

*Andrews (E.)*

REPORT

OF THE

COMMITTEE ON MILITARY HYGIENE.

BY

E. ANDREWS, M.D.

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EXTRACTED FROM THE  
TRANSACTIONS OF THE AMERICAN MEDICAL ASSOCIATION.

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## REPORT OF THE COMMITTEE ON MILITARY HYGIENE.

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YOUR Committee find that the present war has furnished such a vast mass of facts for consideration upon the topic of military hygiene, that no human industry will suffice to digest it into a complete report, in the space of a single year. We have therefore determined to confine our attention to only one subdivision of the subject, viz:—

### THE EFFECTS OF THE AIR OF OVERCROWDED HOSPITALS.

There are four principal sources of contamination affecting the air in hospital wards.

1st. The respiration.

2d. The perspiration.

3d. The effluvia and suppuration of wounds.

4th. The various discharges and excretions of the body.

From all these sources the air of a ward filled with wounded men is rendered unfit for use with astonishing rapidity.

If we take the combined results of physiological experiment, and of our own observation, we shall find the rate of contamination in a ward of fifty wounded men to be about as follows.

Men respire about 350 cubic feet of air each in 24 hours, consequently 50 men consume 17,500 cubic feet. The air thus breathed is unfit for any further use. It is deprived of a part of its oxygen, is loaded with carbonic acid, and, what is worse than either, the moisture exhaled with the breath is loaded with organic matter, in such a state as to favor rapid putrefaction where the air is at all confined. Strictly speaking none of this air should enter the lungs a second time, but as it is difficult to prevent this absolutely, we may assume that it should be mixed with at least ten times its

volume of pure air, to render it at all safe for respiratory purposes. Assuming, therefore, that 50 patients respire, as above shown, 17,500 cubic feet of air in 24 hours, we may assert that they render unfit for use about ten times that amount by mixture—that is, 175,000 cubic feet. But the organic and aqueous excretions of the skin are equally deadly, and about twice the amount of those of the respiratory excretion. They consist of carbonic acid, sulphuretted hydrogen, and various organic materials, including exfoliated scales of cuticle diffused as putrefying dust in the air. The amount being twice that of the organic excretions of the lungs, it is fair to assume that it renders twice the amount of air unsuitable for use, that is, 350,000 cubic feet in 24 hours. It is a matter of experience, that the effluvia of recent gunshot wounds will contaminate the air of a close ward as fast as the action of the skin and of the lungs combined. We may say safely, therefore, that 50 wounded men in the suppurative stage will spoil not less than 525,000 cubic feet per diem, by the stench of the wounds and pus alone. Besides these sources of impurity, there is a large addition from the occasional evacuations of urine and feces of patients unable to walk to the closet, the dribbling of urine from patients wounded in the bladder or unable to retain their urine from other causes, and the expectoration of men injured in the chest. We estimate these influences as spoiling 175,000 cubic feet more.

Footing it all up, the account stands thus:—

*Air contaminated by a ward of 50 recently wounded men in 24 hours.*

By respiration . . . . .	175,000 cubic feet
“ perspiration, etc. . . . .	350,000 “ “
“ suppuration and gangrene . . . . .	525,000 “ “
“ other excretions . . . . .	125,000 “ “
Total	1,175,000 cubic feet.

Now a ward for 50 men usually contains 50,000 cubic feet of air. In the case supposed, therefore, it should be changed not less than 23 times in 24 hours, or about once an hour to render it at all safe. This is a very moderate estimate, for if the air of a hospital is only changed once an hour, it will always indicate danger by the offensive smell of the surgical wards. We think that a change every 20 minutes would be much safer. Yet many large military hospitals are so constructed that the air breathed by many of the patients remains for hours with but little change, and is never for a moment free from the stench of putrid secretions and discharges.

In such circumstances, instrumental tests show that the air is full

of pus-corpuseles floating about as dust, and planting the contagion of erysipelas or hospital gangrene upon every wound and ulcer exposed to it.

#### EFFECTS OF CONTAMINATED AIR UPON THE PATIENTS.

Patients placed in an overcrowded, or ill-ventilated ward, very uniformly come by the third day into a peculiar condition, which has received various names, viz., "the Aplastic Diathesis," "the Suppurative Diathesis," "the Erysipelatous Diathesis," etc. etc. The evidences of its approach are the following: 1st. Erysipelas begins to attack a large number of the wounds, and as its constant accompaniment diffusive phlebitis and pyæmia are prevalent. In operative cases, the incisions do not heal readily by first intention, the sutures ulcerate out too early, the edges of wounds show a phagedenic tendency, and weak yellow festers are frequent on the skin at irritated or abraded points. Ligated arteries also give way with frequency, producing secondary hemorrhages in unusual numbers. The wounds made by bullets also give warning of the mischief; by the following characteristic appearances. When a patient with a gunshot wound lies in a current of perfectly pure and fresh air, the surface of the wound clears off by the fifth or sixth day, and presents a clean rosy coat of healthy granulations. In close hospitals, on the contrary, the wounds continue foul, presenting, on the sixth day, a dull whitish yellow coat like a feverish tongue. If the evil continues for a time longer, the patients begin to have hospital gangrene, and numbers of them die in a rather obscure manner without apparently a sufficient cause. These are the circumstances sometimes complained of and wondered at, when "all cases of amputation die," as at certain British hospitals in the Crimean war, and in some of those of our own army during the present contest.

The effects of foul air upon the system are made more clear by contrast with those of pure respiration. Your Committee have had opportunity to observe, and all military surgeons will bear us out in the assertion, that, as a general rule, wounded men treated in the field do much better than those sent to large general hospitals. The regimental surgeon in the field seldom meets traumatic erysipelas, and never sees hospital gangrene. His wounded, lying under trees or open booths, are blown upon freely by the winds, and though they sleep on the hard ground, are wet with the rains, are shaken in ambulances, and fed on "hard tack" and salt bacon, yet

obtain freely their prime necessity, *fresh air*, and make gratifying recoveries from the most desperate injuries. By the sixth day their wounds are all clean, rosy, and granulating; erysipelas and secondary hemorrhage are very rare, and pyæmia, the scourge of hospitals, is almost unknown. The vigorous plasticity and reparative power of their tissues is in magnificent contrast with the feeble, foul, and suppurative diathesis of patients in all *overcrowded or ill ventilated* general hospitals. A few facts selected out of many are sufficient to illustrate these truths. The following quotation is from the report of the Committee on Diathesis for the year 1863:—

“FILTHINESS AND OVERCROWDING OF HOSPITALS, BARRACKS, OR  
TENEMENTS.

“At the battle of Chickasaw Bayou, near Vicksburg, two of the hospital steamers presented a striking contrast in this very respect. One, the ‘City of Memphis,’ was extremely large, airy, and well ventilated, while the other, the ‘Von Phul,’ was comparatively small and close. The boats were stationed along the Yazoo River, in the rear of the line of battle, to receive the wounded. By the chance of war, the greatest carnage occurred in the vicinity of the smaller boat, so that the little ‘Von Phul,’ with her small, close cabins, received twice the number of patients which the huge ‘City of Memphis’ did. The fighting continued five days, after which the whole army made a sudden movement by water to capture Arkansas Post. Owing to the rapidity of the movements, there was no time to equalize the numbers by transfer, and the two hospital steamers went off up the river as they were. Here was a fair field of comparison by which to determine the effects of overcrowding. One had 125 patients dispersed through vast and airy cabins, easily ventilated and kept clean. The other had 300 wounded men crammed into a small space, where they could not be kept clean, and where they continually breathed the ammonia and stench from decomposing pus.

“My notes of the cases show the following results on the two boats. By the fifth day the wounds of those upon the large boat began to clean off. The whitish shreds of disorganized tissue, which are always seen in recent gunshot wounds, separated and passed away, leaving a healthy surface covered with rosy granulations. At the same time, all the wounds upon the small boat presented a dull, whitish-yellow aspect, no surface of healthy granula-

tions being anywhere visible. Erysipelas had commenced its ravages, accompanied by phlebitis and pyæmia. Injured arteries seemed to have no plasticity to produce adhesion when tied, and hence secondary hemorrhage became alarmingly frequent. Mortification occurred in some cases with appearances approximating to hospital gangrene. The general vital power of the patients was lowered, and they succumbed in many cases from small and unimportant wounds.

“On the seventh day I was ordered to take charge of the smaller boat. I immediately ordered all the doors and windows to be thrown wide open, and a large portion of the wounded to be carried out and laid in the fresh air of the decks. At the same time the most vigorous efforts were made by Assistant Surgeon Witt, of the Sixty-ninth Indiana, to rectify the condition of the entire boat; by which means we very much alleviated the evils which had been produced. Nevertheless, great mischief had been already done, and by the tenth day the balance sheets of death stood as follows:—

Mortality on the well-ventilated boat . . . . .	5 per cent.
Mortality on the overcrowded boat . . . . .	12½ “

“This example does not stand alone. I have observed something analogous to it after every battle that has come under my observation. Wounded men who are kept dispersed in the fresh air of the fields, even though they have been exposed to cold and wet, generally preserve their plasticity, present clean rosy wounds, and recover with vigor and ease; while those who have breathed a confined atmosphere, filled with the effluviæ of decomposing secretions, always show foul, offensive, dull-colored wounds. So striking is the difference in their appearance, that, were a thousand men of each class taken on the sixth day and mingled indiscriminately together, they could be readily selected out again by the appearance of the wounds alone.

“I consider it therefore an established and invariable law of nature, that a full exposure to the atmosphere of an overcrowded and ill-ventilated ward of wounded men will, in five days, produce an aplastic diathesis in every man thus maltreated.”

The danger of cabin passage in overcrowded hospital boats is well known to judicious surgeons in the western armies. A field surgeon of eminence, at the siege of Vicksburg, on placing his men upon a hospital boat was once offered the cabin for his patients. He replied without hesitation, “If I am allowed my choice, put my wounded on deck.”

After the battles of Fort Donelson and Shiloh, great errors were committed from the natural anxiety both of surgeons and of sanitary agents to shelter the wounded from the storms, it being the rainy season. Hence every hospital boat sent north was loaded to its utmost capacity, and the cabins especially were crammed. As the result, erysipelas generally broke out by the third day with virulence, and by the time the patients reached the northern hospitals, great numbers of lives were sacrificed. Countless facts from civil hospitals also might be adduced to show the difference between fresh and foul air. The following extract from the *Transactions of the New York Academy of Medicine* for 1853, page 173, will serve for a specimen. The writer of the letter is the Hon. James Parker, a distinguished citizen of New Jersey.

LETTER FROM MR. PARKER.

PERTH AMBOY, NEW JERSEY, March 15, 1852.

DR. JOHN H. GRISCOM—

DEAR SIR: Having read your treatise on the *Uses and Abuses of Air*, I send you an account of what occurred in this place some years since, and which proves the efficacy of fresh and pure air, not only in preventing, but curing disease.

In the month of August, 1837, a number of ships with emigrant passengers arrived at Perth Amboy from Liverpool and other ports, on board of some of which ship fever prevailed. There was no hospital, or other accommodations in the town, in which the sick could be placed, and no person could admit them into private dwellings, fearing the infection of the fever. They could not be left on board the ships. An arrangement was made to land the sick passengers, and place them in an open wood, adjacent to a large spring of water, about a mile and a half from the town. Rough shanties, floored with boards, and covered with sails, were erected, and thirty-six patients were taken from on board ship with boats, landed as near to the spring as they could get, and carried in wagons to the encampment (as it was called), under the influence of a hot sun, in the month of August. Of the thirty-six first named, twelve were insensible, in the last stage of fever, and not expected to live twenty-four hours.

The day after landing there was a heavy rain, and the shanties affording no protection with their "sail" roofs, the sick were found the next morning wet, and their bedding, such as it was, drenched with the rain. It was replaced with such articles as could be



collected from the charity of the inhabitants. The number at the encampment was increased by new subjects to the amount of eighty-two in all.

On board the ship, which was cleansed after landing the passengers, *four* of the crew were taken with ship fever, and two of them died. Some of the nurses at the encampment were taken sick, but recovered. Of the whole number of eighty-two passengers removed from the ship, *not one died*. Pure air, good water, and perhaps the rain (though only the first thirty-six were affected by it), seem to have effected the cure.

No report has been made of these circumstances, and I send this from my recollection, and the information derived from the physician, Dr. Charles M. Smith, who still resides here, and to whom I refer you.

Very respectfully,

JAMES PARKER.

At the same time the mortality of patients with this disease in the New York Hospital was 13 per cent.

The following facts respecting the Crimean war have never before been published, and are derived from Dr. C. R. Parke, of Bloomington, Illinois, who was one of the American surgeons who entered the Russian service, and whose high character is sufficient voucher for the truth of his statements. One of the Russian hospitals at Simpheropol was a vast hall forty feet in width by one hundred and fifty feet in length, and was occupied by about one hundred patients. The Russians have a national dread of fresh air, seeming to think that it produces great danger. The ventilation in this pest hole was accomplished only by a small circular opening about four inches in diameter, at the top of each window, of which there were only eight. When the American surgeons were present in the room they had influence enough to cause the windows to be raised, but as soon as they were out of sight the prejudices of the Russian patients caused them to be promptly shut for fear of catching cold. In the abominable stench of this den the sick and wounded were laid and treated. The mortality was terrific, the causes of death being principally hospital gangrene, erysipelas, pyæmia, and typhus fever. In February and March of 1856, there was an average of over ten thousand patients present in Simpheropol, and an average mortality of over 20 per cent. About 140 deaths a day was the usual rate.

Out of 27 American surgeons nearly all were made sick, and nine of them died.

Such being the beneficial effect of pure, and such the deadly power of contaminated air, we are justified in assigning the subject of hospital ventilation a position of first class importance. Compared with pure air, all other restoratives for the sick and wounded are secondary. It is not fruits and jellies, potted meats, and delicate drinks; it is not soft beds, nor even shelter from the storm, which the wounded soldier needs most. Give him fresh air first, and at all hazards, and then the other comforts if possible.

#### FAULTY CONSTRUCTION AND SELECTION OF HOSPITAL BUILDINGS.

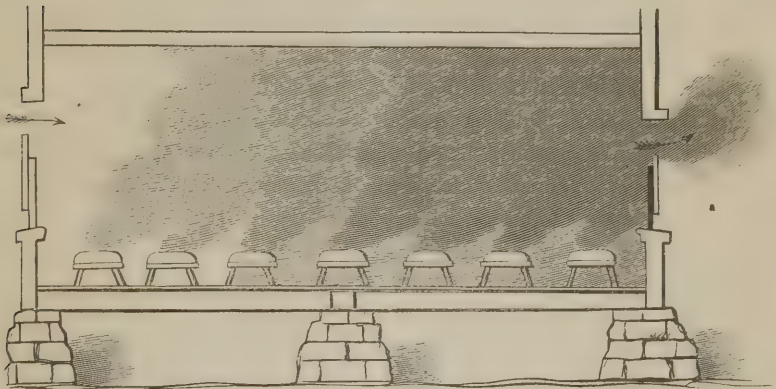
The old hospitals both of this country and Europe are so badly constructed with reference to ventilation that many of them are a positive curse to the community, and a disgrace to the medical profession, the mortality being worse than if the patients were left in the streets. However, knowledge has so far advanced that very few bad hospitals are any longer built by our government for military purposes. Fearful mistakes are still committed, however, by medical directors in selecting buildings already erected. Thus, for instance, when Memphis was captured the chief medical officer chose for a hospital building the Overton House, a vast square hotel built around a central closed court in such a manner that ventilation was an impossibility. Being five or six stories in height, with the corridors all communicating to the grand staircase, the effluvia of one story went up to be breathed over again on the next, and so on with added impurity on every story till it fumed out at the top.

When additional hospitals were required, with an insane hankering after unventilatable buildings, three large blocks of brick stores were taken. These were several stories in height, and the wards were long narrow rooms, 20 or 30 feet wide and about 100 feet in length, and only ventilated at first by end windows, there being none at the sides. Practically the only patients who ever got a breath of pure air were the two who lay next to the windward end of each ward. The air contaminated by them floated on to the next pair of beds, and then to the next, and so on with increasing impurity until it steamed out at the leeward windows. Efforts were made to draw off the foul air by flues, but with so little success that hospital gangrene was by no means prevented. Nothing but

an elaborate system of fan blowers and flues worked by a steam-engine can render such buildings safe.

Similar errors were made in numerous other towns; Memphis is selected only as a specimen. It is a natural but fatal error for thoughtless or ignorant medical directors to choose for general hospitals the largest, finest, and deepest blocks within their reach, ignoring the fact that the difficulty of ventilating the interior increases as the square of the diameter. Deep blocks of stores, and large square hotels are past remedy, and if there is no other choice, it is much better to omit the general hospital entirely, and submit to the inconveniences of a number of small hospitals dispersed among the cottages of the place. The following ground plan and section are introduced to illustrate the difficulty of ventilating a long ward from the end windows. The air comes in pure at the windward extremity of the ward. At the first pair of cots, it re-

No. 1.



Section of a ward ventilated by the means of windows at the ends, showing the accumulation of foul air at one end.

ceives the effluvia of the suppurating wounds, of the perspiration, and of the respiration of the two patients there laid. If for the sake of distinctness we conceive of these impurities as assuming a visible form like a smoke or vapor, we can readily understand the *modus operandi*, as shown by the shading in the wood cuts.

The air comes in pure at the windward extremity of the ward. The air from the windows is rendered impure, as above stated, at the first pair of cots; passing along the ward lengthwise, it receives increasing contamination at every bed until it arrives at the leeward extremity, where it furnishes the last pair of sufferers with

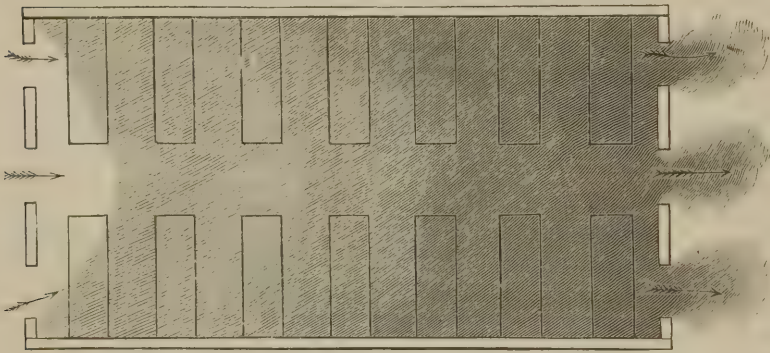
a breath composed of the concentrated putrefaction of all the rest, and then passes out a fuming abomination at the leeward windows.

The shading in the wood cut shows the progress of the impurity.

#### PROPER MODES OF VENTILATION.

The ideal of perfection in the air supply of a hospital is that every breath which the patient draws shall be absolutely a new and pure one, wholly free from any admixture with previous respirations, or with any other noxious exhalation. This is perfect ventilation, and no hospital is to be approved which does not make a

#### No. 2.



Plan of a ward ventilated from windows at the ends, showing the accumulation of foul air at the leeward end.

reasonable approximation to it. Fresh air may be supplied to a building either by means of the natural currents of the atmosphere, or by the propelling power of machinery. If the natural mode is adopted, there must be a complete abandonment of all broad buildings where the wards get air only on one side, and of all structures where they are one above another several stories high, as such edifices cannot be perfectly ventilated by natural means. The pavillion system should be always adopted, that is, a system of narrow wards isolated from each other and opening to the air upon both sides by abundant windows or ventilators. The U. S. Government has adopted this system with immense advantage in several places. The Mower Hospital at Chestnut Hill, Philadelphia, is an example. The wards are just wide enough for two rows of beds with an alley way between. They are only one story, and are of sufficient height to give each patient a space of 1000 cubic feet. The heads of the beds are placed next to the wall as usual. The fresh

air is admitted at openings along the base boards close to the head of each patient, so that it is breathed almost in its purity before it has had time to mix with the general air of the ward. This is a point of extreme importance. The heads of the patients should lie in a positively pure atmosphere, and not in a mixture of good and bad air. The foul hot air passes out in a free opening extending along the ridge or peak of the roof. The result is what might be expected; 6845 patients had been treated in this hospital up to May 1, 1864, of which 2937 were wounded. Not a single case of hospital gangrene has ever occurred. Only one patient has died of erysipelas, and but 49 cases of erysipelas have occurred. Out of all these gunshot wounds, amounting to nearly 3000, but two cases of pyæmia have occurred, and the total mortality of the hospital is only two-thirds of one per cent. Compare this exhibit with that of the crowded Russian hospitals at Simpheropol.

## RUSSIAN HOSPITALS.

No ventilation.

Hospital gangrene, erysipelas, pyæmia, and typhus fever, the chief diseases.

Mortality over 20 per cent.

## MOWER GENERAL HOSPITAL.

Perfectly ventilated.

No hospital gangrene nor typhus, scarcely any erysipelas or pyæmia.

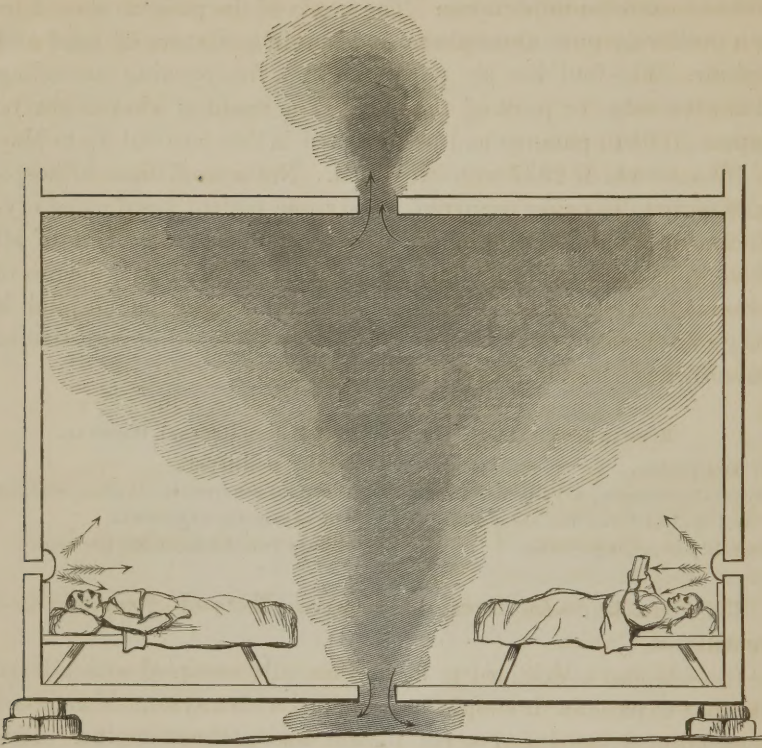
Mortality two-thirds of one per cent.

This is a fair sample of the relative effects of good and bad ventilation.

If a hospital is destined to be permanently occupied with a large number of patients, it should be provided with a system of artificial ventilation by means of a fan blower and a steam-engine. This should be placed in a convenient position, and from the fan wheel flues run around each ward, so as to introduce a current of pure air at the head of each bed. In Europe this plan has been modified, so as to cause a current of air to blow in *under* every bed and thence to rise in a gentle flow around the whole circumference of it, which accomplishes the purpose very well. Probably for a military hospital, where the patients are all accustomed to free exposure, it would be best to introduce the air in a gentle current just *over* the head of each bed, so as to flow along the patient's face towards the foot of the cot. This would sweep the exhalations of the lungs, and every other impurity at once towards the centre of the room, and each breath the patient inhaled would be as absolutely pure as the out-door winds. The impure air should find exit at openings in the ridge or the floor, or both, along the whole length of the

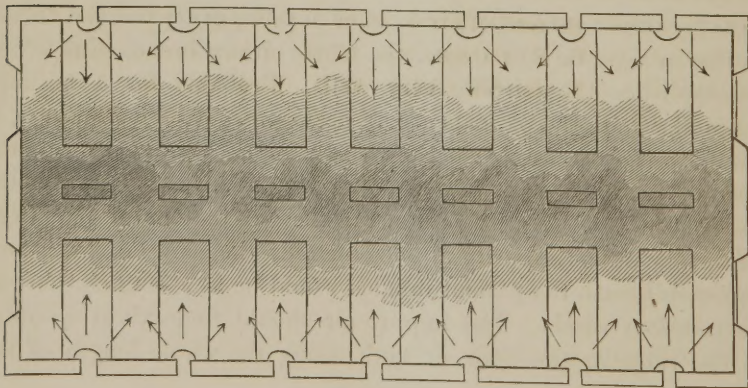
ward. Figures 3 and 4 illustrate this plan, and show how by means of it the respiratory movements of the patient are always

No. 3.



Cross-section of a ward ventilated by air admitted at the head of each bed.

No. 4.



Plan of a ward ventilated by air admitted at the head of each bed.

carried on in a pure atmosphere. The shaded space, as before, represents the location of the foul air.

In collecting the information on which this report is based, your Committee have been greatly aided by the courtesy of medical officers in the army. Our thanks are especially due to the following gentlemen.

J. HOPKINSON, M. D., Surg. U. S. Vols. in charge of Mower Gen. Hospital, Philadelphia.

H. WARDNER, M. D., Surg. U. S. Vols. in charge of Mound City Gen. Hospital, Illinois.

M. BLOCK, M. D., Asst. Surg. at Mound City Hospital.

J. M. WOODWORTH, M. D., Surg. 1st Illinois Light Artillery.

MORSE K. TAYLOR, M. D., Surg. U. S. Vols. in charge of hospitals at Keokuk, Iowa.

JNO. L. SMITH, M. D., Asst. Surg. 55th Illinois Infantry.

A. C. SWARTZWELDER, M. D., Surg. U. S. Vols. in charge of Eruptive U. S. Hospital, Louisville, Kentucky.

F. MEACHAM, M. D., Surg. U. S. Vols. in charge of Gen. Hospital at Lexington, Kentucky.

JAMES H. PEABODY, M. D., Surg. U. S. Vols. in charge of U. S. Marine Hospital, St. Louis, Missouri.

C. R. PARKE, M. D., Surg. in Russian Military Hospital at Simpheropol, Crimea.

—— WEEKS, M. D., Surg. U. S. Vols. Louisville, Kentucky.

We have aimed in this report not to put on record an exhaustive treatise on ventilation, but to array some few startling facts bearing on truths which as yet seem not to be known to all the profession. We hope in this way to render our report practically useful to our brothers in arms before the present war closes.

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