the air is usually expressed by the degree of its saturation with moisture. If it contains all the moisture that it can hold, its humidity is 100 per cent. If it contains only one-quarter as much as it can hold, its humidity is 25 per cent. If the humidity is less than 40 per cent., the air is noticeably dry. It seldom falls below 10 per cent. even in deserts. The humidity of outdoor air on foggy days is 100 per cent.

Humidity may be measured with a hygrometer consisting of a pair of wet and dry bulb thermometers. The bulb of one is enclosed in a bag of wet muslin, and the evaporation of the water cools the mercury. If the temperature of the dry bulb and the difference between the readings of the thermometers are noted, the humidity may be read from tables which are furnished with the instrument. For example: if the temperature indicated by the dry bulb is 80° F., and that by the wet bulb, 75° F., the humidity is 79 per cent. If the air is saturated with moisture, no evaporation will take place. The temperatures of the two bulbs will be identical and the humidity will be 100 per cent.

Humidity effects health principally by its influence on the temperature of the body. A high degree of humidity prevents the evaporation of perspiration. If both the temperature and the humidity of the air are high, the heat-regulating mechanism of the body may be unequal to its task. The body temperature will then rise and there will be a fever and sickness; but if the humidity is low, the evaporation from the skin may be sufficient to keep the body cool even on a hot day. A humidity of 80 per cent. makes an air temperature of 75° F. feel uncomfortably warm, but if the humidity is 50 per cent., an air temperature of 90° F. may not be oppressive.

The temperature which a person feels on a hot day, and the danger that may be apprehended from the heat, are indicated by the reading of a wet bulb thermometer, for the bulb that is bathed in moisture is in the same condition as the skin of a perspiring person. If, for example, an ordinary thermometer shows a temperature of 85° F., while that of a wet bulb indicates 75° F., one's sensation of warmth is that of 75 degrees and not of 85 degrees.

Moisture increases the capacity of cold air to conduct heat away from the body. Humid air at a temperature of 32° F. feels almost as cold as dry air at zero.

Neither a high nor a low degree of humidity has much effect upon the body when the temperature of the air is between 60° and 70° F. A humidity of between 60 and 70 per cent. is usually considered to be the most comfortable and healthful.

Air Movements.—Air currents, like humidity, influence health chiefly through their effect on body temperature by favoring the evaporation of perspiration and the conduction of heat from the skin. The oppressiveness of a hot, humid day is greatly relieved by a gentle breeze even when the temperature and humidity remain unchanged.

Dust in Outdoor Air.—Particles of solid matter are always suspended in the air. They are derived principally from smoke, dust raised by the wind, substances ejected from volcanoes, and mineral matter from sea spray. The number of particles in each cubic centimeter is enormous. Observers find hundreds in the purest air of mountain tops, and hundreds of thousands in the vicinity of cities. The dust in the air has an important effect on our comfort and welfare, for its particles condense moisture on their surfaces. They take up the excess of watery vapor from the air and give it back slowly, and thus have a great effect in regulating the temperature of the air. They are the centers on which water condenses to form clouds. Each particle of mist in a fog and each raindrop has a bit of dust for a center. If there were no dust in the air, moisture would condense on every object on the surface of the earth, and our clothing and houses would be constantly wet. The natural dust of the air is beneficial to mankind, and almost the only exception is that pollen grains inhaled may cause hay-fever or asthma in susceptible persons. Smoke has little or no injurious effect upon the body of a person who breathes it, and its suppression is desirable more for economic and esthetic reasons than on public health grounds. Smoke and other solid particles in outdoor air are soft and small, and lack the size and sharpness which constitute the principal danger in the dust of occupations.

Living Organisms in Outdoor Air.—Bacteria and molds may nearly always be obtained from the outdoor air, but their numbers are not large. About 50 bacteria may usually be obtained from each cubic foot of air in rural districts, and from 75 to 100 in city streets. Nearly all these bacteria belong to harmless varieties. Probably the most abundant disease germs are those which produce pus in wounds, but only about 10 or 20 can usually be found in each 100 cubic feet of air either in the country or the city. The number of bacteria in the air is increased when much dust is raised by the wind, but they are seldom or never so abundant in outdoor air as to affect health. Even the air of sewers is almost free from bacteria.

Weather and Climate.—Atmospheric conditions which ordinarily affect our senses constitute the weather and climate. The principal weather conditions which affect health are those of sunlight, temperature, moisture, and air currents. The body has a great natural ability to adapt itself to these varying conditions, and the adaptibility is made almost complete by means of artificial clothing and housing.

Weather conditions in our homes may be opposite to those out of doors. The indoor air of a heated house on a foggy day may have a humidity of 30 per cent., while that out of doors is 100 per cent. The air of a kitchen or sitting-room often has a temperature of 85° F. and a humidity of 100 per cent., while the outdoor air is at zero temperature. The violent changes from indoor to outdoor weather to which most persons subject themselves many times daily in winter are vastly greater than the natural daily changes in the outdoor weather. It is unreasonable to ascribe sickness to the changeable outdoor weather when no harm comes from frequent exposure to greater contrasts between indoor and outdoor weather conditions. Bad weather affects health principally because it leads people to stay indoors where there are abundant chances of contact infection.

Indoor Air.—While human beings are adapted to live healthful lives amid the changes which naturally take place in the outdoor air, they are readily affected by some of the conditions which develop in the air of closed rooms as the result of breathing and of fires. Air which has been inhaled or made foul by breathing and combustion produces bad effects upon the body both immediately and also remotely. The immediate effects are dulness, oppressive breathing, headache, and general discomfort, and are almost exactly similar to those produced by warm air at a temperature near that of the body.

The remote effects of foul air are a general lowering of bodily vigor, and a vague weakness and lack of tone. These effects may best be appreciated by contrasting them with the tonic effects of the fresh air in the outdoor treatment of tuberculosis.

The changes which a health officer has to consider in the air of dwelling houses, assembly halls, and other enclosed meeting places are those in its chemical composition, temperature, humidity, and movements, and in its content of dust and living organisms.

Composition of Indoor Air.—The change which takes place in the gaseous composition of the air of an occupied room is similar to that which is produced in inspired air by respiration. The following table shows the approximate composition of expired air contrasted with that of outdoor air. The two sides of the table do not exactly balance because some of the gases of the inspired air are eliminated by the kidneys and skin:

	Outdoor air, per cent.	Expired air, per cent.
Oxygen	20.94	16.4
Nitrogen and other inert gases	79.03	79.03
Carbon dioxid	0.03	4.1
Organic gases	none	trace

The degree of the change in indoor air depends on the number of persons breathing the air, the length of their stay in the room, and the quantity of outdoor air that is admitted. Under ordinary conditions excessively foul air will still contain over 20 per cent. of oxygen, and its carbon dioxid will not be much above 0.4 per cent.

The effects of respired air upon the body have been carefully tested upon persons confined in a respiratory chamber in which the air could be analyzed, the work done by the subjects measured, and every condition of the experiments estimated with accuracy. These experiments have been repeated, amplified, and confirmed since 1913 by the New York State Commission on Ventilation. They prove that a diminution in the amount of oxygen and an increase in the carbon dioxid produce no discomfort or other noticeable effects, provided the humidity and temperature of the air remained normal. For example, a group of students were confined in the experimental chamber until their respiration lowered the proportion of oxygen in the air to 17 per cent. and raised that of carbon dioxid to 2 per cent., while the temperature and humidity of the air were kept normal. These students felt no discomfort, and their physical and nervous functions showed no appreciable change. Yet matches lighted by the students would not burn, owing to the diminution of the oxygen. The oxygen content of the air which the students breathed in the experimental chamber was reduced to four-fifths of its normal amount, while that in extremely badly ventilated halls and factories has very seldom been found to be reduced to $\frac{18}{20}$ of its usual proportion.

Similar experiments prove that carbon dioxid does not begin to be harmful to man until it has accumulated to such an extent that it forms 1 per cent. of the inspired air, or thirty times its usual proportion in the air. But it is not found in the air of crowded and poorly ventilated rooms in greater amounts than ten or fifteen times its proportion in outdoor air.

There is a great margin of safety in the air of every poorly ventilated meeting place and dwelling house so far as the content of carbon dioxid and oxygen is concerned. The reason for this fact is evident when the physiology of respiration is considered. The air that remains in the alveoli of the lungs after a forcible expiration contains about 16 per cent. of oxygen and 5 per cent. of carbon dioxid. An abundance of oxygen can enter the lungs when it forms 18 to 20 per cent. of the air. Carbon dioxid can pass off from the lungs and into external air which contains 1 or 2 per cent. of the gas.

Experiments have been made by collecting the organic substances which are expelled from the body with the expired air, and injecting them into animals. The experiments at first seemed to show that they are poisonous, but when they were repeated with due care, nothing poisonous has been found in them. The substances give an unpleasant odor to the foul air of a room, but they produce no harmful effects upon the body.

Temperature, Humidity, and Movement.—The factors of temperature, humidity, and movement of the air are closely related in the ventilation of occupied rooms. The body heats the inspired air, and its whole surface imparts heat to the surrounding atmosphere. Moisture is expelled with expired air and evaporated from the skin. The atmosphere of a closed, unventilated room is practically motionless, and a blanket of warm, humid air surrounds each person who sits quietly in it. The heat, humidity, and calmness act upon the body in the same manner as the same weather conditions on a calm, sultry day of midsummer. Nearly all the effects of the air of unventilated rooms will be reproduced upon a person who breathes air that is warm, humid, and motionless, even when the air is chemically as pure as that out of doors. The effects are due principally to the interference with the elimination of heat from the body, and not to the chemical effect of the air.

The following experiments illustrate the effects of the various factors that are concerned in ventilation:

1. When persons entered a respiratory chamber in which the air chemically pure was kept at a temperature of 80° F. and the humidity at 80 per cent., depressing effects were felt within a few moments, but were relieved by starting an electric fan which caused the air to circulate and dissipate the heat from the bodies of the subjects.

2. When the air in a respiratory chamber was breathed over and over, it became extremely impure according to its oxygen and carbon dioxid content; its temperature and humidity rose; and the subjects felt its depressing effects keenly. The subjects then breathed fresh outdoor air admitted to their noses and mouths through tubes, but there was no relief of their feelings. Persons standing outside the chamber then breathed the hot, moist, impure air that was drawn from the chamber, and they felt no discomfort or ill effects. Electric fans were then started in the chamber, and the subjects in it were quickly relieved, as in the previous experiments.

Such experiments as these demonstrate that the chief effects of air vitiated by respiration are physical and not chemical; and that the principal parts of the body that are directly affected are the skin and the heat regulating system, and not the lungs and the respiratory system. A rise in the body temperature of from $\frac{1}{4}°$ to $\frac{1}{2}°$ F. usually results from prolonged exposure to air which has a temperature of 75° F. and a humidity of 75 per cent.

Dust.—The number of particles of inorganic dust in the air of occupied rooms is usually many times greater than the number out of doors. The number in each cubic foot of air of occupied school rooms is usually over a million, and when dust is raised by violent movements of the pupils, the number reaches several millions. The ordinary inorganic dust of school rooms and other meeting places is seldom harmful in itself, for its particles are soft and light, and the mucous membrane of the nose readily collects them and prevents them from entering the body. The dust which is particularly harmful is that of occupations, and consists of sharp, heavy particles of metals and minerals, and of poisonous substances, such as lead or arsenic. Dust containing bacteria from human sources is also harmful.

Bacteria.—The number of bacteria in the air is greatly increased when dust is raised. While the number in the air of dwellings, schools, office buildings, and factories is usually less than 500 per cubic foot, it sometimes rises to 5000 or more when the floors and furniture are unclean. The air transmission of diseases is now considered to be very exceptional, but still a real danger of its occurrence may exist. It is proved that cases of various contagious diseases may be safely treated in one ward when great cleanliness of both the attendants and of the room is maintained. But it is reasonable to expect that living bacteria will be found in the air of filthy rooms when diseased persons soil the floor with their expectoration, vomited matter, and excretions. Every health officer knows that these conditions frequently exist in dwellings and even in meeting places. If the infected matter is dried, and is raised as dust by tramping feet within a few minutes after its expulsion from the body, the air will very likely contain living disease germs in sufficient numbers to spread infection. It is a common habit for men to expectorate upon the floor and to scrape their feet over the ejected matter in order to wipe out the visible evidence of it. The substances dry almost immediately, and are raised as dust before the bacteria have time to die. The danger of infection with dust will be increased by infectious matter contained in droplets expelled by the acts of spitting, coughing, and sneezing (page 170). The dust of filthy dwellings and meeting places must be considered to be a menace to health.

Ventilation.—The object of the ventilation of occupied rooms is to maintain the air in a condition which approximates that of the outdoor air on a pleasant, temperate day of summer. The principal factors which are to be considered are its cleanliness, chemical composition, temperature, humidity, and currents.

Cleanliness of indoor air is indicated by its freedom from dust and odors. It depends principally upon the source of the supply, and upon the cleanliness of the room and its occupants. The air of filthy rooms will be dusty, will contain many bacteria, and will have a foul odor.

Chemical Composition.—Although the carbon dioxid produced by respiration is seldom harmful in itself, yet it is usually taken as an indicator of the vitiation of the air and of the efficiency of ventilation. The standard of the chemical purity of indoor air is that its percentage of carbon dioxid shall not be more than two or three times that of the outdoor air. The following computation will illustrate the method of estimating the amount of fresh air that is required in ventilation:

30 number of cubic inches of air in each inspiration.
0.04 percentage of carbon dioxid in expired air.
1.2 cubic inches carbon dioxid exhaled per breath.
18 number of inspirations per minute.
21.6 cubic inches carbon dioxid exhaled per minute.
60 minutes in one hour.
1296 cubic inches = 0.7 cubic foot = amount of carbon dioxid exhaled per hour.

0.7 ÷ 0.0003 (the percentage of carbon dioxid in outdoor air) = 2333 = number of cubic feet of air in which the percentage of carbon dioxid would be doubled in one hour by the respirations of one person. The standard quantity of fresh air which is usually adopted by ventilating engineers is 2000 cubic feet per hour for each adult person occupying a closed room. Experience has shown this to be a safe standard for health, comfort, and decency.

The carbon dioxid test that is used in the laboratory of the New York City Department of Health is as follows:

Collect a sample of air by taking a 2-gallon bottle or jug filled with water into the room from which the air is to be taken. Empty the bottle, cork it tightly, and carry it to the laboratory. Add a known quantity of a solution of barium hydroxid ($BaOH_2$) with phenolphthalein as an indicator of acidity, and shake it well. The carbon dioxid will combine with the barium to form an insoluble carbonate, $BaCO_3$. Add oxalic acid carefully until the color is just discharged. The oxalic acid will combine with that part of the barium which has not combined with the carbon dioxid. If the quantities of barium and of oxalic acid are known, the quantity of carbon dioxid in the bottle may be calculated.

Odor Test.—Air that has been made foul by breathing has an unpleasant odor which comes from the breath and perspiration whether the room and its occupants are clean or not. The intensity of the odor is a fairly reliable indicator of the degree of the foulness of the air. When the percentage of carbon dioxid has risen to 6 parts per 10,000, the odor begins to be apparent; and when it reaches 10 parts, the odor is very pronounced. A health officer may properly condemn the ventilation of a room if he can detect the odor of foul air on entering it. The sense of smell soon becomes dulled, and the odor is not noticeable after the air has been inhaled a few moments, and so the test must be made on coming directly from the fresh air.

Temperature.—The standard temperature that is usually adopted for dwellings, school rooms, and meeting halls is 68° F. for the great mass of the air, with a permissible tempearture of

10 degrees lower on the floor and beside the windows and doors. If the difference in the temperatures of the various parts of the room is more than 10° F., there will be uncomfortable drafts of cold air in the room. A standard requirement is that the average temperature of incoming air shall not be more than 10° F. lower than that of the room air.

Each person in a room gives off about 100 calories of heat per hour. One calorie will raise the temperature of 20 cubic feet of air 10° F. The heat which each person gives off in an hour will raise the temperature of 2000 cubic feet of air 10° F.; 2000 cubic feet of air per hour admitted at a temperature of 58° F. will, therefore, be raised to a temperature of 68° F. by the heat that is produced by one person. Under ordinary conditions of heating and ventilation, if the heating of an empty room is adjusted to maintain a constant temperature of 68° F., and a number of persons enter the room, a constant supply of 2000 cubic feet of fresh air per person at a temperature of 58° F. will maintain the room at a temperature of 68° F. continuously. If the standard requirement of fresh air is calculated on a heat and temperature basis, it will agree with that calculated on the basis of carbon dioxid.

Humidity.—The standard degree of humidity of occupied rooms is 60 per cent. at a temperature of 68° F. The humidity may be as low as 30 per cent. without apparent injury to health, but the air will be perceptibly dry, and will have deleterious effects on the furniture and other contents of the room. If the humidity is raised above 60 per cent. by breathing, the temperature of the air will probably be raised also, and the evil effects of poor ventilation will be felt.

Each person gives off about 2 ounces of water to the air during each hour with the breath and perspiration. Each cubic foot of air at 68° F. and 60 per cent. humidity will contain about 5 grains of moisture; and 2000 cubic feet, which is the standard requirement per person per hour, will contain about 20 ounces. Each person in a room will give off 2 ounces or 10 per cent. additional moisture, and will raise the humidity of the air supply to 70 per cent. If a room receives only 1000 cubic feet of fresh air per person per hour, the humidity will rise to 80 per cent., which is too high for comfort and health. The standard requirement of 2000 cubic feet of fresh air per person per hour is usually adequate for maintaining the proper degree of humidity of a room.

The humidity of the air of a room on a cold day may be roughly estimated by observing the condensation of moisture on the windows. If the windows are dripping with moisture, the air is too humid for health and comfort. The combined temperature and humidity of the air may be measured by means of a wet and dry bulb thermometer (page 466).

Air currents are necessary in order to change the air of an occupied room, and also to remove the blanket of warm, moist air that forms around the body of a person who sits quietly in calm air. It is often a difficult problem to maintain the currents without producing uncomfortable drafts.

A current velocity of 3 or 4 feet per second will deflect a light curtain, and may be felt as a movement. A slower velocity will be felt as a chill if the temperature of the incoming air is considerably lower than that of the room.

Air Space.—The air currents will depend largely upon the size of the air space of a room. The air of a room cannot ordinarily be changed more than six times per hour without producing unpleasant currents and drafts. If 2000 cubic feet of air per hour per person are to be supplied by changing the air of a room six times per hour, each person will require 333 cubic feet of air space. A standard requirement per person in meeting places is 500 cubic feet. The New York State requirement of space for a public school is 200 cubic feet per pupil in the lower grades and more in the upper grades. This minimum amount is considered to be adequate, for teachers are presumed to have intelligence to observe the air conditions and interest to operate the ventilating system.

Methods of Ventilation.—Natural ventilation depends upon the wind, and upon the difference between the temperature of air in a room and that out of doors. The wind may either force air into a room, or it may exhaust the air from it by blowing across windows and other openings.

The expansion of air by heat, and the difference in weight between warm and cold air, produce an outward flow of warm air from a room, and of cold air into it. A great exchange of air takes place through cracks in the windows, doors, and floors, and through the walls of houses. Experiments show that 8 cubic feet of air per hour will pass through each square yard of brick wall when the air of an enclosed space is 10° F. warmer than that outside.

Open windows are the most convenient of all means of ventilation. A frame covered with thin muslin fitted to the window like a mosquito bar will prevent unpleasant air currents. These frames are efficient in the ventilation of cow barns, and are equally efficient in bedrooms.

Ventilators in the ceiling allow the hot air to rise out of the room, while cool, fresh air enters through windows, doors, cracks, and other openings.

Hot-air furnaces ventilate as well as heat a house, but the system is usually inadequate for school houses and meeting halls.

Artificial Systems.—The ventilation of large buildings is usually accomplished either by the plenum system, in which air is forced into the rooms; or by the vacuum system, in which the air is exhausted from them; or by a combination of the two methods. The systems require constant expert attention. The artificial control of the air-supply makes it possible to remove the dust and to add moisture to the air. It is even possible to wash the air that has circulated through the rooms and to use it over again.

Methods of Heating.—The great value of an open fireplace is that it is an efficient ventilator. A gas or oil heater may properly be condemned, for it vitiates the air with carbon monoxid, aldehyds, and other poisonous products which are poured directly into the air.

An iron stove does not ventilate a room. When a stove is red hot, carbon monoxid may pass through the iron into the air. A hot-air heater must necessarily send a great amount of air into a room. The purity of the air will depend upon its source. Heating the air neither adds anything to it nor takes anything from it, provided the furnace does not leak gas or ashes.

A radiator heated with steam or hot water does not ventilate a room. A cubic foot of air at a freezing temperature contains about 2 grains of moisture when it is saturated, but the same air can hold nearly 8 grains when it is heated to 70° F. Saturated outdoor air at a freezing temperature will have a humidity of only 25 per cent. after it has entered a heated room. It is necessary to add water to the incoming air of a heated room. This may be done by means of a pot of water set in the jacket of a hot-air furnace or by means of special evaporators placed on the backs of radiators.

The Health Officer and Ventilation.—The health officer seldom has direct control over ventilation, for there are no fixed standards of the purity of the air and of methods of ventilation. But he can have a great influence by educating the people regarding the value of fresh air and the methods of obtaining it. He can also act as adviser of those who have charge of the ventilation and heating of schools, churches, meeting halls, and other places of assembly.

CHAPTER XLI

INDUSTRIAL HYGIENE

Control of Working Conditions.—Some occupations, such as farming, are popularly known to be healthful; some, such as lead working, may directly produce ill health and disease; and in others, such as mining, there is a great risk to life and limb. Skilled workmen are able to take the needful precautions against disease and accident, and to secure the essential comforts of life in their places of work; but unskilled laborers must accept the conditions under which they are compelled to work. The laws are now requiring employers of labor to provide the proper safeguards for the life, health, and comfort of their workmen. The enforcement of the laws rests primarily with departments of labor and factory inspectors, but the control of conditions which directly affect the life or health of workmen is within the scope of the activities of a health department.

The physical welfare of workingmen is becoming of increased importance to a health officer owing to at least four factors:

1. There has been a great expansion of industries in which poisonous chemicals are used.
2. There is an increasing specialization of work in factories and workshops. A man is assigned to a particular duty which he performs over and over through the entire day. He is exposed to the intensive effect of unhealthful influences day after day without change.
3. The physical effects often come on insidiously, and each workman is likely to think that he is immune.
4. There is an increasing employment of ignorant workmen who know little of the trade dangers, take no precautions, and are careless or indifferent.

There is a recognition of the duty of employers of labor to safeguard their workmen against industrial hazards, and to see that they get the protection which they are unable or unwilling to give to themselves. Whatever promotes the health and vigor of laborers benefits the employer. The excuse is no longer valid that employers cannot afford to consider the health and welfare of the employed. The financial cost of ill health resulting from a trade hazard is properly chargeable to the employers and their customers. A laborer bears his share of the burden of a trade hazard when he loses his health or earning capacity as a result of engaging in the work.

Classification.—The subject of industrial hygiene may be considered under three divisions: 1, occupational disability; 2, factory hygiene; and 3, workmen's welfare.

Disabilities resulting from occupations may be divided into two groups: 1, occupational diseases, or those caused by deleterious substances which the workmen handle; and 2, accidents, or those disabilities caused by defective processes of work.

Occupational diseases are classified according to the injurious emanations or substances given off by the materials which are handled by the workmen. These emanations consist of:

1. Metallic poisons.
2. Gases, vapors, and fumes.
3. Chemicals, either liquid or solid.
4. Irritating dusts.
5. Infectious material.

Metallic Poisons.—The metallic poisons which are of special importance to a health officer are lead, mercury, arsenic, and antimony. Lead is used in the manufacture of paints, glass, and storage-batteries, and lead-poisoning occurs in over a hundred common trades and occupations. A health officer investigating alleged cases of industrial poisoning will inquire, first of all, whether or not lead in any form is used.

Mercury is used in smelting precious metals, in the manufacture of incandescent light bulbs, thermometers, and barometers, and in the felt and fur industries.

Arsenic is used in smelting, in the manufacture of certain dyes and paints, and in curing furs.

Antimony is a constituent of type metal, and poisoning by it sometimes occurs among printers.

Metallic poisoning usually occurs from inhaling the dust or fumes from the metals, from their transference from soiled hands to the mouth, and sometimes from the direct absorption of the poisons through the skin. The prevention of the poisoning consists in the use of devices for the suppression or removal of dust and fumes, in the use of respirators and rubber gloves, and in cleanliness of the hands and clothes, especially before eating.

Gases, vapors, and fumes are given off during processes in which hot metals or chemicals are handled, as in metal casting. Painters and varnishers working in closed places are frequently overcome by the vapors of wood alcohol, benzine, or gasolene. The exhaust from gasolene engines may produce dizziness and unconsciousness from the presence of carbon monoxid in the burned gases. When cases of obscure forms of poisoning come to the attention of a health officer, the possibility of poisoning by paints and varnishes or by the exhaust of engines is to be considered.

Chemicals frequently cause eruptions and ulcers on the skin. A common form is an eruption on the fingers of photographers caused by metol in the developer. One of the most important forms of chemical poisoning was formerly the destruction of the bones of the jaws by phosphorus used in the manufacture of matches; but it is not necessary to use phosphorus, and most matches do not now contain it.

The irritant dusts of trades usually do harm in direct proportion to the hardness and sharpness of their particles. The most harmful forms consist of metallic particles, such as those given off during the grinding of sharp instruments. Mineral dusts, such as those of stone-cutting, are less harmful. Coal-dust seems to do little harm, although the lungs of miners may be black with it. Dusts of animal and vegetable origin are usually soft and do little harm.

The harmful effects of irritating dusts occur principally in the lungs, and the principal disease which results is tuberculosis. But the dust is only one factor in the production of the disease, and cannot produce tuberculosis except in connection with other influences, such as bad housing, poor food, fatigue, and exposure to previous cases.

The prevention of the diseases caused by dust consists in the use of respirators by the workmen, and in the removal of the dust by means of hoods and suction fans which take away the dust as fast as it is formed.

The principal infectious material with which workmen come in contact is anthrax spores in the hides, wool, and hair taken from infected animals.

Caisson Disease.—A disease called *caisson disease* is sometimes produced in those who work under an increased air-pressure, as in building tunnels under rivers. The symptoms are severe pains and cramps, and are caused by air-bubbles which form in the spinal cord when the air-pressure is lowered too rapidly. The treatment consists in subjecting the patient to the air-pressure again, and then lowering the pressure slowly.

Accidents.—Three great factors in the causation of industrial accidents are: 1, unguarded machinery; 2, fatigue; and 3, the carelessness of the workmen themselves.

Examples of the dangerous machinery for which an inspecting health officer will look are open gear-wheels, uncovered revolving shafts, especially those having protruding bolts, unprotected knives, and hand-fed presses without guards or guides. Three preventive measures are: 1, provision for stopping the machinery instantly; 2, covering shafts, gear-wheels, and other moving parts; and 3, the use of an individual motor for driving each machine.

Fatigue is a great factor in causing accidents. A tired workman is slow to respond to the signs of danger, and many accidents occur simply from the failure of the fatigued nervous system to act with its usual quickness. There is an increase in the number of accidents in each hour from morning to noon. The number falls during the hour following the noon rest and increases again during the course of the afternoon.

After all possible safeguards against accidents have been taken, there still remains the uncertainty of the action of the human machine. This is usually ascribed to carelessness, but many careful persons are naturally slow in their mental actions, and are temperamentally unfitted to work with dangerous machinery.

The use of alcohol predisposes a workman to occupational diseases and accidents both by making him dull and careless and also by lowering his resistance to the unhealthful influences. Closely related to fatigue are the subjects of child labor, the employment of women, and hours of labor.

Reporting Occupational Disabilities.—There is great need of a deeper study of occupational disabilities. A knowledge of their extent and nature and of the means of their prevention depends upon individual case records made in a complete manner by a uniform method. Such records are necessary in comparing conditions in various places and occupations. It is necessary to secure: 1, a report of every case; 2, a record of the conditions in the factory or shop; and 3, a statement of the exact duties performed by the patient. If, for example, he is a laborer, the record will show the kind of work in which he is engaged.

Factory Hygiene.—The principal points which a health officer will observe in estimating the hygienic condition of a factory are as follows:

1. Sanitary conveniences: Toilets—their number, accessibility, and cleanliness. Washrooms—their location, cleanliness, and supplies of hot water, soap, and towels. Place for hanging clothes; separation of street clothes from those worn during work; each individual suit to have sufficient space to avoid contact with others, and the transfer of lice and infection; provision for drying wet clothes; the use of individual lockers. Eating rooms—cleanliness and conveniences.

2. Cleanliness: Sweeping to be done out of working hours. Spitting—spittoons and their cleanliness.

3. Ventilation, heating, humidity, and odors: Overheating and high humidity are common faults. Provision for suppressing and removing dust.

4. Lighting: Avoidance of dense shadows and of glare in the eyes. Much fatigue comes from eye-strain caused by lights placed on a level with the eyes.

5. Drinking-water: Its purity, coolness, and abundance; provision for drinking-cups or fountains.

Provision for Workmen's Welfare.—It is to the interest of the employer to provide for the comfort and welfare of his workmen. Among the practical means which may be used are the following:

1. Provision for seats, and adjusting the height of tables in order to avoid postural strains, backaches, and spinal curvatures.

2. Rooms for rest and recreation.

3. Medical examinations of the workmen on their entrance to the factory, and periodically afterward; and the adjustment of the workmen to the work for which they are adapted.

4. Provision for first aid, nursing attendance, and beds for the sick and injured.

5. Follow-up work by visitations at the homes of the workmen.

6. Educational work on the nature of special dangers and their avoidance; lunches; recreation during the noon period, and measures to avoid fatigue; the proper use of wash-rooms; the avoidance of infection.

Related Subjects.—Industrial hygiene is closely related to housing conditions, and to economics and sociology. Whatever improves the financial and social standing of workmen improves their strength and efficiency. The proper use of wages in buying food and clothes and in securing proper housing conditions has a far-reaching effect on health. The advice and influence of a health officer will go far toward securing the essential conditions of work and living which make a working man healthy, efficient, and contented.

CHAPTER XLII

CAMP SANITATION

Knowledge Required.—Camps are established either for emergency housing or for pleasure. The object of living in the open or in a temporary shelter in preference to an elaborate system of housing is either to avoid expense or to enjoy a primitive mode of living. Those who conduct a camp are likely to provide a meager outfit, and to manage it in a careless manner, owing to the freedom from the restraints of civilized society and from the incentives to neatness and order which exist in permanent villages. Many persons who go camping are ignorant of sanitation and untrained in sanitary methods, for when they are at home they do no kitchen work, they obtain their water from public sources, and empty their sewage into a public sewer; and when they are in camp they often neglect elementary sanitary precautions. They do this largely through ignorance. The management of a camp requires a degree of skill and sanitary knowledge which is not necessarily associated with a general education. Teachers, ministers, Y. M. C. A. workers, and others who conduct camps often need instruction regarding the elementary principles of camp sanitation.

Camps for laborers are especially likely to be unsanitary owing to the ignorance of their occupants and to the economy and indifference of contractors and employers. The menace from an unsanitary camp is recognized by the Department of Health of New York State, and Chapter 5 of the Sanitary Code is devoted to regulations affecting labor camps. A special feature of the code is that requiring a permit from a health officer for a labor camp to be occupied by 10 or more men during more than six days. The sanitary control of a labor camp by the health officer is justified by the necessity that laborers shall live in it under conditions which are not of their own choosing. The fact that residence in other forms of civilian camps is usually voluntary makes possible their control by educational means.

The general points to be considered in the sanitation of a camp are its location, water-supply, equipment, and management. An experienced camper is able to keep himself comfortable and healthy in an unfavorable locality and with an inadequate outfit. An untrained person will require a favorable site and adequate equipment. A common fault in establishing a camp is that of providing an equipment that is inadequate to the needs of the campers. Inexperienced campers will generally use the equipment which they find at the camp, and will neglect the measures for which no equipment is provided. A fundamental principle in establishing a camp is to provide a location and an equipment that will make the management of sanitary affairs as easy as possible for inexperienced campers.

Location.—The principal hygienic points to be considered in the location of a camp are:

1. Accessibility, including means of transporting, and ease of obtaining, supplies.
2. The soil, its porosity, depth, slope, height above ground water, and area available for the disposal of human wastes.
3. Sources of water-supply.
4. Shade and other protection from the sun and weather.
5. Liability to contaminate a neighboring water-supply.
6. Sources of contamination in the neighborhood.
7. Freedom from flies and from mosquitoes, especially the malarial varieties.

Water-supply.—The water-supply is of fundamental importance in the sanitation of a camp. A health officer will consider its source, the means of preserving its purity, and its relation to the sites for the disposal of wastes. If a well or spring is the source of water, its location will often be the factor which will determine the location of the other equipment of the camp.

Equipment.—The equipment of a camp consists of shelters, furnishings, and food supplies. A health officer will consider the following sanitary points regarding the construction of a shelter:

1. A method of construction and a state of repair that permit of easy cleaning.
2. A floor space of at least 50 square feet per person sleeping in the shelter in order to permit of ventilation and to prevent infection by breathing.
3. Means of ventilation. While canvas may permit the passage of wind through its meshes on dry, windy days, it is almost air-tight on calm, damp days. An unventilated tent may be as stuffy and close as a plastered house. Flaps, windows, or other openings are necessary for ventilation.

A health officer is particularly interested in the furnishings and utensils used in sleeping, eating, and washing. The proper equipment for each of these activities will be found in definite parts of a camp if it is properly managed.

A common fault in sleeping quarters is that of overcrowding.

A space of at least 3 feet is required between beds in order to prevent infection by means of droplets of saliva and mucus expelled during coughing, or sneezing, or loud talking. Additional measures for preventing infection are:

1. Hanging a blanket or sheet between the heads of adjacent beds.
2. Placing the head of one sleeper opposite the feet of the next.

The minimum equipment for handling food and for eating will include:

1. Containers and screens for protecting food against dust, flies, and vermin.
2. Dish-pans and dish-cloths for washing dishes.
3. Metal garbage pails.
4. Metal water pails.
5. Facilities for heating water.

The minimum equipment for washing the person consists of basins, towels, and soap, placed in a definite location in which the waste-water cannot pollute the source of water-supply. It is wise to require the campers to bring their individual basins, towels, and soap. No towel at all is preferable to one that is used in common.

A health officer inspecting a camp will notice the following points regarding the food supply:

1. Does it form a balanced diet? A proper food-supply will contain—

    (*a*) Cereal.
    (*b*) Meat, cheese, or other animal food.
    (*c*) Vegetables.
    (*d*) Fruit.
    (*e*) Salt and pepper.
    (*f*) Sugar.

These foods can be made into appetizing, wholesome dishes by a person who possesses an aveage degree of skill in cooking.

2. Will the food keep fresh with the facilities at the camp? Wholesome foods that will keep fresh may be obtained in dried form or in sealed packages.

3. Can the foods be cooked readily with the utensils at the camp? Desserts and dishes requiring considerable time and skill to prepare are out of place in an ordinary camp.

A health officer will also investigate the source of milk-supply, and will advise its pasteurization at the camp if its quality and grade are not above suspicion.

Management.—The most important element in camp management is the prevention of the transfer of human excretions and wastes from one person to another. The soil, water, and air of uninhabited places are naturally healthful, and will remain so if they are protected from human pollution. The disposal of human wastes requires as constant attention as the preparation of food. The management of the sanitation of a camp consists principally of two classes of measures:

1. Those for general cleanliness, or the disposal of attenuated waste matter.
2. The disposal of gross wastes, such as garbage and sewage.

Cleanliness.—The dirt which a sanitarian seeks to prevent or remove is that which comes directly from human beings. No sanitary effect is usually produced by outdoor dust, the soil of fields and swamps, decaying vegetable matter, or the excretion of wild animals. There are great opportunities for the transfer of infectious material by means of dirty beds, soiled towels, dusty floors, and unclean dining tables. A person does not usually infect himself by means of his own dirt and excretions, but he may infect persons with whom he comes in contact. The danger of infection is in direct proportion to the closeness of contact of the occupants of the camp with one another. The general cleanliness and good order of a camp are fair indications of the care which the occupants take in the disposal of their excretions and in all other sanitary matters. A health officer inspecting a camp will pay particular attention to the cleanliness of every part.

Water-supply.—If the source of the water-supply is a well, spring, or stream on the camp site, the following precautions are necessary for its protection:

1. Locating the buildings so that their drainage will not reach the water.
2. Installing a trough or gutter to conduct the overflowing water away from the source of supply.
3. Disposing of wastes at a place remote from the water-supply.
4. Prohibiting washing near the source of water.

Sleeping Quarters.—A health officer will take note of the following conditions in the sleeping quarters:

1. Cleanliness.
2. Overcrowding.
3. Dryness.
4. Airing the bedding during the day.
5. Open windows, doors, or tent flaps for ventilation during the night.

Kitchen.—The principal kitchen conditions which a health officer will investigate are as follows:

1. Cleanliness of the utensils, tables, and floors.
2. Protection of food from dust, flies, and vermin.
3. Cleanliness of garbage pails. They are to be scrubbed daily with hot water and soap, both inside and outside.
4. Cleanliness of the ice-box. Its inside is to be scrubbed at least twice a week.
5. Cleanliness of the hands and finger-nails of the cook. Facilities for washing the hands are to be provided separate from those used in washing dishes.
6. The quarters and toilet facilities for the cook.
7. Cleanliness of dish-cloths. They are to be washed in boiling water. An odor about a dish-cloth is an indication that it is dirty and unfit for use.
8. The method of washing dishes and their cleanliness. A test for cleanliness is their odor. Cover a dish for a few moments and then smell of its inside. If there is an unpleasant odor, the dish is not clean.

A simple sanitary method of washing dishes is as follows:

1. Provide two pans of water—the first moderately hot, the second boiling hot.
2. Wash the dishes in pan No. 1 in the ordinary way.
3. Immerse the dishes in pan No. 2 in order to sterilize them.
4. Stand the dishes on edge or upside down so that they will dry themselves. Wiping them increases the danger of introducing dirt and infectious material from the hands and towels.

Disposal of Human Wastes.—Camp wastes may be divided into rubbish, garbage, waste water, and human excretions.

A ready means of disposing of rubbish is to burn it. A large part of garbage may be dried and burned. An easy way to dispose of tin cans is to pound them flat, burn them in the rubbish fire, and afterward bury them.

Garbage that is water-soaked is likely to putrefy or ferment and become breeding-places for flies. An efficient means of disposing of it is to empty it into a hole 2 or 3 feet deep and to cover each portion at once out of the reach of flies.

Waste-water consists principally of that from the kitchen and that used in washing the hands and in bathing. Three simple methods of disposing of it are:

1. Emptying it into a pit filled with stones. The pit acts like a stone bed in a sewage disposal plant.
2. Emptying it into a pit and covering the sediment with a layer of soil each day.
3. Collecting it in a pail or barrel and emptying it in a remote part of the camp. Scrub the inside of the pail or barrel after emptying it.

Disposal of Human Excretions.—A sanitary measure in which campers are frequently lax is the disposal of human excretions. Three simple methods of their disposal are:

1. Depositing the excretions in a deep, narrow trench and covering them at once with a layer of earth.
2. Depositing them in a simple latrine made by digging a trench 18 inches wide and 2 or 3 feet deep, and placing over it a box fitting fly-tight, with a self-closing seat.
3. A pail system of disposal, the pails to be placed in a fly-tight box, their contents buried daily, and the pails themselves washed. The helpers are to be provided with a latrine as sanitary as the one used by the campers.

It is important that a camp be left in a sanitary condition, and especially that all excretions be buried where they are inaccessible to flies and cannot pollute the water or surface soil.

Communicable Diseases.—Those who manage a camp often neglect to make provision for the isolation and control of persons who have a communicable disease. It is particularly necessary to recognize a case in the early stages of the disease and to isolate it at once. A well-ordered camp will have an extra tent, or at least a bed, in which a suspicious case may be isolated. The Sanitary Code of New York State requires the person in charge of a labor camp to report cases of communicable disease that occur in it.

CHAPTER XLIII

CHILD HYGIENE

Infant Mortality Rates.—An infant mortality rate is the number of deaths among each 1000 infants under one year of age. The number of infants under one year old in a community is reckoned as the number of births in that community during the year. An infant mortality rate is, therefore, the annual number of deaths of infants under one year old among each 1000 births occurring annually in that community.

The death-rate for persons of all ages in New York City was nearly 30 per 1000 inhabitants up to about the year 1890. The greatest death-rate for any age group was that of infants under one year old, among whom it was nearly 300, or ten times the rate for the whole city. The death-rate of New York City for 1917 was approximately 14, while the infant mortality rate was slightly under 100. The greatest saving in life has been among infants, and the greatest factor in the work has been the City Department of Health.

Child hygiene work was begun in the larger and more progressive cities. There complete surveys of the field have been made, and methods of work have been developed and standardized. Wherever the work has been extended to the smaller cities and to villages, the results have been great. Although environmental conditions are far more favorable to children in the country than to those in the city, yet the personal elements are the same in both places, and rural mothers need instruction and supervision quite as much as those in the city. If the infant mortality rate in New York City is below 100, that in a small city, or village, or rural district should be below 50, and can be reduced to that figure by an application of the same principles that are applied in the city. It is the duty of every health officer to promote the work of child hygiene. If he fails to do so, he neglects one of his greatest fields of usefulness. The need for the work is universal, and exists in the country as well as in the cities. One-fifth of all deaths at all ages occur in persons under one year of age, and one-third occur in those under five years of age.

Organization of Rural Child Hygiene Work.—Child hygiene work cannot be done in a formal, perfunctory way as is possible in establishing quarantines and suppressing nuisances. A health officer will accomplish little simply by visiting sick children and giving prescriptions and rapid-fire advice to mothers. Even a system of medical inspections will reach only the babies that are already sick. Effective work can be done only by reaching the babies while they are well, and by teaching the mothers how to prevent their babies from becoming sick. The greater part of the work is educational, and must be done through personal attention to the individual mothers. The staff that is essential must include, first, a public health nurse, and second, a group of intelligent women who will provide the nurse with supplies and create public sentiment in favor of the work.

A practical method of starting child hygiene work in a small city or a rural community is that the health officer take the following steps:

1. Arouse the interest of a group of women who will form an organization to promote and finance the work until the municipality is ready to assume it.

2. Secure the service of a nurse. Her service a part of the time may be sufficient at the outset.

3. Make arrangements for the medical examination and supervision of the children. The health officer and the practising physicians of the community will find that the experience and knowledge gained from the work will repay them for the time and efforts which they give to it.

When a nurse begins work in a new field, she will adopt the following order of procedure:

1. Obtain a list of babies from the registrar.

2. Visit the mothers in their homes and observe the condition of the babies.

3. Assist the mothers in the care of the babies that are sick or below a normal physical standard.

4. Arrange for meetings of groups of mothers.

5. Establish an infant welfare station after she has become familiar with the field.

Lines of Work.—Child hygiene work is divided naturally into four divisions, according to the ages of the children, as follows:

1. Prenatal care of the mothers.

2. Infant welfare from birth to two years.

3. Work during the preschool age, from the second to the sixth year.

4. Medical inspection of school children.

A health officer will keep these four groups in mind. He will usually begin his activity among the infant group, and will extend it to the other groups as the work develops.

Prenatal Care of Mothers.—Forty per cent. of all deaths among infants are due to conditions which existed among mothers before the births of their children. The principal conditions which cause mothers to give birth to weakling babies are:

1. Disease, especially tuberculosis and syphilis; 2, overwork; 3, poor nourishment; 4, lack of care; 5, ignorance of the common signs of danger.

The remedy for these conditions includes the following provisions:

1. Personal instruction and supervision of expectant mothers by the public health nurse.
2. Hospital care preceding, during, and after the birth of the child.
3. Adequate medical treatment.
4. Improvement of the conditions of living and working, both at home and also in factories and other places of employment.
5. Education and instruction.
6. The instruction and supervision of midwives and amateur nurses.

The health officer and nurse will deal with each mother individually, and will promote her health and strength either by private means, or by the assistance of neighbors, or through public agencies. The special value of the nurse in these cases is that she is the authorized agent who is charged with the duty of securing the proper attention for the expectant mother. The proper care can usually be had in any community if some one is determined to get it for the mother.

It is no longer valid to excuse the death of a baby by saying that the infant was born a weakling. The causes of the weakness are known, and are preventable in most cases. The responsibility for the ill health of the mother is upon society quite as much as upon the mother herself. It is the duty of every community to make public provision for expectant mothers in order that children may be born strong and vigorous. The work of the public health nurse in bringing concrete cases to the attention of officeholders and of the public is an efficient means of arousing the public conscience regarding child welfare.

Midwives and Amateur Nurses.—The control of midwives has a direct effect upon the health and vigor of both mothers and their infants. A considerable proportion of women are attended by midwives before, during, and after childbirth, but there has been little control over midwives except in the larger cities. The sanitary code of New York State, Chapter 4, prescribes the qualifications of midwives, and requires that every woman who practices midwifery shall be licensed by the state, and shall be registered with the local registrar of vital statistics. The New York State Department of Health has undertaken the work of having its public health nurses visit and supervise the midwives, and to instruct them in their legal duties. The nurses particularly instruct them in the necessity of calling a physician when an abnormality is found in either the mother or child. When a nurse investigates a midwife, the principal points which she will consider are as follows:

1. Personal character and general intelligence.
2. Cleanliness of her person, her home, and her midwifery outfit.
3. The possession of instruments or drugs which can be properly used only by a physician.
4. Ability and willingness to apply preventive measures against ophthalmia neonatorum.
5. The general standard of her work, and the health and vigor of the women and infants whom she has attended.
6. Her reputation for calling a physician in difficult and abnormal cases.
7. Her record for reporting births to the registrar of vital statistics.

The influences which the State Department of Health can bring to bear upon a midwife are:

1. Publicity of its approval or condemnation of her work.
2. Revocation of her license.
3. Prosecution for illegal practice or for neglect of cases.

A health officer can render valuable assistance to the State Department of Health in its investigation of midwives. A public health nurse can investigate the midwives and inform the State Department of Health regarding them. She can also secure their co-operation and support in the prenatal care of mothers and in the work of infant welfare stations. Experience demonstrates that midwives will co-operate with the public health nurse when they find that the nurse is not critical, but is helpful.

Americans have a system of caring for women before and after childbirth by untrained amateur nurses who do the housework, care for the mother and baby, and do everything else that a midwife does except that a physician is expected to be present during the actual delivery of the child. The instruction and control of these nurses is a problem which is difficult and unsolved. If a public health nurse is tactful she can do much along two lines:

1. She can secure the confidence and co-operation of the nurses and educate them in their duties.

2. She can educate mothers regarding the proper care which they may expect from the nurses.

Infant welfare activities embrace those relating to infants from birth to the age of two years. The work was originally the care of sick babies, but it is now primarily the prevention of sickness, and the promotion of growth and vigor among infants. It includes an improvement in the social and economic conditions of the homes, for the ability of parents to provide the proper care for their children depends largely upon their financial, social, educational, and moral states. It is closely related to housing, hours of labor, racial habits, and the control of the sale of alcoholic liquors. It requires the co-operation of churches, charitable societies, schools, civic clubs, and other organizations for improving the living conditions of the race. But the problem of infant welfare is primarily medical, and the work is nearly always done under the auspices of a health department, either local, state, or national.

Causes of Infant Mortality.—The causes of sickness, abnormalities, and lack of development among infants may be determined from a study of the causes of death, for the proportion of deaths from various causes is about the same as the proportions of debilitating conditions. The proportions of the various causes of infant mortality in New York City are as follows:

	Per cent.
Congenital conditions	40
Diarrheal conditions	25
Respiratory conditions	22
Contagious diseases	4
All other causes	9
Total	100

Congenital conditions are discussed in the paragraph on the prenatal care of mothers, page 490.

A health officer will keep in mind that the principal causes of diarrheal conditions and digestive disturbances are improper feeding, flies, and uncleanliness.

The principal factors relating to the healthfulness of an infant's food are—

1. Its original composition.

2. Its state regarding fermentation, and the development of unwholesome products.

3. Its infection with the specific organisms of intestinal diseases.

Breast milk meets these conditions so perfectly that it is in a class by itself. It is adapted by nature to the needs of the child; it is fresh and uncontaminated; and its direct transfer from the breast to the infant's stomach prevents the entrance of the organisms of intestinal diseases. One of the great objects of the prenatal care of mothers is their education in the care of their breasts, and the adjustment of their home lives in order that they may nurse their children.

Artificial Feeding.—The substitutes for mother's milk may be classed as follows:

1. Cow's milk.
2. Goat's milk.
3. Condensed milk.
4. Dried milk.
5. Proprietary baby foods.

Cow's milk is the most available substitute for mother's milk. It is a satisfactory substitute when it is produced according to the methods required under an efficient system of milk inspection (page 362). The principal modification which it requires is its dilution with plain, sterile water. Milk rich in cream is not desirable for infant feeding. The so-called curds passed by infants often consist of undigested fat. The mixed milk from large dairies is almost uniform in composition.

The pasteurization of milk is usually necessary in infant feeding unless certified milk or milk of equally good quality is used. The principal hygienic effect of pasteurization is to destroy the specific germs of human diseases that may be in the milk. It also improves the keeping qualities of milk by destroying many of the organisms of fermentation. Its effect on the composition of milk may be somewhat harmful, but this effect is negligible if the pasteurizing temperature is kept below 150° F.

Goat's milk can scarcely be distinguished from cow's milk as an infant food. There are certain advantages in the use of goat's milk, especially for persons of moderate financial means. A goat costs little; it is cleanly, and requires only a small space; it will thrive on coarse food, such as weeds and shrubs; it is not subject to tuberculosis; and it may be milked several times a day without harm. A mother may keep a goat in the back yard, and at each feeding she may draw sufficient milk and give it to the baby at once without preparation except to dilute it. It is desirable that a health officer should encourage the use of goats as a supply of milk for infant feeding.

Condensed milk is undesirable as infant food on account of its usual high percentage of sugar and of the changes in composition produced by the process of evaporation. Yet it is preferable to ordinary market milk which is of an impure quality.

Milk evaporated to a dry powder is a healthful food for infants. Its use will be a great step in solving the problem of providing a food for infants.

Proprietory infant foods have no advantage over plain milk or condensed milk. They usually consist largely of cereal flour, and are designed to be added to milk. Some contain milk powder. When they are used alone, nutritional disturbances, such as marasmus, scurvy, and rickets, are almost sure to develop.

It is necessary that a health officer should know what substitutes for mother's milk are available in his community; and to promote the use of clean, fresh milk for infant feeding.

Infectiousness of Infantile Diarrhea.—A large proportion of the diarrheas of infants are due to special organisms which are found with the bowel movements of the sick and are transferred from the sick to the well by means of flies and unclean hands, dishes, and clothing. A necessary measure in preserving the health of an infant is to protect it and its food from house-flies. Another measure is cleanliness of the hands of the mother and of everything else that touches the child. It is especially necessary that the mother observe the following rules for the care of soiled diapers and underwear:

1. Protect them from house-flies until they can be washed.
2. Boil them during some stage of the washing process.
3. Dispose of the wash-water in such a way that flies cannot have access to it.
4. Wash the hands immediately after handling soiled articles (page 265).

The effect of heat and humidity in producing infantile diseases is principally indirect and secondary through flies and fermentation. Flies are especially numerous and active during hot weather. The processes of fermentation are promoted by heat and moisture, as is seen in the prevalence of molds during hot, humid weather. If a baby's food is kept pure and fresh, and the baby is protected from flies and other sources of infection, hot weather has little effect on the infant's health.

Nutritional Disturbances.—It is important that a health officer should bear in mind the four conditions (1) malnutrition, (2) marasmus, (3) scurvy, and (4) rickets. All these conditions are usually associated with arrest of growth, loss of weight, and increased susceptibility to infections and other influences which have little effect on a normal child. There may be the special signs of scurvy or rickets in the bones, skin, and mucous membranes. Some affected infants may appear to be fat, but they show a lack of muscular development and strength. The conditions are often associated with chronic diseases, especially syphilis and tuberculosis.

Simple malnutrition and marasmus are due either to an insufficient amount of food, or to a diet which is decidedly unbalanced, as, for example, condensed milk containing an excess of sugar and a deficiency of protein.

Scurvy seems to be caused principally by a deficiency of the water-soluble vitamins, and may be cured by giving the juices of oranges or other fruits.

Rickets seems to be caused principally by a deficiency of fat-soluble vitamins, and is cured by the use of fresh milk, cod-liver oil, or other articles containing an abundance of fat-soluble vitamins (page 395).

An encouraging feature in all conditions depending primarily on nutritional disturbances is that the infants recover promptly and completely when they are properly fed. There are three simple principles to be observed:

1. Give the proper quantity of food.
2. Use fresh milk as the principal article of diet.
3. Offer the child the juice of an orange or other fruit daily. If the juice is needed, the infant will take it greedily.

One of the most efficient activities of a public health nurse is to discover infants who suffer from arrested development; to give advice regarding their feeding; and to secure treatment for those who suffer from chronic infections.

Respiratory Diseases.—The two principal avenues for the entrance of infectious organisms into the bodies of infants are the mouth and the nose; and the principal organs which become infected are those of digestion and those of respiration.

The principal source of respiratory infections in infants is their contact with persons who have colds (page 243). Common means of infecting babies with the organisms of respiratory diseases are:

1. Hugging and kissing them by those who have colds.
2. Unclean clothing.
3. Infectious dust.
4. The direct transfer of saliva by such means as putting spoons and feeding bottles to the lips in order to test the food; wiping the baby's nose with another person's handkerchief; and wiping the baby's face with a towel or handkerchief that is moistened with saliva.

A common cause of respiratory diseases of infants is their exposure to dust from human sources, especially to that which contains organisms from dried sputum as a result of spitting on the floor. The overcrowding of rooms is usually associated with human dirt and dust. It is also associated with poor ventilation, overheating, and increased opportunity to exposure to persons having colds.

Dealing with congenital, digestive, and respiratory conditions constitutes nine-tenths of infant welfare work. Health officers and public health nurses who are efficient in these lines of work will also be efficient in dealing with other infantile conditions which require their attention.

Methods of Infant Welfare Work.—If an infant does not thrive, a remedy that suggests itself is to take the child from its home and place it in an institution where there are facilities for its care. This plan has been tried thoroughly, and has been a failure. Nothing has been found to take the place of a mother or foster-mother in a private home. The death-rate among infants in the best institutions is far higher than that among babies in the tenement homes. Individual care in a private home gives far better results than care in an institution, except during an acute illness.

The responsibility for the care of infants in private homes rests upon the individuals who act as mothers to the children. Infant welfare work consists essentially in the education of each mother. Home visitation and instruction by the public health nurse is essential in saving the lives and promoting the health of babies; but that work itself is but 30 per cent. efficient, for there still remains the problem of persuading the mother to carry out the instructions. A mother whom the nurse visits will heed the advice of neighbors who follow the old-time methods and consider the new ways to be unnecessary and unproved innovations. The nurse's full success will come when the women of a community begin to talk about her methods, to seek her advice. The present great success of infant welfare work in New York City is due largely to the fact that the people generally believe in it and accept it just as they accept the work of the public schools. Infant welfare work is a community problem as well as an individual one. Community infant welfare work consists in (1) field work among needy mothers, and (2) that among educated people of financial means who support the field work.

The common field activities in infant welfare work are as follows:

1. Public health nursing.
2. Mothers' meetings.
3. Lectures and demonstrations.
4. Little mothers' leagues.
5. Weighing and measuring babies.
6. Infant welfare stations.

A public health nurse is the field agent in all phases of infant welfare work. She reaches individual mothers, and she also seeks to secure the co-operation of those women who are recognized as advisers of others and as molders of public opinion.

After a nurse becomes acquainted with the mothers, she will arrange that they meet in small groups for the talks and demonstrations which she will give to them, and later she will arrange lectures and exhibits to which the public will be invited. The New York State Department of Health issues pamphlets on various phases of the care of infants.

A nurse will find that little mothers' leagues are valuable, especially in sections where older girls have to care for their young brothers and sisters. A league is organized with a chairman, secretary, and treasurer, and a series of twelve lectures and demonstrations are given. The program of a session consists of reports and discussions of the management of actual cases. Each lesson consists of a ten-minute talk by the nurse, and a twenty-minute demonstration of some phase of the care of infants. Either a large doll or an actual baby is used as the subject for the demonstration. The subjects of the twelve lessons are as follows:

1. Growth and development; measurements and weights; the special senses.
2. Teeth—their development and care.
3. Water internally and externally—bathing; cleaning the eyes, ears, and nose.
4. Fresh air—its value in the home. Outings.
5. Sleep and rest. Making beds.
6. Clothing and cleanliness. Effects of too much clothing.
7. First care of the sick baby.
8. Milk—mother's and cow's. Modification of milk.
9. Artificial feeding. Substitutes for mother's milk. Feeding at various ages.
10. Care of milk and containers.
11. Home pasteurization of milk; preparation of milk foods.
12. Preparation of cereal waters and meat juices.

Members of little mothers' leagues not only prepare themselves to care for babies, but they teach their parents and neighbors, and advertise the work of the public health nurse.

Organizing and conducting baby weeks, baby contests, and baby exhibits are also activities of a public health nurse. One of the principal values of these activities is to create an opportunity to weigh and measure the babies of a community and to reach those who are below standard. The standard table of heights and weights is as follows:

Age	Height, inches.	Weight, pounds.
At birth	20	7½
3 months	23	13
6 months	26	17
9 months	28	20
12 months	29	21
15 months	30	22
18 months	31	24
21 months	32	25
24 months	33	27
30 months	35	29
36 months	37	32
42 months	38	33
48 months	39	35

Infant Welfare Station.—If a community has 10,000 or more inhabitants, it can profitably concentrate its infant welfare work in a station which is supplied with a complete outfit for carrying on all phases of the work. A nurse and physician are in attendance at regular hours. Babies are brought to the station to be weighed and measured at regular periods. Advice is given to parents, and milk of a high grade is sold at cost. Mothers' meetings are held, instruction and demonstrations are given, and pamphlets are distributed. Cases of sickness are treated; but the principal object of an infant welfare station is to keep babies well. To have one of its registered babies sick is a discredit to an infant welfare station.

Preschool Ages of Children.—A public health nurse will discover many defects and deformities among children between the ages of two to seven years, and will try to secure their correction; but it has not been found necessary or practical to do intensive preventive work among them. Children in the preschool age are reached through the activities of infant welfare work and of medical inspection of school children.

Medical Inspection of School Children.—The examination of recruits for the American Army shows that one-quarter of all men of draft age have serious physical defects which disqualify them for service. Over half of these defects could have been remedied completely, and half of the remainder lessened, if the men had been examined and treated during their school days. The medical examination of school children and the treatment of their defects are important activities for every department of health. The examinations and corrections in some states are also done by departments of education. Defects among school children of country districts are as common as they are in cities. Every health officer is expected to know the scope of the work, and to promote the discovery and correction of defects among the children in his jurisdiction.

The minimum staff required for medical inspection consists of a public health nurse and a physician, both of whom have been legally authorized to make the examinations. A full-time nurse can look after 1000 or 2000 pupils.

The inspection of school children is conducted according to two methods:

1. A thorough examination of every pupil made by a physician every year or two.
2. An examination by a physician of children whom the nurse suspects of having defects. The system to be followed will depend largely on the circumstances in the particular school. Either method will produce satisfactory results provided both the nurse and the physician are competent and conscientious.

Special examinations are also made by a physician or nurse whenever they are needed in order to discover contagious diseases or special defects or conditions. A nurse is as competent as a physician in discovering head lice, skin diseases, and sore throats. Nurses make daily inspections of pupils in the schools of New York City.

When a school physician examines a pupil, he will make note of the following conditions:

1. Sight.
2. Hearing.
3. Throat and nose abnormalities, particularly tonsils and adenoids.
4. The hair, for lice.
5. The skin, for eruptions.
6. Hands and feet, for orthopedic defects.
7. Heart.
8. Lungs.
9. General nutrition.
10. Height and weight.
11. Special conditions, such as posture, mental attitude, and cleanness of the body.

The following table, based on the examination of 2,000,000 children, shows the percentage of children who showed various defects:

Teeth,	60	per cent.
Vision,	25	"
Adenoids and enlarged tonsils,	30	"
Malnutrition,	25	"
Orthopedic defects,	5	"
Tuberculosis,	5	"
Heart weakness,	2	"

An examiner who finds few or no defects is either incompetent or careless. Defects which are evident to the nurse and the teachers are common in every school room. About 75 per cent. of all school children have physical defects that require treatment.

Correction of Defects.—When a defect is found, the next step is to inform the parents or guardian of the child, and to advise that the defect be corrected. A weakness in the present system of the medical examination of school children is that no one is authorized to compel the parents or children to have the corrections made. Experience has shown that when the parents are merely notified of the defects, only about 10 per cent. of the cases are corrected. Two measures are necessary to secure the correction of the defects: 1, a system of visiting and instructing the parents by a public health nurse; and 2, school clinics, dental clinics, hospital facilities, and other provision for correcting the defects either free or at a minimum cost. This system secures the correction of over 80 per cent. of the defects of school children in New York City.

An important result of the medical inspection of school children is the discovery of unsuspected defects of sight or hearing which are the cause of mental deficiency, disobedience, bad behavior, truancy, and other manifestations of mental abnormalities. The correction of these cases alone would justify the entire system of medical inspection (page 316).

There is no standard method of making medical inspections and correcting the defects that are found. A complete system of inspection without the correction of defects is unsatisfactory, and a waste of time and money. A conscientious nurse and physician can readily find the ways and means for correcting the physical defects of the school children of their community.

Inspection of School Buildings.—The inspection of school buildings, or the environment of the school child, is closely related to the work of medical inspection. A health officer inspecting a school house will take note of the following points:

1. The state of repair of the building.
2. The arrangement of the rooms and hallways.
3. Cleanliness.
4. Water-supply.
5. Facilities for drinking.
6. Facilities for washing the hands and face.
7. Toilets and sewage disposal.
8. Heating.

9. Ventilation.
10. Lighting.
11. Blackboards.
12. Desks and seats, and their adaptation to the individual pupils.
13. Provision for hanging the outer garments.
14. Unsanitary conditions adjoining the school grounds.

CHAPTER XLIV

LIFE EXTENSION

Adult Death-rates.—The work of departments of health is essentially the prevention of disease. There has been a gradual extension of the scope of health officer activities corresponding to the advance in scientific knowledge and its extension among the people. These activities have developed in about the following chronologic order: 1, the control of contagious diseases; 2, general sanitation; 3, pure water-supplies; 4, municipal sewage disposal; 5, milk control; 6, food inspection; 7, industrial hygiene, including factory inspection and the employment of women and children; 8, child hygiene; and 9, the medical inspection of school children. These activities have greatly reduced the rates for death and sickness. The reduction has not been uniform for all age periods, but has been confined to those in the earlier years of life. It has been the most marked among infants and children when persons are at the most tender and impressionable ages of their lives. The reduction has been less marked in the first half of adult life. There has been no reduction in the death-rate during the second half of adult life; but, on the contrary, there has been an increase in the proportion of deaths among persons between the ages of forty and sixty-five. The average age of persons who are over forty years old at the time of death is now less than it was one hundred years ago. A person who passes the age of forty may now expect to live fewer years than one who lived in the days before public health work was organized. Life extension, or the prolongation of the years of usefulness and efficiency of adult persons, is a coming development in public health work.

A reason that is sometimes given for the increased death-rate among adults is that the work of child hygiene has prolonged the lives of numerous weaklings who are unable to stand the ordinary strains of an active life. While a few grown-up persons may die as a result of weaknesses carried over from childhood, the net result of child hygiene is to increase the strength and vigor of most persons who reach adult life.

Degenerative Diseases.—The principal cause of the increasing death-rate among adults is the prevalence of diseases which begin to show their effects after the middle period of adult life.

These are classed as degenerative diseases, and consist in the replacement of the active cells with fatty or fibrous tissue.

Fatty Degeneration.—An excessive accumulation of fat is often associated with fatty degeneration of the voluntary muscles. A similar condition may also involve the heart, the liver, and other vital organs, and be the direct cause of death. The condition is largely a nutritional disturbance, and is due to at least three causes:

1. The retention of an excessive amount of food material in the body.
2. A deficiency of oxygen with which to oxidize the food material.
3. The accumulation of poisonous waste products which are largely those of suboxidation.

Fatty degeneration is not strictly a disease of declining years; but it frequently develops during early adult life owing to the lack of exercise and to overeating which are often associated with that period. Start a fifteen-year-old boy in a business office, keep him there day after day for years, feed him with great quantities of rich food, and allow him no exercise or recreation, and he will develop an incurable fatty degeneration by the time he is twenty-five years old.

Fibrosis.—The development of fibrous tissue throughout the body is a natural process during advancing years. It is illustrated by the toughness of meat of old animals, and by the increase of lime salts in the bones of old persons. It may involve all parts of the body, but its evil results are especially evident when the process affects the vital organs, particularly the arteries, heart, kidneys, liver, and brain. The signs and symptoms of the fibrosis are those associated with the following conditions:

1. Hardness and inelasticity of the arteries.
2. High blood-pressure.
3. Heart defects.
4. Kidney disturbances.
5. Intestinal and liver troubles.
6. Vague aches and pains, called rheumatic, neuralgic, gouty, and neuritic.
7. Gross changes in the joints.
8. Mental derangements.
9. Apoplexy.

Premature Old Age.—The symptoms associated with fatty degeneration and fibrosis constitute the signs of old age. Physical degeneration after full maturity is a natural condition for man and for all other living beings. The signs of old age are normal for a person eighty years of age; but they are abnormal for one between forty and sixty. The increased death-rate among adults over forty years of age is due principally to conditions which are normally associated with old age. The deaths of persons dying from this class of causes are usually ascribed to heart failure, or kidney disease, or apoplexy, or sudden death without definite cause.

The causes of premature old age are complex and operate insidiously. They are associated with a high state of civilization, and may be classed as follows:

1. High living.
2. Overindulgence in alcohol and tobacco.
3. Syphilis.
4. A sedentary mode of life when personal hygiene is not observed.
5. The stresses, strains, and worries of modern life.
6. Intense application to business.

The evidence that these are the efficient causes of the degenerations are:

1. The improvement that follows their correction.
2. The rareness of the condition in those who are not under the influence of the causes.

Prevention of Degenerative Diseases.—Premature old age is preventable, and its causes may be controlled. The general principles of the prevention of degenerative processes may be summarized under three headings: 1, a simple life; 2, exercise; and 3, recreation.

A physical element which is common to many causes of degeneration is suboxidation. Oxidation in the body may be controlled by regulating either the amount of fuel food or the supply of oxygen. A simple mode of life automatically regulates the intake of food, for it involves the habit of eating simple meals of a few dishes simply cooked; and also the avoidance of alcoholic drinks and of elaborate dinners, particularly those rich in protein. A simple mode of life is also an antidote for nearly every cause of physical degeneration.

The only practical method of controlling oxidation is by means of exercise. It is a life-saving act to choose a mode of life in which some part of the daily routine requires muscular exercise.

The mental antidote to the causes of premature old age is recreation. It is a slow form of suicide for a person to have no other interest in life than that in a business or profession. Both the mind and the body require daily relief from the continuous routine of a business or a profession. An avocation or hobby, as well as a vocation, is indispensable to health and happiness.

Four difficulties which stand in the way of preventing degenerative processes are:

1. The American ideas of personal independence and individual freedom of action.
2. Artificial standards of success and of living.
3. The condition often affects the leaders in business and professional life who barter health for success.
4. The condition does not endanger others.

Duty of the Health Officer.—A health officer has no direct power of control over adults who are threatened with degenerative processes, but he can assist in the work by educational measures. The army authorities have demonstrated the practicability of direct measures for promoting the physical vigor of adults. The more progressive departments of health are instituting campaigns of education with the expectation of developing public measures for the control of degenerative diseases along the lines that have been adopted in the army. The treatment and prevention of the diseases of adult life is becoming an important specialty in medicine.

Periodic Physical Examinations.—A measure of great importance in the prevention of degenerative diseases of adults is the periodic medical examination of each individual. Life insurance workers recognize its value, and some of the more progressive insurance companies are developing a system of regular examinations for their insured. The extension of a similar system to all persons at public expense is a probable development of future public health work.

Special Diseases of Adults.—Special causes of disability and death in adults are focal infections, cancer, and accidents.

Focal infections around the roots of the teeth are frequent in adults, and are often the unsuspected causes of sickness and death (page 158). A health officer can do much to combat the conditions by educational measures.

Cancer is one of the leading causes of death among adults. Millions of dollars have been given for endowments for cancer research, and numerous skilled investigators are working to solve the problem of its cause and prevention. The means by which a health officer can assist in the work are:

1. Promoting the early diagnosis and treatment of cases.
2. Collecting data of cases for research workers.
3. Educating the public regarding the curability of cancer in its early stages.

One result of the hurry and bustle of modern American life is the great number of accidents that are clearly due to preventable causes. Over 9000 deaths were due to accident in New York

State in 1917, and over 1000 were caused by automobiles. A health officer can assist in the prevention of accidents by the following means:

1. Calling the attention of the people to the record of deaths and disabilities from accidents.

2. Promoting the enactment of laws and the appointment of policemen and inspectors for the purpose of preventing special forms of accident.

Public Medicine.—A great hindrance to public health work is the lack of adequate medical attendance upon those of small financial means. Medical service in America is a matter of private contract between physician and patient. It is usually the custom of prosperous physicians to refuse to attend those who cannot pay a fee. The result is that about one-quarter of the people receive little or no medical attendance except in charitable institutions, and another quarter call a physician only in emergencies. Public health demands that every person shall receive competent medical attention. Many industrial corporations consider it good business to provide medical attention for their unskilled laborers. It would be of equal benefit to the public to provide medical attention for those who otherwise would not receive the benefits of curative and preventive medicine. The problem will probably be solved by departments of health. Health officers have already taken up the work of child hygiene and the correction of the defects of school children. It is a natural extension of their work to extend it to the prevention and correction of physical defects of adults.

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