ELECTRICAL CAUSES OF EPIDEMICS.

ELECTRICITY

AS A

CAUSE OF CHOLERA, OR OTHER EPIDEMICS,

AND THE

RELATION OF GALVANISM

TO THE

ACTION OF REMEDIES.

BY

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TO

SIR JAMES CLARK, BART.,

PHYSICIAN TO HER MAJESTY

THE QUEEN,

TO THE AUTHOR OF THE BEST WORK ON CHANGE OF AIR,

THIS

FIRST ESSAY ON CHANGE OF ELECTRICITY

IS DEDICATED,

BY

HIS OBEDIENT AND GRATEFUL

JAMES MURRAY.

ON THE

ELECTRICAL CAUSES OF EPIDEMICS.

INTRODUCTION.

Perhaps the writer of these pages may be excused for premising a few brief remarks respecting the origin and progress of the doctrines submitted in the following abstract. If such relation be imputed to vanity, it is a great mistake. Researches in animal and vegetable electricity were little attended to, nor did that branch of physiology constitute a necessary part of medical studies, or collegiate examinations, in the author's early day. A few fortunate incidents directed his attention to the very interesting experiments and investigations here abbreviated and compiled.

At a moment when such subjects require every degree of attention, in these epidemic times, it may be instructive to present a short summary of the actions and reactions of Galvanism on living beings.

The original notes from which this epitome was condensed, were collected during a period of forty years; but they are too voluminous to occupy the time of professional readers, now otherwise more actively engaged.

Many deductions from these manuscripts have been, from time to time, recorded before various associations, in this kingdom and on the continent; hence the propositions

are conveyed in a plain colloquial style, better adapted to junior students usually present at such societies.

During the promulgation of the theories here deduced, much incredulity was opposed to their advancement; but since electricity came to be more generally embraced as a department of medical studies, numerous converts cease to ridicule this doctrine, and many more, openly proclaim their change of opinion.

At present the murky mists of "*marsh miasms*," which had so long clouded the dark and devious paths of our own and other climes, are partially clearing away, and in some degree disappearing before the new electric light, which begins to illuminate the horizon of science, at home and abroad.

Under this more favourable state of things, almost every writer who early resisted these views of Voltaic agency on the laws of life, and on the alternations of health, now admits their unbounded relations to each other. Many authors are aspiring, in our own, and other countries, to be considered the founders of "the faith that is now in them." They are every where awarding to themselves the priority of discovering these electric theories, which have been in progress of promulgation, by the conductor of these investigations, from 1808, till their publication in the year 1832, and up to the present day.

For the purpose of exciting more extended enquiries by more competent electricians, to the momentous and unbounded influences of Galvanism, or magnetism, as connected with sanatary laws, and also to prevent the misappropriation of the author's part of his researches, he ventures to publish these outlines, which may serve, in some degree, to set matters right, and to invite more extended considerations of them.

The best time to decide disputed claims is surely *when the parties interested are alive, and the witnesses present.* The writer cannot willingly allow to others the merit of his lucubrations, however little that merit may be. He therefore submits this epitome to his professional brethren, who are ever ready, in the end, to award to every one his due.

It is natural that every author should defend his literary property with the same jealousy and care with which he protects his private wealth; the less of either riches a man possesses, the less of either can he afford to lose, and the more vigilantly should he resist any communism calculated to deprive him of his rights.

It may be encouraging to young practitioners under difficulties, to be informed how the mind may be easily diverted, almost by accident, to one particular branch of medical studies, rather than to any other of its numerous departments.

A few circumstances, at his early outset in life, favoured the author's inclination to electrical investigations. During his studies at Edinburgh, in 1806—7, he had the good fortune to attend the lucid lectures, then for the first time delivered in that city, by the celebrated *Dalton.* These brilliant discourses were attended by several Professors of the University, and by many enlightened residents of that city. The expounder of the "*atomic theory,*" in which the grand philosophical principles of the new chemical revolution were so clearly explained and established, excited the most ardent feelings of admiration. His able discourses carried conviction to every mind, and brought chemical laws almost within the range of mathematical reasoning, whereby he was enabled to class chemistry among the exact sciences.

From that time, the author of these notes endeavoured to apply the rule of *definite proportions*, to the *qualities* of living atoms, as well as to the *quantities* of organic particles. He sought to make that scale a continual auxiliary, in unravelling many intricacies of anomalous modifications, which otherwise remained almost inexplicable. This comparison was of advantage afterwards, when enumerating the number of atoms of two or more simple bodies entering into a compound substance, and when the writer was calculating the amount or extent of *atomical inherent quality*, or exact proportions of heat, or electricity, naturally belonging to such living atoms, in a state of health. He also tried to compute, how great became the transition from a healthy state, by a certain *rising* or *falling* in the scale of true atomical proportions, which ought to prevail in *sane conditions* of the molecules of matter. *The ascending or descending gradations of this scale, is the principal doctrine here attempted to be submitted, for further inquiry and elucidation.*

Here, it is just to remind junior readers, that long before Mr. Dalton's Edinburgh lectures, this most important of all chemical discoveries, "the atomic theory," was previously invented by Professor Higgins. Some of the exact items of its true laws of combinations, were recorded and exemplified in his works, previous to any right investigation of them by other chemists. But, Mr. Dalton extended the atomic calculations *to all chemical combinations*, and carried out the doctrine to such extent, as to be supposed, or at all events named, as its founder. He was the fortunate cultivator of that vast land, which the Irish Moses did not enjoy. The *Americus*, of Manchester, became the great expounder, if not the founder, and obtained the name and credit of the immense discovery, which the Dublin

Columbus made before, but had not sufficiently settled or followed out. Neither of these philosophers, however, applied the "*atomic theory*" to explain the *causes* of unhealthy derangement of living particles, or their healthy reunion, by the natural Galvanic influence of electrical remedies.

The writings of Higgins, and the more luminous lectures of Dalton, however, fixed the writer of these pages upon a line of study and experiment which he never wished to leave, until its *extension* should explain the *lost balance of health*, as well as the means of restoring its *normal equilibrium*.

Fortunately, after his examinations at Edinburgh, (being conversant with the preparation of medicine,) the author was appointed a resident medical officer in an extensive hospital and dispensary, in a great and flourishing town. In that hospital was a medical library, and what was all-important to the writer, a large and excellent electrical apparatus. The surgeons and physicians connected with the establishment, were liberal and enlightened men, assisting and encouraging the early endeavours of one, who is grateful for their kind and good feeling on all occasions.

Although at the risk of repetitions, of some detached trials or deductions, spread over the experiments and inferences of so many years, yet it may be here allowable to enumerate a few of the principal conclusions which the fortunate opportunities above mentioned gave rise to.

Series of trials were instituted to ascertain, and generally, in the end, to shew, that following up the atomic doctrine to a *pathological* application of its laws, there appeared some atomic relative changes in the natural proportions of electric equivalents, among the atoms of vitiated

or altered animal fluids, or secretions, under certain diseased conditions. This ratio of disproportion, or difference from the true balance, was also observable by minute experiments, pointing out a distinction of the atomical Galvanic equilibrium, in the blood, in different diseased states, and in different aspects of that fluid, from bright scarlet, to a blackish shade.

The intensity of electric currents, or circles of magnetic action, also varied in the solids, as well as fluids, and the ratio of intensity, or its defect, was generally in proportion to the progress and character of disordered action in muscular, nervous, mucous, serous, glandular, or other tissues.

Similar loss of equilibrium of atomical Galvanism, was traced in untoward secretions of mucus, such as catarrh, diarrhœa, whites, and other disorders of passages, opening out upon the exterior of living bodies.

As far as experiments could reach the seats of ailments in close cavities, such as the pleura of lower animals, a broken electrical balance was also observable between the natural Galvanic relation of the serous surfaces. The extent of loss of balance, shewn on the scale of equivalents, in these instances, first led the author to account, in some degree, for fatal serous effusions being poured through soft mucous membranes, by the subjacent fibrous tissues, in dangerous intestinal fluxes and discharges.

Similar absence of due electric vitality was easily demonstrated by long series of trials, in cases of persons suffering from the effects of intemperance, want of nutrition, or after long exposure to damp air. There was observed in such instances, a definite loss of electric agency or influence, exactly equivalent to the waste of animal atoms, when not repaired or restored by food or drink.

It was also noticed, that animals whose natural elec-

tricity was diminished or exhausted, were amenable to epidemics, exactly in the ratio of such exhaustion or diminution of their proper atomical electricity.

The loss of nervous energy in such exhausted states of animals, seemed proportioned to the loss of electric power. So fully was this proposition borne out, by experiment and observation, that *nervous energy* and *electric power* seemed to be *identical*, or, at least, that they appeared to stand in the relation of *cause* and *effect*. The author often lamented to see young creatures punished for what was called *stupidity*, at times, when their nervous vitality was reduced, and their Galvanic spirit expended, by over-work and confinement, during the unreasonable lessons of tyrannical schools, or the odious discord of unsuitable music. Under such circumstances, juvenile *victims* could not exhibit a spark of talent from their brains, nor a spark of electricity from their bodies.

Vast facilities for observation were afforded to the author, by his plan of introducing into the stomachs of animals, small metallic balls, or globules, appended to slender insulated chains or wires. The comparative indications passing from these points, shewed, that the energy of electric development is directly equivalent to the activity of digestion after meals, and to the formation and assimilation of chyme, chyle, or incipient blood. That, on the contrary, the want, or deficiency of Galvanic display, was noticed to be in the ratio of the absence or defect of aliment, or of the power of converting it into nourishment.

The many favourable opportunities presented during the treatment of the sick poor in hospital, and at their houses, confirmed the author's theory, *that definite disturbances of natural electricity, occasion definite* proportions of epidemic diseases. This doctrine was also traced in the

pathological origin and progress of many nervous and muscular maladies, and in particular instances of intermittent, and other fevers.

But not only was the relation between a *broken Galvanic balance* observed to hold good, with reference to *broken equilibrium of health*, but a similar scale could be traced in the *treatment of complaints*. Every medicine, or rather every particular preparation of medicine, seemed to have (if any influence were observable) a *particular Galvanic action*, on some *function, secretion, or organ*. Remedies of *positive properties*, exercised a very different power from others of a negative range: metals differed in these effects from their oxides, and the oxides themselves differed widely from each other, according to the atomic proportion of the oxygen in them. The same remark applies to the other elements. We see that bi-muriate of mercury (corrosive sublimate) poisons, whilst the proto-muriate (calomel) is a safe medicine; black oxide of iron is magnetic, whilst red oxide of the same metal is not attracted by the loadstone. Even the different *doses* of medicinal substances, exerted very different electric agencies on animals and plants. One dose causing an energetic display of electric intensity, another dose depressing and driving it away. The electric sparks obtainable from the same patients, when insulated, being very different in length and brilliancy, after some medicines or doses, in comparison to the phenomena exhibited after the use of others. Many similar topics might here be glanced at, but their fuller explanations will be submitted in succeeding details.

PART I.—SECTION I.

The following deductions, from thousands of experiments, must appear detached and unconnected; but the trials were so varied, and conducted in so many parts of the world, that their details would be found difficult to understand, if set forth in a continuous series as they were severally instituted.

The author does not affect to consider himself the originator of the entire *pathological doctrines* connected with the influence of *electric agency* on human health. Before 1808, numerous suggestions bearing upon such reciprocal relations, may be found scattered in medical and other works, on various subjects. Such are the hints by D'Alambert on fevers, with the interesting speculations of P. Brydone, and other writers.

The following are some of the inferences and data which the author has endeavoured to collect and confirm, and which he yet hopes to see more extensively improved and adopted. He thinks himself the first experimenter who endeavoured to deduce the following conclusions from the results of trials, on philosophical principles, which it would be difficult to bring under the sway of mathematical demonstration:

DEDUCTION I.

That, as all living bodies are composed of indivisible atoms, particles, or molecules, endowed with an inherent quantity of Galvanism, proper and peculiar to such bodies, and as every particle of the primitive or ultimate elements composing each body, has also its own distinct and definite portion or quantum of electricity, attached to itself, and

surrounding every molecule, like a spirit or etherial film; so, every undue or untoward addition to, or subtraction from, such natural defined proportion, ordained to each atom, or congeries of atoms, must produce some variation in their relative feelings, functions, health, or organization, according to the ratio of every increment or decrement, above, or below, the natural standard, limited by the law of definite proportions.

That, as the all-pervading and all-conserving power called Galvanic (fluid) is a spirit, or essential ether, not yet appreciable to any material tests, and as we hitherto only know it by its effects, it would not be deemed philosophical to speak of an "*atom of electricity*," more than to designate equivalents of caloric by the term "*atoms of heat.*" We cannot logically say, that an *atom* of Galvanic (fluid) unites or combines with an *atom* of oxygen, of carbon, of nitrogen, hydrogen, or any other simple element, to make up or constitute any of the integral material molecules or compounds, called *proximate principles*, of which organic beings are formed. We therefore venture to explain the union of this imponderable *spirit*, with a material particle, or its compounds, as an ADJECTIVE QUALITY, regulated to belong to all bodies and parts of bodies, in defined proportions, and which we here endeavour to render intelligible under the name of "*atomical Galvanic equivalents.*"

The importance of these explanations will be more apparent, when we come to consider the "agency of *atomical Galvanism* on the mutations of animal organization, and the consequent interchanges of epidemics and other disorders."

DEDUCTION II.

The author's earliest experiments, since 1808, led him to conclude that no such peculiar poison as that called

"*marsh miasm*" exists, or ever did exist. There are many offensive, and even insalubrious emanations from decaying substances, but none of them are capable of inflicting the multifarious injuries attributed to that nightmare of the mist, "*malaria.*"

There is no occasion to evoke such noxious spirits from the vasty deep, to account for damages done, *positively*, to animated beings. Instead of *receiving* such a deleterious agent into bodies, to originate pestilence, it appears more certain that bodies *lose*, or *give out*, some of their own qualities of sanatary influence, the deprivation of which renders them amenable to certain scales of disordered conditions—millions of trials shew, that the infliction is generally of a *negative*, not of a *positive* kind, in localities calculated to withdraw vital powers from living things.

DEDUCTION III.

Continued trials testify, that fens, marshes, sewers, drains, cess-pools, mud-banks, filthy garments, wet floors, damp factories, sunless rooms, and houses near grave-yards, are the *carriers*, but not the creators, of pestilential and epidemic maladies.

That these ready conductors convey away part of the natural *atomical electric power* which every particle of living matter should enjoy; that where partial privation has already been effected by sorrow, intemperance, hard studies, bad diet, damp clothing, or night air, then a further abstraction of galvanic vitality readily robs the body of its healthy energy. Under such exhaustion there remains no tone, or sufficient nervous power to resist the assaults of diseases, and the system soon becomes reduced to a condition suited to be assailed by the disorders prevailing in such unhealthy localities. Such abstraction of the living prin-

ciple, so rapidly breaks the normal galvanic balance, that the victims suffer the more dangerously, the more their atomical stock of electricity becomes exhausted or discharged.

DEDUCTION IV.

The converse of the above proposition is also proved, by experiments, to hold good. Because other severe injuries and disorders are inflicted by *overplus electricity*, or by either of its elements. The gradation of such baneful action, when in untoward quantity, is proportioned to its excess, above the due atomical equivalent of a part, or of the entire body.

DEDUCTION V.

The doctrine, that all epidemics are the same character of diseases, differing only in degree, according to the extent of broken equilibrium between atomical galvanism and the living atoms to which it belongs, is startling, and appears extravagant; nevertheless, such theory can be sustained by experimental data, as well as by reason and analogy. The consideration of this curious "*theory of medicine*" will be submitted in the section treating of the *relative scale* of galvanic epidemics. Mean time, any *new theory* of diseases may be easily accounted more reasonable than the best of the old ones.

It is clear that the mode of action of medicine might be more satisfactorily explained, by referring their effects to an altered condition produced in our component elements, than by resting satisfied with the theory advanced and maintained by Dr. Cullen, and those who preceded him. They attributed the activity of remedies to their "*impulse* on the extremities of the nerves, which impulse

produced a *motion*, propelled along the course of the *nerves* to their source, and thence arose a *sensation*, which again caused a *volition*, whereby a motion is produced, which being determined along the course of the nerves, into certain muscles, or moving fibres, the action of these, as well as the various effects which their action is said to occasion, are in consequence produced." This curious non-electric philosophy, like the *phlogiston* of the old school, mystified what was before abundantly obscure.

Should those members of the profession, most conversant with electrical phenomena, come to compare and adopt the following views of pathology and materia medica, not only would the origin of sanatary changes be traced to intelligible sources, but so also would be the prevention and treatment of many epidemics.

Four elementary substances, oxygen, hydrogen, carbon, and nitrogen, are the simple constituent bodies which make up or compose the proximate *principles*, or integral organic particles, or *materiel*, of our flesh and blood. These principles, or animal parts of our organization, are called *fibrine*, *gluten*, *gelatine*, and *albumen;* as was said above, every atom of these elements, and also of their products, has its own defined atomical equivalent, or proportion of atomical Galvanic distribution. Therefore, every change in that Galvanic distribution is capable of producing a corresponding change, removing from, or adding to, the number of elementary atoms of which the bodily *principles* are formed.

If it be admitted, that an agent of well known powers, such as Galvanism, can alter one proximate principle or compound atom of our bodies into a different principle, then it may be reasonably allowed that such mutation of our substance may produce mutation of our health.

If electric agency or passes, can turn albumen or gluten into *fibrine*, febrile diseases may be readily induced. Inversely, if Galvanic action can convert *fibrine* into gluten or gelatine, disorders of debility, such as scrofula, dropsy, dysentery, or scurvy, may be engendered, or a disposition towards them established. In animal and vegetable atoms, as in mineral substances, there is no chemical change without a corresponding Galvanic change also, and *vice versa*, all Galvanic displays of action, positive or negative, produce positive or negative chemical alterations in fluids, or moist solids, within the sphere of atomical Galvanism.

DEDUCTION VI.

The powers of many remedies being in proportion to their action, in restoring or preserving proper atomical equality of electricity, will also be explained in a future part of these essays.

Superadded to the above galvanic origins of chemical changes, and even mechanical arrangements of animal constituents, must be joined other extensive mutations, in operation through electric or magnetic agency, acting upon circulating fluids, and upon the black protoxide of iron in the blood.

There now remains no doubt, from many series of trials, that galvanic attraction or repulsion can diversify the relation, mutual contact, position, and aggregation of moveable animal or vegetable atoms. We see that negative or positive electricity can vary, controul, and determine the conglomeration or configuration of crystals, when forming in solutions of salts, minerals, earths, or metals. Therefore, if certain relative galvanic proportions of power, can range inorganic particles, and retain living atoms, side by side, meridian to meridian, in a state of natural apposition

and rest, so also can the same influence, exerted in a different degree, or under a state of disturbed equilibrium, alter the relative contact, and relation of particles, or molecules, in living fluids, or in moist solids.

If the defined natural atomical balance of electric power be *broken*, by undue attraction or repulsion of the same (fluid), either from the earth or the air, there is readily set up, in beings predisposed, by causes already enumerated, a corresponding *broken balance*, and a divellent attraction or repulsion, whereby the atoms within the sphere of such agency, may be moved or drawn into a different aspect, in their relative contact, so as to be poised, by a subtle surrounding agent, into longitudinal relations with each other, and be placed, like oval bodies, pole to pole.

Where this altered state of aggregation is suddenly excited in the animal solids, by external injuries, or internal disturbance of the natural galvanism of the part, it becomes enlarged, swelled, and warm, because extensive congeries of spherules revolved, so as to present their ends to each other, occupy more space than where they repose together in their natural state, side by side. Without doubt, there is, at the same time, set free a large proportion of animal heat, liberated by the altered atomical quantities of it, naturally belonging to atoms in the one state, compared to that of atoms in other conditions.

A curious illustration of this doctrine takes place when water is expanding, as its temperature is diminishing, under 40° down to 32° of Farenheit. This degree, in ordinary circumstances and pressure, is the freezing *point;* viz., the *point*, when the atomical galvanic equivalent, which is naturally possessed by *liquid water*, loses that balance, exactly at that determined range of the scale, and when a new galvanic balance of electric agency, is required for the

new arranged atoms of *solid water*, in the state of crystal, frost, or ice. Polarity expands all fluids.

Steam, again, is water converted into gas or vapour—the exact equivalent of reaching that point, under ordinary states of things, is at 212° of temperature, viz., at the exact point, when the atomical equivalent required by fluid water, ceases to be the proportion requisite for atoms of aeriform water. The resulting atomical difference is liberated, as a flood of free electricity, which sometimes bursts boilers if not conducted away.

The very same thing occurs, in a minor degree, all over the face of the world, and the face of the waters, whether hot or cold: evaporation is the vast and unbounded distillery which supplies endless oceans of electricity, rolling in waves, and often in awful clouds and torrents, which, by their tremendous states of unequal intensity, find their safety-valves in thunder, or inflict various injuries on living things, by communicating or abstracting Galvanism, to equalize their own excesses or defects.

If it be true, as so many experiments lead us to conclude, that *animal heat* is a display of galvanic fluid, or of its action, *setting free* part of that calorific quality, during the mutations of atomical *quantities* in the organs and circulations, and if it be also true, that the same power or modifications of it, be identical with what is termed nervous energy;—if these two propositions can be established, by able electricians, then, many other physiological phenomena will be traced to the influence of the same universal power, or cause of power.

How easily the balance of the elementary parts of our bodies may be disturbed, and the constituents changed, may be seen by considering how nearly their proximate principles approach to those of each other, and how nearly

the number of ultimate elements approximates in each principle. 100 parts of

Fibrine consists of,

Carbon,	53·360
Azote or Nitrogen,	19·934
Oxygen,	19·685
Hydrogen,	7·021
	100·

Albumen consists of,

Carbon,	52·883
Oxygen,	23·872
Hydrogen,	7·540
Azote or Nitrogen,	15·705
	100·

Gelatine consists of,

Carbon,	47·881
Oxygen,	27·207
Hydrogen,	7·914
Azote or Nitrogen,	16·998
	100·

The same laws apply to vegetable physiology and organization. The untoward derangement of vegetable principles, of late years, destroyed potatoes and other succulent plants.

The ultimate constituents of vegetable matter are oxygen, hydrogen, and carbon, and sometimes nitrogen. All the products of fermentation must be new compounds of these three or four ultimate constituents.

Sugar is a vegetable oxide, and consists of,

Hydrogen,	6·90	57·53	Water.
Oxygen,	50·63		
Carbon,	42·47	42·47	
	100·	100·	

Yeast sets up new electric action, disturbs the affinities of the elements of sugar, and takes its oxygen from it; the equilibrium being broken between the principles of the sugar, these so re-act on each other, as to be converted into alcohol and carbonic acid.

Many truths have been established, the investigations of which derived their first deductions and elucidatious from analogy; and we draw examples from the vegetable world to explain the nature of the animal agencies. Thus, the proximate principles of sugar, starch, gum, &c., composed of carbon, oxygen, and hydrogen, are convertible into each other by relative increase or diminutions of their ultimate elements. Like the constitution of animal matter, that of vegetables is controlled by the changes and reactions of these organic agents, determined by Galvanic action, through the medium of temperature, air, and humidity.

The breaking up of the due and healthy compounds, and the consequent formation of altered ones, must produce an altered state of the entire frame, or of a part, and constitute complaints, general or local. Thus if we suppose an atom of albumen to contain one equivalent of nitrogen, and that from some cause, a second equivalent of nitrogen be disposed to join the first, we then have the proportion of nitrogen existing in uric acid. If we follow this mutation of atomic interchange, we can conceive how the remaining equivalents of oxygen of this altered albumen, and also those of carbon, may join some other nascent compounds, together, or separately; one part joining to form carbonic acid, and another part uniting to gaseous elements of some new evolving product.

In some such way we can conceive how readily a particle of uric acid can be produced, not made up (de novo) from the blood, but a new product, resulting from the

decomposition of some broken down principle, previously existing in the system, or circulation. Is this the reason that abundant evolutions of uric acid, and similar matters, succeed the too copious formations of fibrine in fevers and inflammatory diseases, and in acute rheumatism and gout? We see how urea is artificially obtained from cyanate of lead and muriate of ammonia: the cyanogen containing nitrogen and carbon, and the ammonia nitrogen and hydrogen, all essential to the formation of urea.

Tannin, composed of carbon, oxygen, and hydrogen, can be formed by art, by contributing to carbon the other requisite elements, from the action of water and acids.

The letters which we read in the scale of music are few, and yet, by their different combinations, the varieties produced are extensible *ad infinitum*. In like manner, the number of the ultimate elements composing animal matter is small, but the resulting combinations varied and variable without limit.

How readily albumen and fibrine are reciprocally converted into each other may be imagined, when we reflect, that they only differ in composition by fibrine containing one proportional of carbon, one of hydrogen, and one of nitrogen more, and one of oxygen less, than albumen is made up of; and hence we might suppose that in inflammatory diseases, the atoms are disposed to form fibrine in undue proportions; and in dropsical cases, scurvy, and diseases of debility, a contrary affinity is exerted, and albumen and gelatine too copiously produced; and hence we would explain how venesection and antiphlogistic regimen diminish the quantum of fibrine, and promote the formation of softer principles of less tonicity and exciting powers. Hence we reason on the above *modus operandi* of various medicines producing new chemical affinities of atoms, and

moderating the attraction of those that combine or act with untoward energy.*

The above detailed doctrines have been submitted by the author to professional consideration at various intervals of time. The electric theories were first laid down in the pages of the Belfast Magazine in 1809–10, when Sir Humphry Davy's brilliant Galvanic decomposition of earths and alkalies attracted such merited attention. The writer's curious theories, including the attractions, repulsions, mutations, and consequent disorders of animal and vegetable organization, were published in a translation of his Edinburgh *Thesis (de Temperatura)* in 1827–8.

Since that time various explanations of the same atomic alterations and consequent changes in structure, functions, health, and disease, were printed. One of these, written in 1831, was addressed to Dr. Ferguson, then at Sunderland, calling his attention to the untoward atomical revulsions set up in the human system during cholera, causing the evolution of lethal re-unions of broken down molecules fatal to human life. Some heads of this letter were afterwards sent to the *London Medical and Surgical Journal* in February, 1832. (*See Appendix A.*)

More particular extensions of the author's doctrines were discussed at meetings of the College of Physicians, and of the Surgical Society of Ireland. These papers were curtailed in the *Dublin Journal of Medical Science*, July 1836, p. 401. The following, among other suggestions and opinions of the writer, were there published, and are repeated here, to fix them more strongly on the reader's mind. It was maintained "that some of our constituent elements become deranged and liberated, by the AGENCY OF ELECTRICITY, and that the unions of those atoms deviate

* *Vide Thesis*, by J. Murray, M.D., 1828.

to such extent, that disintegral chemical operations are set up, so that the elemental molecules sometimes join in proportions suited to generate *prussic acid, in our system*, as we know they so readily do out of it, (p. 405.)

During the author's first residence at Rome, 1834–5, his experiments on the electrical causes of atomic *transitions*, with their consequent play of new affinities, ending in *agues and other fevers*, were widely circulated and impressed upon the attention of many eminent professors in Italy and France.

In the next year, 1836, the author delivered public lectures, at the Royal Exchange, Dublin, in which the agency of electricity, in the preservation of atomic unions during health, and its broken balance during disease, were strongly inculcated, and illustrated by experiments.

Some of the results of his earliest experiments and observations at Belfast, were read to a meeting of the Surgical Society of Ireland, at the Dublin College, 9th Nov. 1844. The discussion of these subjects appeared in the *Dublin Medical Press*, November 27th, same year, and was copied into "*The American Journal of the Medical Sciences*," April, 1845, p. 456, by Isaac Hays, M.D., Philadelphia.

More lately, 1846, when human beings, birds, beasts, fishes in the waters, and vegetables on land, became more or less disordered in certain lines of localities, the author being at Brighton, observed, that the prevailing inequality of electricity in the earth and air, blackened the potato fields in one night. He printed, in the Brighton Gazette, his views of the cause. *(See Appendix B.)*

Several years since, when the French were engaged in Algeria, some copies of the above publications were sent by residents of France to an able army surgeon, Dr. Charles

Shrimpton, now of Paris; that gentleman kindly intimated to the author, that he made known this new doctrine amongst his medical friends in that colony, and that his own experience of intermittents, and other fevers, fully confirmed the reality of the causes suggested in the author's publication. The report of this doctrine was widely circulated by Dr. Shrimpton in that distant region, and again among the faculty of Paris, on his return to that city. It is remarkable, that one of the army physicians who was with the troops in Algeria at the same time, Dr. Pallas, has since sent a communication to the *Academie des Sciences*, 7th June, 1847, in which he maintains the same doctrine, almost word for word. *(See Appendix C.)* This is gratifying, as an additional testimony to the author's exertions, and to the merits of his publications twenty years before.

Whilst these sheets are passing through the press, M. Andraud has addressed to the President of the *Academy of Sciences, Paris*, a letter containing exact evidences to the same purport. *(See Appendix D.—See also Dr. M'Cormick's reply.)*

Some years since, four vols., notes of experiments in Italy in 1834, and again in 1844, were sent to the Lancet for publication, but the magnitude of the papers prevented their insertion, until an extract of them was condensed; these abbreviated abstracts appeared in that able journal in the course of 1848, and are here concentrated for further consideration. These series of notes in the Lancet were fortunate to merit the notice and approval of Dr. Castle, and many other able writers in America. *(See Appendix E.)*

An abstract from the observations of Dr. Castle in the Medical and Surgical Journal of Boston, 29th Novem-

ber, 1848, and January 17th, 1849, will be found in *Appendix F.*

Under all the circumstances, the author ventures to hope, that although public attention was very slowly turned to his early attempts, he may yet live to see them entertained, in a manner gratifying to himself, and beneficial to mankind.

SECTION II.

When the cholera of 1832 appeared in Ireland, the writer was appointed a member of the Central Board of Health: the various duties of this office embraced communications from every part of the country. Ample facilities were thus afforded for observing certain effects of the march and influence of altered electricity, within and along a portion of the globe. The disordered galvanic state of earth and air was followed westward by maladies, and the disposition to maladies, which never failed to assail man or beast, more or less, after every similar march of vast terrestrial disturbance in the generation or distribution of westward galvanic inundations. Desirous to lighten the density and pressure of the atmosphere, around cholera patients, the author introduced an apparatus for that purpose, and published an account of it in the Medical and Surgical Journal, of London, July, 1832, p. 749. Here he urged the value of allaying the disordered electrical agency in cholera cases; so well known were his Galvanic doctrines, among his medical friends, that he merely appended his belief of such agencies in a note to that publication, as follows:—

"The mystical nature of the origin of cholera, and the total failure of preventive means, justify a person in venturing suggestions and hypotheses which might otherwise be deemed extravagant.

"The Globe on which we move, is the source and reservoir of the electric fluid. That fluid is composed of two elements, the *resinous* and the *vitreous*, or, according to others, of positive and negative electricity, combined in due proportions. The air arround us contains inexhaustible stores of electricity. If the earth's electricity be excited in any part of the globe, by chemical action or other causes, such as central convulsions, polarity, magnetism, or by intense or long-continued heat, the excess will rush to the super-incumbent air, into the susceptible bodies of men, and into all other good conducting media, placed upon such overcharged portion of the earth. On the contrary, if the electric fluid be disturbed or reduced, either in its due quantity or in the proportion of the two fluids of which it is constituted, then the air and all bodies in contact with the earth will communicate part of their electricity to it, as a warm body would distribute heat to a colder, until their temperature become equal. The repulsion or attraction of these Galvanic currents will therefore take place between the air and the earth so long as either of the electric elements is in excess, or so long as one portion of the globe contains more or less of the electric fluid itself, than is held in the atmosphere over that space.

"The passage of electricity between the air and the earth must produce effects on man, proportioned to the intensity or quantity of the fluid of which he is the conductor, and to the state of his nerves at the time of the hidden transition of the minute Galvanic shocks.

"As man is more an artificial being than animals left to nature, he suffers more severely; damp clothing, and other causes, contribute to make him the ready medium of passing the electric element between the air and the earth, and also predisposes his frame to suffer more severely from the transit of the fluid through him, and from the consequent derangement of his own electricity.

"The nerves conduct electricity as readily through man, as bell-wires convey it through the rooms of a house; the same influence, in a minor degree, which melts the metallic conductor in the apartment, disorganizes and alters the texture or condition of the nerves and of the elementary constituent principles of the human body, particularly if already disposed to derangement. This lesion of the nervous tissues and animal economy, unfits the vital organs for performing their functions, permits the equilibrium of the circulation to be lost, and the blood to run from the weaker and more minute branches of vessels into the larger trunks, hinders the evolution of animal heat, and allows the blood to part with its serous constituents, which filter through the relaxed membranes of the intestines. Many other diseases are also probably occasioned by such an unequal current of electricity as is capable of disposing the solids and fluids to derangement of the elements which compose them.

"In this injured state of the ganglionic nerves, spasms supervene, and apathy depresses the powers of life; deep debility follows, with a train of symptoms which nervous people feel when the clouds are unequally charged with electric fluid, and when their equilibrium is about to be established by the phenomenon of thunder.

"If this analogy hold true, that in India a part of the globe lost its balance of the electric fluid, by induction, or

otherwise; that this untoward surcharge of the earth continued to advance at the rate of about a furlong an hour, or ninety miles per month; that the adjoining air and earth endeavoured to effect an equilibrium of their electricity; that in doing so the susceptible human nerves were made the media of communication, then we could, in some degree, account for the march of this dire disorder, and for many of the appearances of its progress till death, and of the bodies after death; appearances similar in many respects to those resulting from the more sudden and fatal transit of the electric fluid through man by lightning. We could also explain why better conditioned and well clothed persons escape, and others suffer; and how damp air and fogs, possessing such good conducting powers, bring so many people at one time and place under the influence of the passing electricity. How the disease diminishes in frequency and fatality, as the equilibrium between the air and earth, and the balance of electricity in man himself, become established, and how the situation or locality improves, as its electro-Galvanism becomes saturated or neutralized.

"Many other phenomena resulting from the intercharge of the electric fluid itself, or of its elements, present themselves. The supposed contagion of some diseases may be owing to the distribution of the electric fluid between healthy individuals in whom it is equal, and diseased persons in whom it is irregular, which circumstances would occasion a degree of disturbance in the natural electricity of a healthy body.

"But speculations would only amuse, unless we aim at useful suggestions; might not therefore the use of some good non-conductor be recommended to be worn as raiment during the day, such as silk garments next the

skin, and silk sheets in which to sleep by night. Flannel clothing on the one hand, and silk on the other, occur as hints probably worth being mentioned to suit all classes, and to assist the poor and rich in warding off the mysterious and all-pervading currents of irregular electricity.

"Having had numerous proofs of the advantages derivable from covering damp floors with a layer several inches deep of fresh burned lime, I propose that plan also for the low clay floors of the poor. New dry lime is a non-conductor of electricity, and by imbibing water or moisture improves the temperature of cold rooms, and absorbs carbonic acid, so plenteously floating about in confined apartments. I also recommended that baskets filled with fresh lime should be kept under beds and tables, by way of precaution and prevention, in the tenements of the poor, to abate untoward galvanism.*

"It appears to me that these means may alter the condition of the spinal column and ganglionic nerves, and improve their electrical state, by partly insulating the body, and by keeping it some time surrounded by a drier atmosphere, and consequently modifying electrical influences on the nervous system.

"At all events, by the use of large quantities of fresh burned lime placed in baskets in every part of the house, and by all other means of absorbing water from the atmosphere, we may greatly diminish the conducting power so largely possessed by damp air.

* Essay on Temperature and Humidity, 1828.

SECTION III.

The heads of the following outlines were printed in the Lancet, in various numbers, in 1848:—

Abstract of certain Experiments on the Nature of Epidemics.

Being anxious to solicit the attention of my respected medical brethren to a further consideration of malaria and epidemics in these alarming times, I long since sent for publication in THE LANCET, four fasciculi of experiments upon these important subjects. Those papers contain details of experiments made by me when a member of the Board of Health at Dublin, during the occurrence of the cholera in 1832, and of various investigations in the malarious districts of Italy in 1834, and again in 1844.

Since it appears the above details are too extended for insertion in that periodical just at present, I have ventured to ask space for an *abstract* of the conclusions to which my trials have led me since the promulgation of my electrical theories in 1832.*

Only a short summary of the volumes of manuscript notes remaining at the office of THE LANCET can now be given. The reasons and experiments which led me to the following conclusions are so numerous that they would require a separate publication to lay all the explanations before my readers. The results of my experiments and observations led me to abandon the ordinary doctrines of *marsh miasmata*, and to attribute to emanations of a very different kind, the exciting causes of what are called malarious diseases. Without the notes of evidence, however,

* London Medical and Surgical Journal, July, 1832, p. 721.

the summing up, here condensed, must of course be very imperfectly understood:—

1st—I consider that the exciting cause of epidemics, which is called *malaria*, is not "bad air" at all, as the name implies.

2nd—That marsh miasms, gases, or effluvia of vegeto-animal matters or putrid emanations, are not, as is commonly supposed, the exciting causes of agues or other diseases called malarious.

3rd—That in denying the usual doctrine of marsh miasmata, I do not deny that general "malarious" ailments proceed from terrestrial, paludial, or atmospheric emanations of active, dangerous, and subtile qualities.

4th—But I consider these noxious emanations are disturbed *electro-galvanic currents* and accumulations, sometimes positive, sometimes negative, causing a want of electrical equilibrium in human bodies.

5th—That these electric agencies are untowardly excited or set free from soils of fens or marshes, drains, and sewers, by the known effects of evaporation, chemical action, and infiltration of decomposing substances and putrid deposits, or from foul waters, among minerals, ores, metals, and dissimilar strata of soils and sub-soils, and also in wet lands, or during rainy seasons, after long-continued absorption by the earth of solar heat.

6th—That as it is notorious that there are more insalubrious dry and high places in the Campagna di Roma affected with malarious diseases, than in wet and low situations, I consider that in such elevated and arid spots, long noted for insalubrity, there is emitted from the earth's surface an untoward emanation of electro-galvanism, with its concomitant lethal agent called ozone, set free by causes operating within the soils of that locality, either by the

juxta-position of strata of dissimilar materials, acting electrically upon each other, or by the infiltration of subterranean streams or mineral waters, and by internal heat and consequent liberation of steam-electricity, or by some other agents, acting upon materials contained in the ground, analogous to the manner in which we operate upon artificial substances in a galvanic apparatus.

7th—That in some of the thousand ways in which electro-galvanism is produced in the earth or air, its undue influence (under certain circumstances) disturbs the natural electricity of human beings, particularly when recumbent in contact with the ground, or on beds near the earth.

8th—That this disturbance, either in the relative quantity of electricity itself, or in the due proportion of the positive or negative (fluids), alters the condition and functions of the human nerves, and probably the relative state of the particles, and the polar relations of the atoms or corpuscular molecules, and at all events is capable of exciting or depressing the vital functions, and of acting chemically on the circulating animal fluids. This is obvious near foul rivers, and during east winds, the agency of passive or negative electricity, then, and there, inducing diseases of debility.

9th—That these untoward galvanic agencies account more clearly for the specific cause, specific symptoms, and specific cures of some classes of complaints, such as intermittents, than the hitherto assumed action of *marsh miasmata*, which are supposed to be so various in their nature. In regions in which there are no fens or marshes, such as the Island of Ascension, &c., the agues incident to strangers are the same as where morasses are extensive; in both circumstances the disorders occur at particular seasons, are confined to particular situations, and require particular and identical treatment.

10th—That the doctrine of marsh miasms is untenable, because malarious diseases attributed to them are common where there are no marshes, and because domestic animals are in general perfectly healthy, whilst human beings fall by thousands, which surely would not be the case were noxious miasm *inhaled* into the lungs during respiration.

11th—The immunity of lower animals seems to arise from the comparative density of their integuments, rendering them less liable than men to the influence of electric accumulations, galvanic currents, or the disturbance of the natural (fluid) in them by induction. The hairs or wool being wet at night, serve as pointed conductors, which diffuse or dissipate opposite electrical currents into the earth or air, and prevent their effects on the small brain and nerves of domestic animals.

12th—That the general immunity of blacks (even those who have long lived in our climate) from malarious diseases, appears to prove that inspiration of malarious air by the lungs is not absolutely noxious, and that the cutaneous texture, oily secretions, and non-conducting varnish of their daily anointing and painting, render their skins less susceptible, or more repulsive of electric agencies, than the integuments of whites. The black colour, as it absorbs heat sooner than white, may also make a difference in the electric conducting power. Even a black silk thread, ribbon, or stocking, presents very different electrical phenomena from those of white twist, or fabrics of the same texture.

13th—That this doctrine of the electrical origin of malarious diseases enables us to approach much more nearly to salutary means of prevention, than the old theory of inhalations of miasms wafted in the air, can lead us to apply preventive measures against.

14th—That, with this view, in order to enable colonies to be planted upon the Campagna di Roma, and other insalubrious or desolate regions, I proposed to *drain some suitable sites thoroughly;* to place a horizontal zinc or copper rod or tube in each drain; to connect these cross-wires or tubes with two or more upright conducting or lightning pipes or rods; to carry away excess of electricity outside the habitation, and not to permit its passage up or down through the house or tenement, or through the bodies of its inmates.

15th—That many trials have convinced me, that houses, when built upon such insulated platforms, floored with non-conducting compost of asphalt or bitumen, and protected above and below from electric currents by copper tubes or wires, are comparatively healthy in all situations. These insulated chambers prevent the natural electricity of the bodies of men from being untowardly augmented, diminished, or irregularly distributed through them, by the *abstracted*, or the *excited* electricity either of the earth, or of the air, as I have many times witnessed.

16th—That as many failures have occurred to common protecting rods for want of moisture in the ground, in dry seasons and arid elevations, I have found hollow pipes, such as our copper gas-tubes, to present several advantages as lightning rods: by terminating below in the horizontal pipes or drains containing water, and by being always wet inside by the rain contained in them, their efficiency is secured.*

* In trials on rocks and dry mountains, on my experimental protecting pipes, small funnels were fixed to collect rain. The lips of the funnels were furnished with points; part of the horizontal pipes in the ground were bent down like an inverted syphon, to contain water where none was naturally to be found. The overflow from these tubes always kept some parts of the contiguous earth or sub-soil wet or humid, so as to form a good conductor at a sufficient depth.

17th—That having secured a perfectly *drained area or platform* for a house or houses, I lay over the arches of the drains a solid floor of Roman cement on brick or stone work, and when the tenement is erected, and this platform is perfectly dry, I make it hot by a fire laid upon it. Whilst still hot, I spread over it a melted layer about four inches thick, of asphalt and pitch, mixed with fine dried and sifted powder of Spanish clay. This makes a floor which does not crack, and which is almost impervious to moisture, or to passes of electric currents, either from the air above, or from the earth below.

18th—That in building the walls in the first instance, a layer of sheet lead is laid in pitch and tar compost, on a level with the intended floors, with which layer the insulated compost above mentioned is made to unite, when making the non-conducting floor, after the building is finished.

19th—It is too tedious to detail in this abstract, but I have devised a ready insulating medium for existing walls and buildings, and also for raising small tubes or pipes from the house-drains into the air, higher than the chimnies of houses, or spires of churches, to serve as efficient *lightning rods*, and to allow odious smells and hydrogenous gases to be blown away in the higher regions of the atmosphere.

20th—This principle of insulating the areas or ground upon which the buildings are erected, is intended for habitations, hospitals, barracks, and all public or private edifices, in malarious localities, and particularly in those places where insalubrity is prevalent and dangerous. In such desolate situations, the inmates may, in a great degree, be preserved from the direct action or disturbance of electric passes, up or down, through the apartments or places of rest—the same plan applies to towns.

21st—That this precautionary insulating measure is also well adapted to diminish the damp prevailing in many basement stories of houses, and, by rendering the air of the apartments dry, and therefore non-conducting, is calculated to diminish the danger of moisture, and many of the other evils commonly associated with the old or current theory of marsh miasms.

22nd—That for so-called malarious districts, wet floors, or low places, a thick layer of dry lime, fresh from the kilns, produces very favourable galvanic changes; abates the low indication of negative electricity of these places for the time; puts a speedy end to several chemical changes going on in sewers and soils; and tends very much to ameliorate the atmospheric condition of the insalubrious habitations, in so far as electro-galvanic currents and accumulations are concerned. Dry lime *is a non-conductor*, and has been useful in absorbing the moisture of damp rooms, and thereby diminishing their power of carrying electric currents to or from the inhabitants.

It had long since been proposed by Dr. Priestly to electrify a great number of patients at once, by placing them in a chamber raised upon glass feet.

Mr. Ellis recommended, in 1831, that persons seized with cholera should receive their medical treatment in beds placed upon glass bottles, and be supplied with their remedies in glass vessels. All these ingenious suggestions were proposed for the use of persons already diseased, but my desire is to *prevent persons from being epidemically diseased at all*, as far as can possibly be accomplished. The above able gentlemen have suggested means of *cure;* I recommend measures of *prevention.* Their propositions were never carried into effect: whereas my insulated houses were *tried*, and saved the inmates from attacks of

disease in places where labourers, unprotected, fell by dozens in faintings and fevers, from want of sufficient electricity to sustain the natural balance. Persons insulated by a very bad conductor, such as a floor of cold asphalt, and by *clean dry flannel, silk, or other insulators*, cannot readily communicate electricity to the earth, nor receive electricity from it, if the air of the apartment be dry, and free from filth, mist, or vapours.

The following may serve to convey an outline of my reasons for insulating public and private buildings:—a cloud strongly charged with positive electricity over the individual, will attract his negative electricity upwards, and repel his positive electricity towards the earth. After the cloud is discharged, passes away, or is neutralized, the two elementary fluids rush towards each other into the centre of the person's body. The opposite currents of the two elements often kill instantly. In milder cases, such electrical disturbance affects the animal fluids, as it affects beer in the cellar, or milk in the dairy.

I consider that men's bodies, between the atmosphere and the earth, represent the chain of a Leyden jar, or of an electric machine, conducting negative electricity from the outside of the jar to the ground, or supplying positive electricity from the earth to the rubber. Were the surface of the floor well *insulated*, the chain could not readily give or receive the currents which otherwise pass through it. Men, in like manner, may be saved in towns, camps, and houses, from being made the vehicles of currents, which are quite capable of deranging the mechanical order, the chemical action, and the physical function of every atom and organ of the human body.

I have also recommended portable insulated chambers, or sheet-iron cottages, and pitch floors, for sailors or others

while frequenting noxious shores or swamps for wood or water.

SECTION IV.

Deductions from certain Experiments made to ascertain the Nature of Epidemics.

23rd—That "*marsh miasm*" is a misnomer, and a weak invention to cover want of knowledge—a "*mysterious emanation*" supposed to arise like a spirit from the fenny deep, and to infect air, soil, and water—a "*pestilential something*," reputed to be *malaria* itself. But no chemist has yet separated this "*germ* of *evil*" from the marshes in which it is said to be engendered.

24th—That early in life, a believer in these misty delusions of "*marsh poison*," I did hope that improved tests and apparatus would arrest the "*gas*" and detect its composition. But continued trials during twenty years all failed to render it tangible. As yet, there has been no analysis of this "*pest*," although its sway is dreaded alike in the lowest valleys, and on the highest hills.

25th—That no doctrine can be more mischievous than this of "*miasms;*" for if there be such a poison, *sui generis*, wafted about in the air we breathe, there can be no precaution by which we may hope to ward off such an enemy, whilst it continues unknown and unseen.

26th—That no harm can result from any attempts to overturn the faith that *was* in us, and to believe in some other power capable in various ways of being felt, seen, heard, or understood. If, therefore, we come to ascertain that electricity at rest, or electricity in motion, or that some of its modifications—Galvanism or Magnetism—can

induce *a broken balance of electrical equivalents* in animals and plants, we may more easily devise means of warding off a *known power*, and preventing its transit through the conducting materials of living beings.

27th—That whilst the relations of electrical influence to the laws of life, are universally admitted, the very existence of marsh miasms may be well denied. An able writer observes, that "their nature is not known; neither their physical nor their chemical properties have been ascertained. Even their presence is known only by their effects on the human constitution; no other test of their existence has yet been discovered. Some conjecture that this poisonous gas is carbonic acid, others that it is azote and oxygen; but chemistry has yet to discover whether this poison be simple or compound, as well as by what test other than its action on the human body its presence may be determined."

Were miasms of ponds and fens, of drains, sewers, and swamps, the exciting causes of cholera or agues, this pestilence, wafted in the fleeting winds, would be just as variable in its effects as the wind itself. We should then have every possible shade of suffering, but no parallel epidemics. Every variety of *inhaled poisoning* would prevail at the same time and place. But, on the contrary, intermittents and all symmetrical diseases, induced by symmetrical causes, are similar in character, and no two of them prevail in the same place at the same time. Definite causes produce definite effects, and it was justly observed in the late sanatary reports, "that cholera and typhus seldom, if ever, rage in the same locality simultaneously, although the fever track and the cholera track are identical."

28th—That by no hypothesis deduced from the theory

of *miasms* can we account for the *known* fact, that in the Campagna di Roma, in Tuscany, Ceylon, and other places, localities are pointed out where malarious influence is insulated, and limited to defined spaces—as, to one side of a hill, one range of a street, one end of a field, or even to one particular habitation. *Malaria*, tossed about in the air of Rome, will not account for one portion of the *Via Babuina* being infected, and not the other; nor will it explain why the dry and clean Pincian Hill, and the beautiful Monte Mario, are *unhealthy*, whilst the marshy streets and courts below are salutary; why the rich and well-planted grounds of the Villa Borghese are insalubrious, whilst the flooded Piazza Navonna, the Velabra, and the Jewish quarter, are safe, like other crowded towns of equal temperature, or similar sanatary regulations.

29th—That it is well known there are, even in these climates, numerous small spots circumscribed by a distinct boundary, which have been noxious for ages. If this diseased state be owing to a want of equilibrium of galvanism in the earth or the soil of such places, it merits a series of rigid trials, to examine their condition to the utmost extent, and to divert or cut off the sources of unequal galvanic influence, where unduly exerted. It is also known, that in various situations physicians cannot readily cure or relieve certain nervous or rheumatic complaints, owing to causes which are undoubtedly electrical. This renders the removal from such localities absolutely necessary to sensitive patients, a change of air to whom is *change of electricity.*

30th—That the condition of low decomposing, or fermenting places themselves, might in many instances be improved by the means hereafter recommended; but to carry out in detail experiments and plans on a sufficient

scale should be the work of *governments* or *municipalities*, not of an individual. To arrive at conclusions of absolute certainty, experiments require to be instituted on an enlarged system. It is, however, fortunate, that the chief means here pointed out will well repay their cost and trouble by the diminution even of the former imputed causes of "*malaria.*" There is, therefore, the less necessity to dispute about the existence or non-existence of *marsh miasms*, if we can prevent or abate the desolation attributed to their influence in cities, towns, and marshy districts.

31st—That whilst the nature, and even the very existence of *marsh miasm* as a poison, *sui generis*, are without proof, demonstration, or reasonable explanation, the connexion of electricity with all the agencies of nature is unbounded and undeniable. Its power is equal to the production of every effect here suggested. It is able to separate and again unite the elements of water—to tear metals from their oxides—to shake the clouds in thunder, and to operate in developing the evolutions of crystals. In its form of currents, it contorts the muscles of lifeless animals, and it flies, in its condensed form, instantaneously through a circuit of many persons, producing a manifest shock in them all.

32nd—That the physiological effects of galvanic electricity are such as scarcely to admit of any limit to its endless influence. We are warranted, from analogy, to ascribe its agency in passing through the human body to a *sudden disturbance of the electric equilibrium—to an energetic or a depressive agency on the nervous system—to a partial decomposing or disorganizing power over the polar or chemical state of the atoms of our solids and fluids, and to oscillations of them.* Its manifest phenomena in man

are awful to contemplate. A small charge sent artificially through the spine compels the person to fall to the ground, deprived, for a short time, of all muscular power. If sent through the diaphragm, that muscle contracts, causing the person to emit a loud shout, or an involuntary laugh. Through the limbs, a dull pain directly affects the joints, owing probably to the resistance which the force meets with in passing from one bone to another, like the *ticking* in nerves, owing to obstructions in their conducting power. Through the head, the sensation produced by a slight charge is that of a stunning blow, with temporary blindness, loss of memory, and confusion of ideas; or through the body of an eel, it kills that creature, so tenacious of life. Even after death its action is evident; a human being killed by thunder rapidly blackens and putrefies.

33rd—That we observe, by experiment, how various is the quantity of electricity required to charge different persons; the amount is shown by obtaining sparks of the same size from separate individuals when insulated. Even their capacities for electricity, and their conducting powers, vary considerably. It is little wonder, then, that endless diversity prevails in the ailments and sensations of persons who are so sensibly affected by what they call the state of the weather, damp, and change of winds. These three enemies are supposed to be the actual perpetrators of injuries, which, of themselves, they have not the power to inflict. *They are only vehicles of the disturber:* they are not the *real exciting cause*, *they only conduct it.* They convey through the cold cottages of the poor, and the warm mansions of the rich, that invisible, subtle, disturbing agent, galvanism, which speedily probes and searches the bones, muscles, joints, and inmost organs of invalids, deranges the nervous functions, affects the animal spirits,

and acts magnetically on the protoxide of iron in the veins.

34th—Nature employs but few means to accomplish many ends. Electricity can produce thousands of effects—it is heat, light, galvanism, magnetism, chemical action; or it is convertible into them. Its intensity of *attraction* in its vast store-house, the earth, is probably the *cause* of the power called *gravity*. Its modifications constitute, in my opinion, that universal *æther-film*, which encircles all particles of matter, and preserves, by its powers of attraction and repulsion, the ultimate molecules of all bodies in their natural relative connexion and condition, when in due *atomical* proportion.

35th—That it is very probable, that this all-pervading agent is the force, or cause of the forces, called *vis vitæ* and *vis insita:* already it is recognised in certain animals as the *vis nervea.* Electrical *aura*, also, seems to be the *aura epileptica.*

36th—That, as a definite proportion of electricity belongs, and is peculiar to every thing, and as a natural quantity of it is essential to health, so, any excess, deficiency, or derangement of it, causes corresponding derangement in living bodies. As the integrity of specific *atomic* relation is essential to the identity and preservation of all beings, so the natural integrity of electrical *equilibrium* cannot be broken, or have its balance disturbed, without an equal disturbance in all the functions influenced by definite electrical agency.

37th—That observations and experiments give reason to believe, that there is a certain *defined amount*, *plus* or *minus*, (above or below the natural standard of electric agency,) capable of producing certain *defined diseases* in susceptible individuals. In such localities as have their

natural quantity of electricity reduced, augmented, or disturbed, to the *specific degree* calculated to induce *specific disorder*, the effects of such derangement will be proportioned to the cause. The particular kind of epidemic will depend upon, and be equivalent to, certain assumed points in the scale of disturbed electricity.

38th—I have noticed that the atomical galvanism, this regulator of the balance, is broken, on many occasions, *long before* the consequent break of health sets in; that the loss of electric equilibrium in the earth and air *precedes* the loss of healthy equilibrium in man; that, like the supposed incubation of some disorders, the reaction consequent upon the oscillation of animal molecules does not always advance, *pari passu*, with the occasion of their agitation; that in certain constitutions the effects occur several months later than in others; that when the epidemic has set in, after the waves of positive or negative electricity had passed over or through a place, the epidemic has manifested itself long after the terrestrial or atmospheric condition of the district had been restored to a neutral state, either by the equalizing power of thunder between *plus* and *minus* clouds, or by both these being blown away by currents of the air.

39th—That it is only by careful atmospheric and telluric examinations we can learn the advent and cause of epidemics *before their invasion;* and that after they appear we may sometimes find the electricity of the situation restored in its due quantity or balance.

40th—That from twenty years' practical experience in a meteoric and marshy district, I have concluded that, as electricity, in all probability, is heat, or the active cause of heat, its laws hold similar relations to those of caloric. That as cold is the absence of heat, the same electrical

ratio applies to cold also; that as water boils at 212°, strong nitric acid at 248°, oil of turpentine at 314°, sulphuric acid at 620°, and mercury at 662°, so, certain *steps* of electrical alterations or disturbances will reach certain peculiar epidemic consequences or points. Each particular *step* produces its own particular results in susceptible persons, and sooner or later, according to their aptitude or susceptibility.

41st—That, as we are taught by experience, some people are scarcely liable at all to impulses of galvanic inequality, some are very slightly so, and others slowly affected, or only after long intervals. We have also seen that some persons escape altogether the shocks or oscillations of galvanic passes; others slightly feel their premonitory signs or symptoms; whilst some withstand the *concussions* or derangements for weeks or months. I cannot believe that similar differences would result were *marsh miasms*, or poisons, (inhaled by the breath,) the exciting cause; such active poisons, if in existence, and capable of destroying strong men in a few hours, would bring every human being within their reach, under their destructive sway, without omission or delay.

42nd—That as free electricity very generally prevails in the air of most places, it may be asked why *cholera* in man, and *blight* in vegetables, do not commonly prevail at all times. To this I reply, that the integuments, even of delicate human beings, are not susceptible of ordinary or slight electric passes, unless the part be moistened, or the skin abraded. The whole surface becomes moistened in hot climates by dew at night, and hence, I think, that cholera or agues invade people at night, particularly towards morning, as we know that negative electricity reduces men in the rice-lands of Italy, and in the Ma-

remma of Tuscany, to the most awful state of disorder. But were the cause, as said to be, *miasms*, extricated from fens by the heat of the sun, their lethal violence, would, on the contrary, assail all persons by day. As multitudes labour in the fields *by day*, multitudes would fall by daily poison; but thousands escape the pest, provided they do not sleep in the air, or on any ground-floor *by night*—wet grass is the best conductor of galvanism.

43rd—That, I believe, to produce *certain grades* of epidemics, *certain stages* of galvanic disturbance must be in operation. But it is *seldom* that such *rates of derangement* traverse the atmosphere or globe, consequently, we have not cholera or intermittents in all places and at all times, although electricity, at rest, or in motion, may be variable or disturbed to a *certain extent* in every situation. As we reach *definite degrees* of heat, to boil water or to freeze it, we must contend with a *definite degree* of disturbance in galvanic force, fit to inflict epidemic catarrh, and a *different definite point*, sufficient to occasion epidemic cholera.

44th—That, I consider, to cause specific diseases, similar in all respects, and parallel in progress, some specific agent must be in operation; such agent must be capable of producing *peculiar symptoms or signs of derangement*, by exerting *peculiar proportions or quantities* of disturbing actions.

45th—That the latent galvanic *equivalents* in living things are seldom so much deranged as to damage the laws of life: *mild points* in the scale of disturbance inflict only mild *corresponding ailments*. Were we to assume, by way of illustration, a symbol of figurative quantity, as the neutral, *latent*, or natural equivalent of atomic electricity in a man, and state the standard amount (say) at 10.000,

or any other number of equivalents, then we might infer that if ten degrees be added, abstracted, or *disturbed*, some local epidemic would result to persons similarly struck in that situation at the same time. As the cause (only ten degrees) is not considerable in this supposed case, so the effects will be mild in proportion. Periodical and nocturnal returns of old pains, nervous complaints, neuralgia, or nightly rheumatism, would probably be the symptoms of disorders corresponding to such points of definite or atomic galvanic alteration.

46th—That when the east wind (almost always passively electrified) prevails—when stagnant rivers, ponds, sewers, cess-pools, filthy streets, and drains, fens or marshes, fed by charges of *decomposing* matters, create *galvanic troughs* of great extent and active energy—when their *intense emanations* flow in currents, and are linked to people by electric chains of vapour, damp air, wet floors, or filthy garments, then, as the disturbing forces are severe, the loss of electric balance is severe also. Should the *derangement of the balance* amount to forty, fifty, or sixty degrees out of the normal quantity, these points will correspond with the ratio of *broken balance* which may stand in relation to catarrh, epidemic influenza, diarrhœa, dysentery, fevers, and other local epidemics, similar in character under similar circumstances.

47th—That when millions on millions of horse-power of galvanic forces are hourly evolved in the sultry morasses and festering deltas of the hot east—when strata after strata of our globe are daily galvanised by communication or induction—when miles of excited earth transfer conduction to adjoining miles—when electric wave follows wave, flowing round in a zone of resistless disturbance—when a *belt* of such stupendous streams of untoward galvanism

encircles the earth itself, which is the great source and reservoir of electricity, then it is no wonder that plants, fishes, birds, beasts, and men, placed over such an electrified girdle of the globe, should suffer, each according to their susceptibility and organization, and to the extent or continuance of oscillating currents. A hoop or circumference, broader than the peninsula of India, conveying long-continued electric concussions, and steam electricity under land and water, will carry the disturbing range to eighty, ninety, or one hundred degrees of broken equilibrium, every series pointing to different series of disorders.

48th—That there is reason to believe a disturbed cincture of the earth arrives and retires with the revolutions of this planet. Perhaps the time may come when the dreaded advent of these revolving sources of disturbance may be predicted by calculation, as the march of the cholera was estimated, in 1832, at the rate of about ninety miles per month.

It is, therefore, when the excited air above, and the exhausted earth below, attract and repel long interchanges of galvanic emanations, that greater and more dangerous pathological degrees of disturbance ensue, fit to derange the scale to the point of such vast loss of balance, as to indicate the exciting causes of typhus fever, sweating sickness, bubo-plague, yellow fever, black vomit, and black death.

49th—Within and around our cities and towns we contrive the most extensive BATTERIES for extricating galvanism; we establish currents and counter-currents of the electric (fluid) and of its *vehicles*—viz., the noisome gases escaping up our sewers and drains. These foul airs rush up into our apartments, conducted by walls and floors, and carry up torrents of overpowering galvanic emanations.

The walls and atmosphere of the rooms being in general positively charged, induce negative passes from the human bodies within their range, and from the moist earth below, attracting the electricity of the persons present, if of an opposite, and repelling it, if of the same kind.

50th—That instant *and efficient* municipal means should be adopted to TAP and release the air, *ozone*, and other confined gases from our house-drains, sewers, and cess-pools. Sewers near buildings can easily be *tapped* by inserting copper or iron pipes, and adapting existing spouts, so as to bring all the rain-water into the drains, and to allow dangerous vapours, loaded with *ozone*—another lethal product of electricity—and also undue electricity itself, to escape up the air-conduits. These air-spouts should be fitted to the buildings *outside*, at proper intervals, and ought to be inserted into the arch, roof, or top of the sewers, and be well secured in their upright position to walls, chimneys, steeples, or posts, so as to reach as high as possible above the range of the highest edifices. These air-spouts would secure the most perfect sanatary reform that sanatary laws can accomplish—viz., preventing filthy odours, and diverting and dispersing among the clouds disgusting gases, disorganizing electric concussions, or decomposing currents.

SECTION V.

Further Deductions from Experiments on the Nature of Cholera and other Epidemics.

51st.—The abstracts hitherto abbreviated, are, from their nature, chiefly of a theoretical character. The pathological consequences of electrical alterations are not yet sufficiently ascertained to admit of mathematical demonstration. Long tables could be here given, showing the amount of electrometric indications at different times, and their comparison with epidemic gradations since 1808. But as such registers are tedious, and as improved instruments enable scientific searchers better to conduct investigations for themselves, I will here only adduce some practical evidence from my note-books and diaries of diseases.

Whatever may be the conclusions other physicians may draw from the propositions already submitted, and from the following practical inferences, they were sufficient to convince my own mind. Experience leads me to the electric doctrine which I now believe, and to renounce the misty theory of miasms, which ought to be abandoned.

52nd.—During many years I attended the sick of an unhealthy district in the valley of a muddy river. It flows through swampy suburbs, and receives in its course several sewers from neighbouring streets, from a house of correction, a lunatic asylum—from a great number of cotton-factories, a distillery, and other extensive sources of animal and vegetable deposits and impurities.

Pursuant to the fatal polity so long endured, those floating collections are detained and spread over a large surface of extended cess-pool to the windward of Belfast. This putrescent reservoir detains the deposits of the house-

drains in an immense basin or dam, which is used to turn a wretched mill. This pond is in a constant state of fermentation from the floods of refuse pent up within it, and from the accession at every tide of an intermixture of brackish water. Thousands of voltaic experiments proved to me that this dam is a *vast galvanic trough.**

53rd.—The substratum of this marshy district is blue clay, covered with a layer of sea-shells, and a thin soil of red clay and sandy earth. The elevation of the town is only a few feet above low-water mark. The land along the valley is so engorged with the pent-up floods of this putrid river, that the soil of the adjoining fields and ditches is at all times emitting streams of gases and galvanic currents up and down. This *battery* is called the "*Blackstaff.*"

54th.—To add to the offensive nuisance of this great cess-pool, its clay margins are dug up in summer for making bricks. Turning up this clay with the filthy deposits of a hundred drains, engenders clouds of marsh emanations sufficient to generate miasms enough to spread illness over a whole province, were putred miasms the *actual cause* of pestilence. But notwithstanding the unremitting emission of fœtid gases from that effervescing fen, they did not *always* engender sickness, although the exhalation was *constant*, and although for nine months in the year the offensive miasms were wafted into the apartments of the town by a south-west wind. But it soon became apparent that if these putrid vapours are not *themselves* the primary causes of disease, *they conveyed the morbific* agent. If not the plague, these filthy clouds of miasmata *carried the pest*, and applied it in a potent form to the unfortunate families of

* See Report of the Surgical Society of Ireland, *Dublin Medical Press*, Nov. 27th, 1844.

Whilst these sheets are in the press, it appears that the cholera, now at Belfast, is particularly *fatal* in and around *Cromac-street:* it is built on ground reclaimed out of this pestilential mill-pond. The family of the respected proprietor of the mill, fell victims, together with many of their neighbours.

cotton spinners and others who reside along this noisome morass, and who sink under particular epidemics only when east winds and untoward fits of negative electricity reach the *specific* points of *specific* diseases.

55th.—I also found that the periods or effects of the unhealthy influence conducted by those vapours, varied with the state of the atmosphere, but not with any variation in its constituents, such as is understood by the term *good or bad air*. I noticed, that during some weeks, when nocturnal lightnings flashed in the horizon, almost all the poor applicants for advice were affected by one uniform train of disorder, such as *diarrhœa*. Then an interval of health occurred in the district for a time. *Soon after the appearance of meteors in the air*, a general attack of *catarrhal diseases* of parallel character invaded the people, and once more a period of comparative healthiness ensued. In some weeks or months afterwards, an attack of *feverish excitation*, of an inflammatory nature, assailed the poor, when the air was very strongly charged with positive electricity, and the train of mists formed an electric chain like wires, carrying the galvanic passes to or from the people.

After another space of time, general influenza set in, during the east wind and variable clouded atmosphere. Thus diseases appeared and disappeared *in gales*, and were succeeded during the next electrical disturbances by new disorders of a different type. It was evident, that after stormy weather, when positive or negative clouds had hovered near the earth, one train of malady commenced, and continued whilst that *electric condition* of atmosphere remained. Again, after an interval, when *meteoric signs*, such as *aurora borealis*, had prevailed, some other disease ensued during the period of that particular electro-magnetic change in the earth and air. Such atmospheric alterations

of electricity *(but without reference to their epidemic agency)* have been well described by Arago, Saussure, Thompson, and many others, in the mutations of stormy, serene, dry, rainy, or unsteady weather. The electric states which I measured were sometimes positive and sometimes negative; that of the effervescing earth, drains, and bubbling sewers being occasionally in excess, but at all other times that of the atmosphere preponderating.

56th.—During the above periods, so many different atmospheric phenomena occurred, and so many repetitions of lightning appeared in the above and similar places, that I could not fail to associate corresponding attacks of diseases with the electric influences which so manifestly prevailed at the same time, or immediatly before.

57th.—In the summer and autumn of all these years, various repetitions of electro-galvanic excitations in the air and soils of a similar marshy district with stagnant drains and ditches, were always accompanied by as many *fits* of what might be termed local epidemics, particularly autumnal *cholera.*

Upon being satisfied, by many trials and observations, that electro-galvanic *disturbance or want of equilibrium* was at least a *principal exciting* cause of these periodical or symmetrical diseases, I watched their origin and progress narrowly, and made many experiments on the waters, soils, and air of filthy and damp localities.

58th.—The vast number of chemical trials which I conducted in these marshy valleys, all demonstrated, as far as can be proved by negative evidence, that there is no such *peculiar morbific agent (per se)* as that which is understood by the name of *marsh miasm* or paludial malaria. In most of these experiments, animal exhalations, *supposed putrine,* and organic remains, were traceable, with more or less of

ammonia, and all the gases evolving in low fens or clay soils. But ammonia and all the other impregnations were found in most regions of the air in Ireland, England, France, and Italy, where no epidemic at the time prevailed.

59th.—These results led to the conclusions which were afterwards confirmed by more extended researches in Italy, I found that when human beings recline upon moist ground, or on beds placed upon it, their *natural latent or neutral electricity* is disturbed or decomposed by the extensive surface of the body exposed to telluric attraction and repulsion of galvanic currents, conducted by the fatal chains of damp walls or floors, stagnant drains, filthy beds, or soiled clothing.

60th.—In the places described, extensive evaporation, and energetic chemical action during the day, charged the atmosphere of the place with positive galvanic fluid. This surcharge passed through the moist conducting bodies of the people, into the earth, attracting their *negative*, and repelling their *positive* electricity. Again, when during the *diminution* of the electric fluid of the air, *before sunrise and sunset*, the effervescing earth transmitted its excess upwards, through the persons so exposed, the neutral (fluid) in their bodies was disturbed, or the positive (fluid) was attracted to one side or extremity of the bodies, and the negative fluid repelled to the other side; and thus a process of attraction or repulsion exerted untoward oscillations in the bodies, brain, and spinal cord, and in particular, in the great sympathetic system.

61st.—From practical observations and analyses, I concluded that the insalubrity called "*malaria*" is neither a specific and peculiar miasm directly from water, nor land, nor mist, nor vapour alone; but that there is *something else in action* which may have a certain degree of relation

to all these things, and therefore the former are suspected of being the *whole primary* cause, whereas I consider them but *secondary* agents.

62nd.—The deductions derived from long practice and meteorological registers in the above districts, were amply confirmed by more extended trials in warmer climates. There, more energetic thermo-electric indications were evident. Steam electricity in many places displayed high tension. During the day, the conversion of water into vapour, from shallow fens, maremmas, ponds, rice-drills, and slow-moving rivers, as well as from neglected drains and filthy streets, engendered an amount of free electricity exactly in the ratio of *evaporation.* At Rome, in 1833-4 and 1844, I always found the indications of the electrometer in exact proportion to the hygrometric point. A familiar experiment easily points out this power of evaporation. If a red hot cinder be dropped into a litle water in the cup of an electroscope, positive electricity escapes with the vapour into the air, whilst the gold leaves diverge with negative electricity.

63rd.—In warm climates the more intense degree of disturbance was easily traced as the exciting causes of more dangerous classes of fevers, agues, and nervous shocks. There, the consequences of terrestrial contact on men during the night were demonstrated. There, it was curious and instructive to observe, that of those who remained in the fields by night, none escaped except herds or keepers, who were clothed with skins of goats or other hairy animals. These primitive habiliments presented millions of bristly points exteriorly, all good conductors when wet with dew. They distributed any undue electric forces betwen the air and the individuals, and prevented its unequal accumulation or agitation in human beings.

Such bristled garments call to mind the protecting powers afforded by the gilded spikes on Solomon's temple, and of prickly seal-skin roofs on the houses of Terracina.

64th.—Careful observations of the long-established customs of nations, and the contemplation of the silent operations of Nature, frequently lead us to useful conclusions. *I made strict inquiries in many places, and I never yet could find that a house or wall covered at the top with ivy, vines, or creeping evergreens, was at any time destroyed by lightning.* Similar observations may have led the ancients to surround their houses with *white* vines and laurels in Etruria, and other parts of Italy most subject to thunderstorms.

Pliny praises the laurel as the only earthly production which the lightning does not strike. He says—

> "Ex iis quæ terra gignuntur lauri fruticem non icit."
> *Plin. Hist. Nat.*, lib. ii. cap. 56.

Columella tells us, that Tarchon defended his house from thunder by growing white vines around it.

> "Utque Jovis magni prohiberet fulmina Tarchon,
> Sæpe suas sedes percinxit vitibus albis."
> *Columella De. Re. Rustic*, lib. x.

In like manner, we find that in Hindostan, fat or succulent trees were planted around habitations to defend them from lightning.—*Des Sciences Occultes*, tom. ii. p. 157.

Byron relates how lightning respected or avoided the true laurel, but melted an iron imitation of a laurel crown over the bust of Ariosto.

> "The lightning rent from Ariosto's bust,
> The *iron crown* of laurel's *mimicked leaves;*
> Nor was the ominous element unjust,
> For the *true laurel* wreath which glory weaves
> Is of the tree *no bolt of thunder cleaves.*"
> *Childe Harold*, canto 4, st. 41.

The temple of Jerusalem stood untouched by a single stroke of thunder for a thousand years, in a region of thunder. This glorious edifice was studded or bristled over

with gilded iron spikes.* Their object was to prevent the roofs from being a resting-place for birds, flies, or insects. but another and unexpected purpose was fulfilled by these bristled roofs—the gilding prevented the spikes from oxidating, and rendered them at all times admirably adapted to ward away irregular quantities of electricity. If that fluid prevailed *above*, it was silently and effectually carried down by the points and gilded pillars, quoins and columns, to the earth. If excessive *below*, the current was conveyed up by the same golden channels, and flowed away into the air from the millions of points which studded the glittering roofs.

The beautiful country from Terracina to the Temple of Foraria was always a prey to lightning; all the high towers were overthrown, and people defended their houses with *the skins of seals*, the only marine animals, as Pliny affirms, which the lightning does not strike:—Aut tabernacula e pellibus quas vitulas appellant, quoniam hoc solum animal ex marinis non percutiat."—*Plin. Hist. Nat.* The seal-skin being covered with hair or points, is a remarkable circumstance in reference to the subject already under consideration, with respect to the skins of domestic animals and the property of spikes to diffuse or dissipate electricity, and to prevent its condensation upon living bodies.

There is not any quality in the skin of a seal that can endow it with repelling powers greater than those belonging to marine animals of equal thickness of integument. We must therefore attribute this quality of the seal-skin roofs to the millions of bristles from which the negative electricity of the earth flows up readily, and neutralises the positive cloud hovering over them, or *vice versa.*

The seal is the only fish, I believe, which reclines upon

* Josephus Antiq. Jud., lib. iii. cap. 6, sec. 4.

damp and electric rocks and shores, and therefore requires some material provision to guard it from the accumulation of positive or negative galvanism, within, or upon it. Should this reasoning be borne out by experience, it furnishes another wonderful instance of provident adaptations in favour of creatures which bask on sea borders, where electric currents are sometimes incessant.

65th.—The exemption of certain religious orders, wearing hair shirts and garments night and day, is an example in point, an argument in favour of the electrical causes of malaria, and a good reason for the use of non-conductors as a measure of prevention. Silk, however, is certainly much more agreeable, and, I believe, more effectual. It is said that even silk veils have been beneficial as guards against malaria; they are worn for that purpose in Malta and Sicily, but there, the idea is, to prevent the inhalation of the "*cativaria*" by the breath.

Fouillett states, that near Digne, in the Basses Alpes, France, on Sunday, the 11th of July, 1819, a church was invaded by lightning; nine persons were killed, and eighty-two dangerously wounded and bruised, but the celebrating priest, being covered with a *silk vestment*, was not touched. —*Naples Translation*, vol. ii. p. 449.

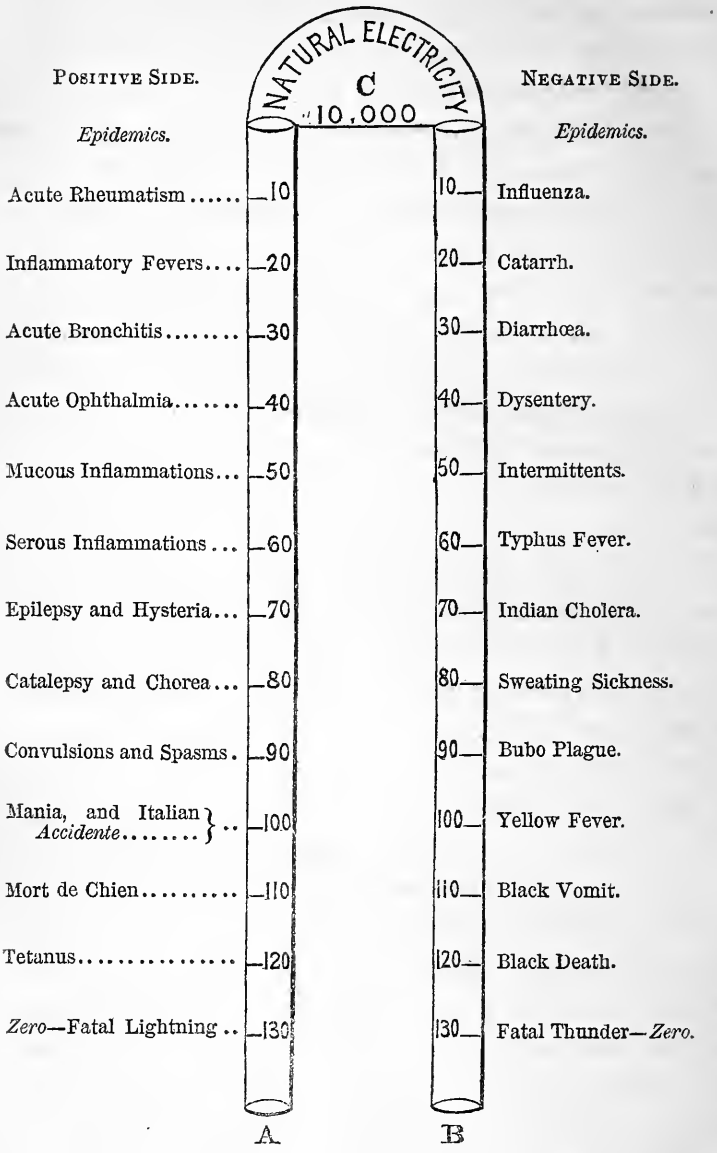
Most of the Italian writers recommend a return to the use of woollen garments, as they say, to guard persons from sudden changes of *temperature*. Their use is obvious also in defending and insulating the body from unequal shocks of galvanism. The same may be said of the oilmen of Barbary, who are exempt from malarious influence, probably, because of the non-conducting powers of the oil upon the surface of their bodies. Wood boiled in linseed-oil, as also oil of turpentine itself, insulate effectually.

Fur, feathers, wool, and hair, are bad conductors of

electricity as of heat. Dry shoes in some degree insulate; silk stockings more effectually. Gutta percha shoes are highly valuable as insulators.

66th.—I have thus far adduced deductions from experiments, analyses, practical observations, and analogy. I am now anxious to explain more clearly my particular theory—"*Epidemic gradations are in proportion to electric derangements.*" I wish to institute a small *scale*, or figurative symbol, to familiarize these comparative degrees to the eye as well as to the mind. Perhaps this imperfect attempt may attract the attention of those who have more time and ability to investigate such difficult endeavours, (see Deduc. 42, 43, 44, 45, 46, 47, THE LANCET, September 23, 1828.)

67th.—This little ideal *epidemic electrometer* assumes to fix its *zero* of electric lesion at a known effect, or *point.* The fatal consequences of lightning are, before, and after death, in a great measure ascertained. This symbolic scale of comparison between *pathological disease* and *electrical disorder*, descends or approximates from the natural or latent, to the lowest or morbific degree. That point depends upon a known fact, such as a mortal stroke of lightning. The next epidemic strokes which most resemble death from lightning, are placed in the intermediate spaces, commencing above the fatal point of *thunder*, and ranging higher and higher, towards the natural standard, according to the lighter and lighter shock, or derangement, supposed to be caused by the comparative intensities or forces alluded to, (32.)



Explanation of Graduated Scale.

A refers to positive electricity; *B*, to negative electricity; *C*, to the normal or latent electricity, inherent in a body.

68th—In this simpile wood-cut, the letter *C* may be supposed to represent a *space*, or *body*, containing its latent or peculiar quantity of electricity in a neutral or dormant condition. At foot, *zero* is fixed, 130 degrees or stages lower than the natural standard, at a point taken as that of the broken balance or derangement, corresponding with a fatal shock or disturbance from thunder. This zero point is computed at a nominal number, 130°.

Having attempted to ascend from what is known to what is unknown, I contrived to represent the positive element, as if continued from *A* to *C*, and the negative kind, communicating from *B* to *C*. It is not easy to explain this arrangement in words; but the plate renders more plain to the eye a notion which is very generally entertained—that *positive* electricity induces or augments vital *excitation*, and that the negative is connected with, or causes, diseases of *debility*. I have much reason to believe, although not yet able to prove the fact, that positive electricity bears a relation to *active ailments*, and negative electricity to *passive complaints*. The former occasions or augments *phlegmasiæ* and muscular contortions; the latter brings on, or contributes to, atony and collapse.

As the post-mortem results of thunder are in some measure understood and ascertained, I have marked the next range of the negative scale at *B*, ten degrees or proportions less terrible in its indication than that of fatal lightning, the appearances being characteristic of that awful stroke called "*black death.*" Ascending again ten degrees, to 110, the scale points to a less frightful blow, producing a less mortal malady, evincing appearances, both before and after death, similar to those consequent upon a violent flash of lightning. This awful disorder was called "*black vomit.*"

Passing ten degrees farther up the scale, the amount of electric disturbance indicates the relative equivalent of *yellow fever*, of which we will speak hereafter. Rising a little farther, ten degrees nearer the natural or latent point, 90° may indicate the definite proportion of atoms supposed to be out of balance, and capable of causing *bubo plague*. Again, eighty degrees indicate electric derangement equal to the production of *sweating sickness*, the history of which assimilates to that of some violent effects preceding thunder. Next, it may be supposed, from the accumulation of black magnetized blood in the veins, and the disordered signs of shocks in the eighth pair of nerves, and from other pathological appearances, that severe electric commotions were at work, producing *cholera*, by a break of 70° of equilibrium, or seventy proportionals out of the entire number here computed as being latent and inherent in man. 60° of broken balance may bear relation to *typhus fever;* 50° to *agues;* 40° to *dysentery;* 30° to *diarrhœa;* 20° to *catarrh;* and 10° to epidemic *influenza*. Slighter disturbances may refer to common nervous *malaise*, such as sensitive people experience before the explosion of thunder.

69th.—*The positive side* of this figure, at *A*, may, like the other, be computed so as to commence its zero from a *known result*—that of a *positive stroke of lightning*. Approximating to the ascertained effects of that deadly blow may be placed *tetanus*, or clonic contortion or contraction, known also to result from electric disruptions, not so suddenly fatal as thunder itself. We see, how even common electricity, sent along a nerve, either in the living or the dead body of an animal, causes contraction of muscles, and principally those of volition. The most dangerous and rigid tetanic spasms may be, therefore, ap-

proximated near the zero point of lethal lightning, and be estimated at 120°, as a sign of disruption, or violent *break of balance*, equivalent to that definite break of *electric equilibrium*. Above *tetanus*, the horrid disordered condition called *mort de chien* (hereafter to be explained) may be computed at 110°, being ten less atrocious than the last awful cramp of death, tetanus. A little less deathly, 100° of disturbance may stand in relation to a similar atomic medullary, or cerebral disturbance, supposed to constitute that kind of *mania*, which has been known to rage in certain *localities* at certain times, when no analyses could discover any chemical change of the water, soil, air, food, or drink, but where I have found very marked changes and disturbances in the electricity both of the earth and atmosphere.

Catalepsy, spasmodic cramps, convulsions, epilepsy, chorea, hysteria, and periodic nervous complaints, when they assail several persons at one time, may be placed on the scale between 100° and 90°. This is a range less severe than that of epidemic mania. 90° may be taken as the point of galvanic derangement equal to the point of the nervous derangements here classed in relation to each other, *when prevailing epidemically*. In a future abstract I shall endeavour to render "periodicity" of diseases and symptoms reconcilable to the periodicity of nocturnal and diurnal electric evolutions, well known to rise and fall at certain hours of the day and night. I hope also to attempt some better explanation of what is called "*nervous imitation*." Here I may briefly remark of imitative and infectious diseases, that they are much more probably owing to electric disorders. The same cause, operating in the same place, at the same time, may more reasonably account for the appearance of similar disorders under similar

circumstances, than imitation and infection, or any other imaginary exciting causes to which epidemics have been attributed. The introduction of *material contagion*, such as that of small-pox, or the bites of rabid or venemous animals, is a *material thing*, and its infliction does not militate against other inflictions by different agents. Were this doctrine of *electric equivalents* to displace the theory of infection, odious quarantines would cease to punish the innocent, and relatives would not abandon their helpless friends in time of need.

After excessive shocks or derangements of electric forces, well known to be capable of producing every gradation of nervous contraction or disturbance, we venture to compare such quantities of broken equilibrium as are sufficient to excite reaction or disturbance in the circulation, less violent shocks or accumulations than the foregoing, suffice to induce epidemic inflammatory disorders of the mucous and serous membranes, such as croup or pleurisy, and also medullary oscillations equal to occasion various types of febrile attacks; and by lighter and lighter derangements causing lighter excitations, such as acute opthalmia, bronchitis, and rheumatism. The points on this sliding scale equivalent to these gradations of animal excitability, may ascend from 90° to 10°. This ascending ratio, approaching the latent or normal standard, rises from 90° at the point corresponding to the broken balance of convulsions; 80°, that of catalepsy; 70°, that of epilepsy; 60°, that of serous inflammations; 50°, of mucous inflammations; 40°, acute opthalmia; and 30°, more mild kinds, as bronchitis, &c.; 20°, inflammatory fevers; 10°, acute rheumatism, and periodic pains.

70th.—Dr. Garnet, in 1804, published in his "Zoonomia" a graduated scale called the scale of *excitability*,

to illustrate his belief in the *sthenic* and *asthenic* doctrine of Dr. Brown. By this he endeavoured to explain the degrees of exhaustion or augmentation of *excitability* to which man is exposed in consequence of the variation of the *stimuli*, meat and drink, heat, exercise, and emotions of the mind.

Dr. Garnet says, that "electricity may be *hydrogen*." Entertaining such an idea of the nature of electricity, he could little understand its relation to his favourite *sthenic* or *asthenic* doctrine. His approval of the theory of Brown would bear a more reasonable complexion, had he attributed the former to the agency of positive, and the latter to that of negative, voltaic forces, or to the excess or deficiency of one or both elements.

My scale of *electrical equivalents* is entirely different, and adapted to represent a different thing. I need scarcely explain that these figurative degrees are merely *relative* terms of comparison between various ideal amounts of broken electric equilibrium, and of consequent commensurate atomic degrees of broken *vital powers*, or of such other powers as perform and control vital actions. This symbol is merely *convenient*—it is not pretended to be *accurate*. It is an humble endeavour to give a figurative explanation of certain supposed effects—a thing which cannot be truly accomplished whilst the real nature of all the phenomena is entirely unknown. I doubt whether the phenomena of disease will ever be reduced, in this or any other way, to an approach even to mathematical accuracy; still it is our duty to advance as far as possible in the investigation of causes and effects.

71st.—Until more minute explanations can be given, I may briefly remark, with respect to epidemics affecting the *respiratory* or the *digestive organs*, that most of their phe-

nomena bear very intimate relation to those of electricity *at rest*, and *in motion*. The physiological analogies are very similar.

72nd.—As the *oxidation* of one of the metals in the galvanic trough is the cause of decomposing electricity, and as the presence of a fluid is essential to that display, so the *oxidation* of carbon, and of blood, and its iron, may exert similar decomposition of dormant electricity of the air, in an admirably adapted *voltaic pile*, like the cells of the respiratory organs.

73rd.—All my experiments show a difference between the electrical equivalents of venous and arterial blood. No system of contrivance can be more beautifully fitted to equalize the distribution of electricity than the system of respiration and circulation—black iron in the blood under magnetic influence—circulating fluids, revolving and controlling polar arrangements—pulmonary evaporation, generating electricity from a surface thirty times the extent of the man's exterior—steam electricity at every expiration—pressure and expansion of all the cells and cavities in the chest—water passing off in vapour, and vapour condensing into water—all and every one of these being the greatest and best known generators of electricity—all of them contributing, in health, enough of that vital fluid, or of its elements, to maintain due equilibrium, to revive the animal functions, to support animal excitability—all communicating a sufficient proportion to parts, or to the whole body, if partially exhausted, and neutralizing or rendering dormant other parts, or the whole system, if overcharged or overloaded with the *vital spirit* now under our consideration.

74th.—If electricity be heat, this diffusion of it through an individual at every breath, presents a simple and most

efficient security for distributing and preserving animal warmth. Birds, in higher regions of the air, where it is very cold, are much warmer than men or cattle below. Is this because positive electricity is the more intense in the air, the higher it reaches? These topics will be again alluded to; but it may be here mentioned, that so much of electrical disturbance as may take place from untoward currents when taken in by the breath, will affect men and lower animals by inhalation. Is this the reason that cattle have everywhere, at times, suffered from epidemic inflammations of the lungs? Cattle can resist the *cutaneous* transit of electric passes, but are quite amenable to those *positive* and *negative excesses* affecting the interior surfaces of the mucous membranes, opening from the exterior orifices, mouth, and nose.

If the respiratory machinery be admirably adapted as *voltaic piles*, the alimentary cavities are equally so, as *galvanic cells*. Endless peristaltic motion and friction—chemical changes between molecules of dissimilar materials —saline and other fluids charging the evolving substances —the liberation of elements, carbon, oxygen, hydrogen, and nitrogen from their nutritious atoms—hunger exhausting electricity, repletion overloading it—secretions composing and decomposing without end—all produce electric alterations in proportion to their own changes, and all of these phenomena are controlled and regulated by that universal principle of health and life, electricity itself.

It is no wonder, then, if we have contrived to place disordered conditions of mucous surfaces, opposite certain degrees of electric disturbance, and to risk suggestions, which I trust to render less extravagant in appearance, by showing hereafter, certain parallel progress between these causes and their effects.

The propositions are not entirely visionary; we find some confirmation of electric capacity in the following able observations of Professor A. T. Thomson, of London:—"Electricity thus accumulated increases the action of the heart and arteries, both in force and velocity; and that this does not depend on any mental feeling, is obvious from the fact that electricity may be applied to animals asleep, and in them the pulse is quickened. The temperature of the body is also augmented, and perspiration excited—circumstances, however, not depending upon the heating power of electricity, but upon the increased velocity of the circulation. A clergyman in whom I could never produce perspiration by any of the ordinary diaphoretics, and who never perspired by exercise, nor the heat of summer, when isolated and electrified, perspired freely. This effect on the skin has been ascribed to the power which electricity possesses of increasing the flow of fluids through capillary syphons; but in the living body it is more probable that it depends on the excitement extending to the extreme vessels."

SECTION VI.

Deductions from Experiments on the Nature of Cholera and other Epidemics.

Having so far attempted to give an outline of my inferences, "*that definite proportions of derangement of natural electricity occasion definite proportions of epidemic diseases*," I postpone, *for the present*, the "abstracts" intended to elucidate this doctrine. Hereafter, I hope to compare the history, origin, progress, and treatment of the disorders above specified, with the phenomena of broken

electrical balance, and to reconcile many pathological appearances with those of the variations of the magnet, and of magnetic currents in the earth and air.

That such influences affect physical states of human health may well be admitted, seeing that the intensity of the globe's magnetism varies at different points of its surface, and changes at different seasons of the year, and different hours of the day; also, that large *extraordinary motions* of the magnetic needle are produced when the *aurora borealis* is visible. M. Arago found that the needles, even at Paris, were almost invariably affected by *auroræ*, seen in Scotland. He could even predict the appearance of these meteors by disturbances of the needle ten or twelve hours before the *auroræ* could be seen in the north. Captain Back observed similar phenomena; even in full day, when the *auroræ* could not be seen, their presence was indicated by rendering the needle restless and vibratory. From these and many other considerations, it may be reasonably inferred, that there is some relation between the point of *specific disease* and the intensity of magnetic force, or of its *disturbance.*

We observe that the flesh, and particularly the blood, of animals are acted on by the magnet, and that common iron can be rendered magnetic by contact with the nerves. Dr. Prevost, of Geneva, has succeeded in magnetizing very delicate soft iron needles, by placing them near the nerves, and perpendicular to the direction which he supposed to be taken by the electric current. The magnetizing took place at the moment when, on irritating the spinal marrow, a muscular contraction was effected in the animal.* Everybody knows that powerful magnets may be formed by induced electrical currents on soft iron. It

* Comptes Rendus, 183?.

is reasonable to infer that the iron in venous blood, when in motion, is liable to this kind of induction, under certain circumstances. When I come to show the influence of protoxide of iron, as a remedy, in improving languid electric or magnetic action, in certain passive complaints, this relation to cause and effect will be rendered less incredible to those who have not taken the trouble to compare the *actions* of remedies with the *indications* of galvanometers.

When the inversion of magnetism by electricity is considered, those laughing philosophers who smile at all novel notions, may be disposed to entertain more seriously my ideas, set forth in THE LANCET, respecting the meteoric signs, described as appearing, *pari passu*, with electric or magnetic *breaches* of human health.

It is an admitted fact, that the *aurora borealis* is a powerful source of magnetism, and that the *south* pole of the needle has a distinct connexion with it. Dr. Dalton, in a work published in 1793, has advanced several ingenious hypothetical views respecting the cause of the *aurora*, and its magnetic influence. He says, "The region of the *aurora* is 150 miles above the earth's surface. Immediately above the earth's surface is the region of the clouds, then the region of the meteors, called falling stars and fire-balls, and beyond this region is that of the *aurora*.

"We are under the necessity of considering the *beams* of the *aurora borealis* of a *ferruginous* nature, because nothing else is known to be magnetic; and consequently, that there exists in the higher region of the atmosphere an *electric fluid* partaking of the properties of *iron*, or rather, of magnetic steel; and that this fluid, doubtless from its magnetic property, assumes the form of cylindrical beams.

"With regard to the exciting cause of the *aurora*, I believe it will be found in change of temperature. Nothing

else is known to affect the magnetism of steel: heat weakens and destroys it; *electricity does more; it sometimes changes the pole of one denomination to that of another, or inverts the magnetism.* Hence, we are obliged to have recourse to one of those two agents in accounting for the mutations above-mentioned. As for heat, we should find it difficult, I believe, to assign a reason for such sudden and irregular productions of it in the higher regions of the atmosphere *without introducing electricity* as an agent in these productions; but rather than make such a supposition, it would be more philosophical to suppose electricity to produce the effect on magnetic matter *immediately.* The beams of the *aurora* being magnetic, will have their magnetism weakened, destroyed, or inverted, *pro tempore*, by the several shocks they receive during the *aurora.*" In another place he says, "I conceive that a *beam may have its magnetism inverted*, and exist so for a time," &c. Again—"As the beams are swimming in a fluid of equal density with themselves, they are in the same predicament as a magnetic bar or needle swimming in a fluid of the same specific gravity with itself; but this last will only continue *in equilibrio* when in the direction of the *dipping needle*, owing to what is called the *earth's magnetism;* and as the former also rests in that position only, the effects being similar, we must, by the rules of philosophizing, ascribe them to the same cause. Hence, then, it follows, *that the aurora borealis is a magnetic phenomenon, and its beams are governed by the earth's magnetism.* I am aware that an objection may be stated to this: if the beams be swimming in a fluid of equal density, it will be said they ought to be drawn down by the action of the earth's magnetism. Upon this, I may observe that it is not my business to show why this is not the case, because I propose the mag-

netism of the beams as a thing demonstrable, and not as an hypothesis; we are not to deny the cause of gravity because we cannot show how the effect is produced. May not the difficulty be removed by supposing the beams of *less* density than the surrounding fluid?"

Lastly, although it has been clearly proved that a source of magnetism does exist in the atmosphere, yet it may be asked, is there any reason for believing that the magnetism in the atmosphere is strong enough to be considered as the *only* source of terrestrial magnetism. It has been shown by M. Arago that the *auroræ* which exist only at St. Petersburgh, in Siberia, and even in North America, *actually disturb the magnetic needle at Paris;* and he considers it highly probable that the *auroræ* even round the south pole of our globe extend their influence to Paris. Sufficient, however, has, I think, been said, to show that many more inquiries are wanting before this question as to the true cause or causes of terrestrial magnetism can be satisfactorily answered.*

Every one is familiar with the ordinary phenomena of a magnetic needle freely suspended, and with its tendency to assume a position more or less approaching to parallelism to the earth's axis—that is to say, all over the world a magnetic needle points nearly north and south. Most persons are also acquainted with the phenomenon termed the dip or inclination of the magnetic needle: thus, in the latitude of London, a needle exactly poised and freely suspended, instead of assuming an horizontal position, will settle at an angle of 70°, the north pole being downwards, It is said, however, that the *needle did not obey these natural attractions in Russia, during the late awful visitation of cholera.*

* Noad, p. 333.

The earth may be considered as acting like a great magnet. When a magnetic needle is in its natural position of north and south, there exist *electrical currents* in planes at right angles to the needle, descending on its east side, passing under it, from east to west, and ascending on its west side. Hence we must suppose currents of *electricity* to circulate within the earth, more especially near its surface, and to be constantly passing from east to west, in planes parallel to the magnetic equator, which electrical currents, if such can be demonstrated to exist, will, in their turn, completely account for the magnetic directive property of the earth.

We have already alluded to the opinion that heat occasionally enters into the electric and magnetic energies. This seems to account, in the most satisfactory manner, for the general distribution of electricity and magnetism over the earth. The explanation is this:—the earth, during its diurnal motion on its axis, from west to east, has its surface successively exposed to the solar rays in an opposite direction, or from east to west. The surface of the earth, therefore, particularly between the tropics, will be heated and cooled in succession, from east to west, and currents of electricity, on thermo-electric principles, will, at the same time, be established in the same direction.

Numerous diaries show that nearly all, or a vast majority of persons assailed by fatal cholera in 1832, were attacked *before sunrise*. We have shown already that negative electricity is then prevailing. But, in addition, it should be mentioned that Humboldt observed at Berlin perturbations especially of oscillations of the needle, the amplitude of which extended beyond all the divisions of the scale, which occurred repeatedly at the same hour *before sunrise*, and the violent and accelerated movements

of which could not be attributed to any accidental or mechanical cause. These vagaries of the needle, the almost periodical return of which has been confirmed by M. Kupffer, appeared to Humboldt the effect of a reaction of the interior of the earth towards the surface of magnetic storms, which indicate a rapid change of tension. For all these reasons, and many others, I hope I am justified in attempting to point out *physical relations between epidemic diseases and disturbed electricity or magnetism.*

Abstract of Practical Deductions, 1848.

As cholera may be daily expected in this country, (Ireland,) it may be useful to comply with the request of several friends, by deducing at this moment a few practical conclusions from the premises already submitted.

1st—It is shown in THE LANCET, p. 261, that wet floors, damp beds, filthy clothing, close rooms, moist cellars, and soiled integuments, convey away natural electricity from the human body as readily as it is conducted by the bell-wires in our rooms. Hence boards of health may infer that there is little chance for preservation or cure, unless the *places* and *persons* are kept *perfectly clean* and *perfectly dry.*

2nd—The results of experiments set forth in THE LANCET, p. 343, demonstrate that sewers, drains, and cess-pools, are all acting generators of galvanic disturbances; the odious grates and gutters of our streets and areas are constantly emitting filthy currents and vapours under our noses. It is therefore absolutely necessary to reform this state of things altogether, and to dissipate these lethal emanations *far above our roofs*, rather than allow such miasms to be constantly discharged into our apartments.

3rd—That as chimney-flues are required to carry up smoke above our houses, and as ventilators are necessary to mines and tunnels, so they are also needful to tap pent-up gases, and to waft away unequal electric currents among the clouds, rather than introduce them into our halls, kitchens, and bed-rooms.*

4th—With respect to *personal cleanliness*, that is also essential both for prevention and treatment. Energetic friction of the skin, *not with a hard brush*, but with warm dry flannel, will go very far to keep the body well charged with good vital atomic equivalents of electricity. The vigorous exertion of active rubbing during an hour night and morning contributes largely to the above electrical distribution, as the electrometer demonstrates.

5th—The dress ought, if possible, to consist of dry shoes, silk or woollen stockings, and flannel drawers, washed and dried daily, warm woollen and cotton clothing to be worn next the skin. Carpets and cushions of hair, wool, or cotton, as insulators, are useful between the floor and the feet. Beds may be well insulated by placing the posts on blocks of baked wood or timber, boiled in linseed oil, cakes of wax or rosin, in cups of thick glass or earthenware, or in wooden, or other small vessels containing asphalte. The bedding should consist, as much as possible, of perfectly clean and dry woollen blankets, with cotton sheets, pillows, and quilts, all well dried every day before an open fire, in well ventilated rooms.

6th—With respect to *internal remedies*, the directions of the Board of Health ought to be well observed. Perhaps

* Such tubular shafts are particularly required to carry away the exhausting galvanic currents generated in pestilential golgothas, intra-mural grave-yards. [See letter to George Alfred Walker, Esq., London.] So lethal are the passes of these hourly-charged batteries, that people living on their borders cannot be well electrified, and do not emit sparks of any length or brilliancy during the trials of the best machines. *(Appendix G.)*

I may be excused for mentioning that, pursuant to the theories above advanced, I severely tested the effects of various medicines in changing galvanic indications during former trials in cholera; but I cannot here enter into comparative details of their merits. The following were the indications displayed by delicate galvanometers:—the use of diffusible stimulants created only short electric excitations, followed by depressing galvanic abstraction; *camphor* in *very large doses* maintained an improved state of galvanic action in the system, longer than any other excitant. In the first and second stages of cholera, its value was also tested by Professor Hart. As a member of the central board in 1832, I had many opportunities of observing the utility of camphor; but, at the same time, when taken in substance, or precipating from spirituous tinctures or emulsions, it was too *slow of digestion* when the stomach had lost its power: these considerations led me to extend the use of fluid camphor, combined with carbonic acid gas, in which form it is very grateful to the stomach. That gas affords to the system an abundant supply of *carbon*, which Dr. Parkin and others esteem as invaluable in cholera.

Although it is excusable to evince a parental fondness for this preparation, it is here spoken of only from its power of sustaining the equilibrium of animal electricity—this power justifies the character given of it in my treatise on *temperature* in 1828*—when used in the prevention of cholera, adults require a wine-glass-full of the fluid three or four times daily, to exhibit its action on the electrometer—but during the treatment of actual cholera the above quantity should be given every ten or twenty minutes till heat and circulation are restored; a few drops

* Page 35.

of laudanum or any other suitable tincture may be given with it. The minute proportion of *bicarbonated* magnesia combined with the fluid camphor, abates gastric irritation, and prevents acid fermentations in the stomach, which are so productive of galvanic disturbances in the primæ viæ. In algide cholera the fluid should be given warm.

7th—From the theory of cholera published in the *London Medical and Surgical Journal*, 1832, and since amply confirmed in many parts of the world, it is to be concluded that the judicious use of long continued *galvanic passes* through the *respiratory* and *spinal nerves* is one of the most essential adjuvants that can be employed during collapse, or in that state of passive galvanic abstraction which *ought to be treated like suspended animation.*

8th—During cases of collapse in cholera, I had not sufficient opportunity of *inflating the lungs with electrified air;* but it is surely a rational resource, where the natural electricity is deficient. Were scientific electricians employed to charge the atmosphere of a room with *sufficient* galvanic intensity, or with the due balance of its elements, where either may be defective, new and useful remedial measures might thus be added to our former therapeutic endeavours. Air is a slow conductor, and may readily be rendered more active of electric energy, which, if contributed *gently* to the lungs, might go far to improve the ordinary effects of their artificial inflation, in cases of atony, want of respiratory powers, or in deficient voltaic energy.

9th—The advantages of judicious and delicately-conducted inflation of the lungs have not been duly attended to in the second stage of cholera, when the diaphragm is *contracted*, and the intercostal nerves and muscles are cramped. When the chest and lungs are unable to inspire

spontaneously, we should expand them *artificially*. The importance of communicating a supply of enlivening warmth to the immense surface of the circulating and respiring organs must be also admitted, particularly at a time when they can generate no animal heat of themselves. If we except a complex contrivance of Leroy, no author has proposed means of inflating the lungs with *warm air*. Although some cases (such as suffer from fixed air, or blows on the stomach) derive more benefit from inflation with cold air, or dashing on cold water, yet in the greater number of instances of *collapse*, the inflation of pure and warm air will excite the vital organs, and set the heart in motion sooner than can be expected from currents of air sometimes fifty or sixty degrees colder than the natural temperature of the lungs. The advantages of this artificial respiration, particularly in winter, must tend very much to bring it into use in cases of collapse, or where the nerves and muscles of respiration have lost their power. By its means natural respiration may be imitated, and the circulation maintained until all the vital functions can be re-established. Thus, in the weak stage of cholera, when the powers of respiration are almost extinct, the tongue, breath, and skin cold, and the voice gone, when very little air is drawn in at each languid inspiration, when the surface is frigid, blue, and bloodless, the heart's action feeble, the nervous system depressed, the circulation ceasing in the extremities, and the black unaerated blood accumulating in the right side of the heart; at a time, in short, when the entire vital powers are sinking, it is then we might expect that filling the air vessels and cells with a warm and pure atmosphere would impel the circulation onwards, improve the chemical condition of the blood, and afford even mechanical support to the cir-

culatory system. In natural respiration the lungs are kept *soft* and *pliable* by the warm water so copiously *condensed* in the breath; but the inflation of dry air hardens and parches the tender membranes. For this reason, hot vapour of water should be diffused through the atmosphere, when drawn into the pump or syringe for inflation. This plan is calculated to supply the necessary degree of *moisture* as well as *temperature* to the air infected, which renders the cells humid, soft, and *permeable* to the air.

Many years since the author related a case to the *Surgical Society of Ireland*, (Dr. Houston in the chair,) in which dangerous collapse and sinking of the vital powers rendered the chest and lungs unable to expand; the breath and skin were cold, and the body blue and bloodless; hot steam, mingled with the air, was freely introduced; the artificial expansion and heat communicated a speedy impulse to the circulation, the pulse returned, and the heat was felt extending, inch by inch, to the trunk, head, and extremities; the patient recovered from impending death.

Great care must be taken not to rupture the air-cells by over inflation, or undue *distention* of the lungs. As inordinate inflation may compress and diminish the calibre of the vessels in the chest, so, on the contrary, moderate distention of the lungs sustains the vascular system, aids the arteries in driving the vital fluid to the extremities, and thus prevents the heart and large veins from remaining gorged, or congested with blood. Breathing *oxygen gas*, at first proposed by Hooke, had been frequently tried, but, in collapse, the chest and lungs are contracted so that they cannot expand *naturally*, but require to be *artificially dilated*. Oxygen diluted with air might be delicately introduced by a *graduated syringe* in blue cholera, to fill the pulmonary cells.

However, in any case, we must not introduce air warmer than "blood heat:" twelve or fifteen supplies per minute, at this temperature, will speedily diffuse a genial glow of heat through the adjoining membranes and organs, and, if the circulation can be maintained, will soon warm the entire body. The occasional employment of tepid air, in *bad cases*, will appear the more reasonable, when we reflect upon the injurious influence of external *cold*, and the fatal lethargy it produces, as experienced by Doctor Solander and Sir Joseph Banks, and which Captains Ross and Parry so well describe.

In like manner, the introduction of volumes of cold air into the lungs augments the torpor of the nerves and small blood-vessels, contracting their diameter, and arresting their circulation; on the other side, when we consider the influence of warm temperature in exciting dormant sensibility, in evolving vitality, stimulating *chemical and electrical energies*, and even in reviving hybernating animals, we may be surprised that the artificial introduction of warm air into the centre of the system remains to this day almost untried in cold and contracted collapse in the winter season.*

SECTION VII.

Nothing can better shew the necessity for discovering some rational cause or *common origin of diseases*, than the absurd theories still extant. It is allowed or believed that three great classes of diseases, *epidemic*, *endemic*, *and contageous*, depend upon disturbed conditions of the body. But instead of looking for some natural cause to account for

* See Lecture on Artificial Respiration, delivered at the Royal Dublin Society, May, 1838, pages 12—19.

such *disturbance*, *fermentation* is selected, as the great parent of *intestine motions* among the particles of *matter!*

In many public registers, the term "*zymotic*" *or fermenting*, is the denomination of the above classes of complaints. This designation implies the notion that the *germ* of a disease must be sown in a sound person, in order to produce a *similar* disorder. But unlike all other processes of *germination* the *seed* becomes *yeast*, sets up *fermentation*, and disturbs the fluids and solids, as barm acts in a brewer's vat, or as leaven ferments bread. This is the head and front of the foolish faith in *zymotic* or *barming* pestilences.

Instead of admitting the imaginary existence of fifty particular *specific* germs of *poisons*, each of which is thought necessary to induce its own particular *specific epidemic*, it is surely more conformable to the simple law of nature, to suppose, what experiments testify, that one vast general disorder of our *terrestrial* or *atmospheric relations*, superinduces one vast general *state of susceptiblity* among living beings. In this manner certain classes, ages, circumstances, and states of constitution, acquire the condition of being disordered in a similar manner.

This *common origin*, may deviate or modify its assaults, so as to produce diseases apparently different in form and danger. But although the type may vary, and the transitions appear unconnected, yet delicate trials shew, that the primary *origin* is the same in them all; there is probably no epidemic in existence without a corresponding rise or fall of *telluric* or *atmospheric electricity* in the affected district.

This is my fixed belief of epidemics, that they have but one *common parent*, no matter how red, black, blue, or yellow be the hues which the offspring may assume.

But it has been always objected to this doctrine, that, were one *common source* of constitutional disturbance in ac-

tive operation, over extended territories, *all the inhabitants* would sicken or die. Reference may be had to the *experimental deductions* (No. 33 to 44,) in explanation and answer; besides, we know, that certain degrees of electric disturbance, may prevail over vast regions, whilst people only suffer in particular places, where certain personal or local states render particular classes, or temperaments vulnerable or amenable to attacks.

In proof of this, the description of the fatal effects attributed, five years since, to the *disposing agency* of the *Blackstaff marsh*, may serve to confirm the above doctrine *(see deductions* 52 *to* 57*).*

I have always thought that general terrestrial or atmospheric disturbance of electrical equivalents, acts like a mordant, on a web of silk, or damask; the mordant may remain clear, transparent, and unobserved, until it become imbued with some colouring matter, when instantly, the dye is displayed and fastened in the tissue or fabric—So, in like manner, the earth, the air, and the waters may be affected by degrees of unequal galvanism, which may pass away unnoticed, until, in some unfortunate situation, human filth, or human folly, human want, human weakness, or municipal wickednsss, stain certain spots or places, and fix the deadly dye, which may merge from red, or scarlet, to yellow fever, green sickness, blue cholera, or black death.

Epidemics are in general really present in a country and disorder the health of the people, before they are manifested in their peculiar and recognized forms. The significant sign by which their presence is declared are commonly called *premonitory symptoms.* These premonitory symptoms are more than warnings; they are indications of the actual presence of the disease; evidences that it has already commenced its work.

It has been long observed, that "great epidemics are usually preceded by circumstances evidentiary of a change of condition in the health of the people, which is commonly regarded as constituting a predisposition or susceptibility to their influence some time before they make their decided and general attack. Thus it was observed by Sydenham, who has left a record of the epidemics that prevailed in London in the middle of the 17th century, for a successive period of sixteen years, including the time immediately before and after the great plague, that a remarkable change took place in the character of fever and other diseases, approximating the general type of disease in several striking features to the distinguishing characteristics of the pestilence at hand, some months before that dreadful malady assumed its distinct and proper form, which it did at last, quite suddenly.

A similar observation was made and recorded by Dr. Southwood Smith, with reference to the type of fever in London, six months before the visitation of cholera in 1832. During the six months immediately preceding the first appearance of cholera in this country, the character of fever in London so entirely changed, that typhus, which for a long series of years had been essentially an inflammatory disease, became a disease of debility, so closely resembling cholera, that the fever into which cholera patients commonly fell, could not be distinguished from the primary fever found in the wards of the fever hospital, when cholera was at its height.

Many volumes might be filled up by descriptions of the altered phenomena of nature preceding pestilential invasions, but our space is limited to a few such quotations.

State of St. Petersburgh during the present Pestilence, 1848.

"A remarkable change took place in the weather. There were almost constant high winds, shifting frequently and suddenly round to every point of the compass, and often accompanied with torrents of rain and sometimes thunder. This disturbed state of the atmosphere was indicated by sudden fallings and risings of the barometer, sometimes to the extent of between 1 and 2 inches. The changes of temperature were equally frequent and rapid, the heat being for several days together very great, as high as from 84° to 90° of Fahrenheit, and the air extremely sultry and oppressive, with a damp relaxing south wind; and then suddenly, on a change of wind, and sometimes on the occurrence of a thunder storm, this oppressive heat would be succeeded by great cold, the thermometer falling as much as 50° in a few hours, so that it was several times in June nearly as low as the freezing point."

"Another peculiarity in the condition of the air was the disturbed state of its electricity. This was clearly demonstrated by the fact that the electric machines could not be charged, and, to a great extent, lost their power, as generally happens whenever the atmosphere is damp and unsettled. The same remark was made respecting the strength of several large magnets."—Dr. Adair Crawford.

The peculiarities in the condition of the atmosphere just described have been observed by several ancient writers, and especially by the celebrated Dr. Sydenham, to precede and accompany usually all great epidemics. It has also been supposed that these peculiarities are connected with epidemics as their exciting causes, though the precise manner in which they act has hitherto remained unknown.

"During the plague seasons, the atmosphere is constantly

charged with moisture; so much so that the difference between the dry and the wet bulb of the thermometer is not more than two or three degrees, the average throughout the year in Egypt being about eight or ten degrees. I do not know that this applies to Cairo, my observation being made at Alexandria, but I suppose that the evaporation is greater at Cairo. The effects of these atmospheric phenomena are so well known to the natives in Egypt, that they express their hopes or their fears according to indications presented to them by the state of the weather. When there is a N. W. breeze with a dry atmosphere, they say—If it please God their friends will recover; but on the contrary, if the wind is S. E., it is considered as markedly fatal."—Dr. Laidlaw.

"We cannot tell, because meteorological science, as connected with the propagation and spread of disease, is as yet in its infancy. We have, indeed, some knowledge of the influence of two of the more obvious conditions, namely, those of heat and moisture; but of the action of the subtler agents, such as electricity and magnetism, the present state of science affords us little information. Still there are unequivocal indications that there is a relation between the conditions of the atmosphere, and the outbreak and progress of epidemic diseases, though we are as yet ignorant of the nature of that relation; but whatever it may be, we may be quite sure it is beyond the influence of any such agency as that of quarantine."

"The extent of the range of great epidemics, equally shows that they are beyond the control of quarantine. Influenza and cholera, which often follow each other, and which observe similar laws of diffusion, traverse the globe in zones, generally, if not always, from east to west."—*Report of the Board of Health, London*, 1849.

The influence of great epidemics is not limited to human beings; it extends to all classes of domestic animals, and there is reason to believe even to *plants*, thus apparently affecting the health of both kingdoms of organized and living beings. It is stated in the report of the Sanatary Commissioners, that contemporaneously with the change noted in the character of fever in the London Fever Hospital, an analogous change had been observed by the professors of veterinary medicine and surgery, in the diseases of dogs, horses, sheep, and cattle; namely, a change from an inflammatory type to one of debility, and that has been observed to be particularly the case with regard to all the diseases properly considered epidemic, to which these animals are subject. This change, it is stated, was so complete, that it had been found absolutely necessary to alter the entire system of remedial treatment, with reference to the diseases of these classes of animals, and instead of using bleedings and other means of depletion, suited to diseases of an inflammatory type, to employ remedies of a sustaining and stimulant character, suited to diseases in which the powers of life are depressed and feeble—precisely the change that had taken place in the wards of the London Fever Hospital, as observed by Dr. Southwood Smith.

SECTION VIII.

Having thus far alluded to the effects of *general loss of galvanic equilibrium*, marching through vast districts, or countries, and producing parallel *epidemic* gradations among entire nations, I come now to speak of particular relations of disturbed electricity peculiar to particular individuals or constitutions.

It has been noticed *(page 40)* that there are *isolated spots*, almost in every part of the world, in which *solitary cases* of illness almost always prevail. It was also observed, that disorders common to such localities, are relieved or cured, only by escaping from the originating causes or predisposing agency of such places. The transition is sometimes so sudden, that no change of air, *merely as regards air*, can account for the rapid alteration, especially in complaints unconnected with the functions of respiration.

The ocean of atmosphere is almost everywhere the same, sometimes more or less damp; but moisture, of itself, in ordinary degrees of temperature, is comparatively a hurtless quality of the air. It is not very injurious in Ireland, where it greatly prevails. Damp is quite innocent on the banks of Newfoundland, where thick mist and spherules of water, envelope the fishermen in dense clouds of moisture, during three months of the year. Yet these fishermen are remarkably healthy. No marsh miasms in these mists. There is no difference between the exact atomical quantities of oxygen or hydrogen, constituting the atmosphere, in the deepest glens or highest mountains. In either case, the minute quantity of fixed air, or of ammonia, can make no general change in the salubrity of the air. Some other agent, therefore, must be capable of accounting for the vast and sudden transitions of health in one place, compared to another.

But the philosopher, with his delicate measurer of magnetism, with his electrometer and nice tests of diurnal rise and fall of electric intensity, although he can trace no variety in the air, can soon detect many variations in the zigzag film of electric ether, which everywhere alters its energy, and is different many times daily, in different places.

Nearly a volume of the author's experimental notes is taken up, by showing the diurnal and nocturnal varieties of electric tension prevailing on the hills in or around Rome. The air of the Pincian Hill did not differ from that of the Palatine, or of Monte Mario, or along the undulations of the Esquiline and Viminal ranges; but the electricity in their air, differed in them all, and rose or fell unequally, several times during the evenings, mornings, and nights.

Long-continued trials exhibited the same variations on the healthy hills about Genoa and Turin, and again in the plains of Lombardy and Tuscany.

Similar gradations of atmospheric electricity may also be distinguished in ordinary conditions of the air, in various districts of our own climes. Even in the circle of a few miles, the tension of electric phenomena differs in these countries.

Postponing the consideration of epidemic maladies, and of galvanic evolutions in the actions and reactions of medicines, it may be necessary, for their better understanding or explanation, to premise some further remarks, upon atomical galvanic mutations, in the production of *ordinary ailments*, not embraced in epidemic transitions.

For this purpose the principal features of the discussions already alluded to (*page* 22) may be here set forth. The *original* appeared thirteen years since in the *Dublin Medical Journal*, as examples of *atomic alterations* in human bodies, producing corresponding changes of health, pursuant to the theory laid down by the author, in the *London Journal*, four years previously, in his essay on electric agency.

Outlines of certain Changes of Organic Elements.

[Read at a Meeting of the Surgical Society of Ireland, 20th Feb. 1836.]

GENTLEMEN—Having had the honor of taking a part in a discussion at the College of Physicians, respecting the evolution of urea in the blood, and the detection of various saline products in the urine, I have been induced to invite further attention to subjects so interesting.

As the discussion alluded to, took place on the evening before last, the shortness of the time, will, I hope, excuse the imperfections of this paper.

My object is to elicit information from those whose studies are more immediately directed to organic chemistry.

The elements composing the inorganic world are few and simple, and their combinations intelligible, but the investigation of the elementary mutations of organic matter encounters difficulties at every step. Here we meet such boundless variety, such perpetual change and complexity, that we cannot reduce their combinations exactly to the same order of laws, which regulate the simple arrangements of mineral bodies.

The immediate principles composing the human body have been already alluded to. (see page 19.)

The proximate principle of bone is mostly phosphate of lime, the elements of which are lime and phosphorus with oxygen, (other less essential constituents are postponed to a more advanced paper.)

In animals there is a continual progress of removal of the old organization, and a deposition of new particles to supply its place. In this removal, the older molecule is resolved into its constituent elements, and is not absorbed or carried away as an integral compound.

As the original elements combine in determinate atomic

proportions, so the resulting animal particles are always similar in one healthy body to those of another, and alike in every part of the same body. The unions of the atoms are precise and uniform, and hence the uniform results. But for these definite laws, no two or more combinations would produce the same effects except by accident, but like the reflections of a kaleidescope, an unceasing series of transitions and unstable variations would take place.

As four leading colours, black, blue, red, and yellow, by varied combinations afford all other shades, so would the undefined or proportionless junction of four elements produce endless varieties, dissimilar in construction and properties. But in the regeneration of new principles or particles from food, air, or imbibition, certain causes may interfere to occasion an alteration of atomic arrangements, and one or more combinations, different in properties from those which should be naturally deposited, may ensue. Such changes of relation are much facilitated among the ultimate elements, by reason of the energetic affinities with which they are endowed by electric agency. The presence of nitrogen in animal particles, greatly strengthens this elective tendency. The nitrogen sometimes unites with hydrogen, and forms ammonia, leaving the oxygen to seize carbon and run into carbonic acid, and this product again joins some nascent combination, or is liberated through the permeable membranes of the lungs.

In the progress of other mutations, the hydrogen attracts oxygen, and forms water, and the remaining elements are carried away, or combined with others in some morbid proportions.

In the present state of science, electric attractions and repulsions may account for these abnormal additions or subtractions of atoms, the presence of the new or altered

products in the fluids or secretions, furnish signs of such untoward elementary evolutions by galvanic agency.

As the order, number, and proportion of atoms are the same in each proximate principle of every part of the body, so any deviation which produces disorder in the structure or functions of one person, will, *cæteris paribus*, occasion, similar disorder in the structure or functions of another.

Hence, as we have classes, orders, genera, and species of animal particles, and of the elements composing them in a state of health, so their variations from that state may distinguish diseases (which are the signs and consequences of these variations) into classes, orders, genera, and species.

During health, the due electric equivalents regulate and determine the natural affinities of regenerative chemical unions, but when their balance is weakened or deranged, then disintegral chemical operations are set up. Translations of one proximate principle into another take place; functional deranged actions arise; deviations from the qualities of the natural secretions ensue; and at last, by reciprocal agencies of these causes and effects, organic alterations are superinduced in the molecules or materials of which the glands, nerves, and animal or vital organs are composed.

Thus, errors in regimen will occasion a circle of galvanic changes, and cause the contents of the stomach to ferment, and morbid acids to be generated. These acids then re-act upon the gastric nerves, and produce irritation; this irritation causes vitiated secretions from the gastric glands. These corroding secretions decompose and deterge the mucus of the stomach, pain and excitation are thus engendered. The result of this state of things is increased vascularity, condensation of the coats or tunics, congestion of the glands, and, at last, schirrus or cancer may come to be established.

In a work which I published, translated from my Latin

Thesis of 1828, in Edinburgh, I urged the importance of chemical investigations, to elucidate the nature of many atomic changes evolving among the constituent elements of which we are composed. I shewed how easily the changes of a few elementary atoms would convert fibrine into gelatine, and thus produce a reduction of our animal energy; or *vice versa*, change albumen or gelatine into fibrine, and thus promote the vital actions, increase tone, and determine towards acute diseases and inflammatory excitations. I urged that the formation of fibrine in excess caused or accompanied the phlegmasiæ or fevers, and on the contrary, that deficiency of fibrine preceded, or was concomitant with disorders of debility. I strenuously urged the minute examination of the animal fluids, to discover the untoward results of these chemical mutations.

In the London Medical Journal for February, 1832, in a letter to Dr. Ferguson, then at Sunderland, I offered the opinion, that some of our constituent elements become deranged and liberated by the agency of electricity, and that these atoms sometimes generate prussic acid in our system, as we know they so readily do out of it.

In the same Journal of July last, I observe that certain distinguished Continental physicians have adopted the theory I had proposed so long before. This encourages me to invite your attention to similar inquiries, in the hope that such investigations may lead to a clearer understanding of the origin and progress of diseases.

Without in the least degree undervaluing the all important changes influenced by the vital powers, there is nothing unreasonable or unphilosophical in attempting to investigate the chemical mutations of organic matter, and the consequent alterations from a state of health to that of a disordered condition.

If we have recourse to chemical agents *for the removal of a complaint*, why are we forbidden to search for chemical causes to explain the rise and development of the malady?

We are aware that the operations of nature are regulated by a system of laws; that there is a connexion between the influence of a remedy and the economy of animal life; that various classes of medicines determine effects very nearly similar in results; that almost every mutation is produced by the agency of one kind of matter upon another, and that therefore it is our duty to understand the pathological condition of the structure or functions we desire to improve, how vicissitudes of such condition originated, and in what manner the proposed remedy is expected to dispose the affected part, or the whole system, to assume the natural order previously existing.* It is true, we were deterred by the errors of soladists and humoralists, as well as of those who attached odium to the chemical treatment of diseases, before the doctrine of the atoms was understood. It is also true, that the laws of life so far surpass those which regulate inorganic matter, that we are almost discouraged from entertaining the reasoning of analogy. We are met by the objection of descending into materialism, and dissuaded from venturing to explain physically or chemically those influences which are supposed to depend on vital powers alone.

I shall now proceed to offer a few suggestions on atomic evolutions in the animal economy, submitting my speculations rather to *elicit* than to *impart* information on subjects so extensive, uncertain, and almost unexplored.

If we look to the elementary table, we observe in round numbers, that fifty-three parts of *carbon*, seven parts of hydrogen, twenty parts of nitrogen, and twenty of oxygen

* The time is certainly come when we should answer to ourselves these questions, before deciding upon a remedy—*What is this medicine to do? and how is it to do it?*

are joined together, to constitute one-hundred parts, or atoms of fibrine. But suppose that this fibrine shall, by some evolution, acquire three atoms more of oxygen, and lose four or five of nitrogen, it will no longer be fibrine, but go back to albumen. To this, if you add four atoms more of oxygen, and deduct the same number of carbon and hydrogen, you have a conversion into *gelatine.*

In the following proportions per cent (in round numbers) these four elements compose urea, 20 carbon, $6\frac{1}{2}$ hydrogen, $46\frac{1}{2}$ nitrogen, and 26 oxygen.

The evolution of cyanogen from our carbon and nitrogen, and its junction with an atom of hydrogen, were already alluded to as the probable origin of hydrocyanic acid in cholera, and other epidemics of sudden danger.

In a medical point of view it may be proper to observe, that carbon, hydrogen, and oxygen, are the basis of fat. Obesity may be owing to the undue abstraction of nitrogen by some other process or emunctory. Might not the continued use of some highly azotised remedy diminish the disposition to generate fat in excess?

Oxalic acid is generated in our systems by a combination of equal measures of carbonic oxide and carbonic acid; hence its atomic proportions are three of oxygen to two of carbon. The artificial production of this salt is an instance of the easy conversion of one organic body into another. Thus it is obtained from sugar by means of nitric acid. The acid breaks up the integrity of the sugar, deprives it of hydrogen, and in return gives it the equivalent of oxygen, capable of turning the sweet and nutrient sugar into the sour and corrosive oxalic acid. When this acid is generated in man, and combines with other elements, it constitutes very injurious compounds: it seizes upon lime from the bones, forming oxalate of lime, a salt very

interesting in a pathological point of view; first, as an example of untoward formations in our economy; and next, as being the basis of the worst urinary concretions, such as the *mulberry* calculus.

But all the injury does not end here, for if the oxalic acid take up a portion of the lime, which either has already formed, or should constitute bone, the osseous proportionals of phosphoric acid will be left in excess, and we shall have a superphosphate of lime, which being a soluble salt, will occasion the bones to become flexible. You may well conceive, Gentlemen, that the victim of these actions and reactions will be a very *rickety* subject indeed. We may here remark that starch, gum, wool, hair, and silk, may be converted into oxalic acid, by giving their carbon its atomic proportion of oxygen by means of nitric acid.

The acid called oxalic, furnishes us with three oxalates of potash, in which the acid is in the ratio of one, two, or four atoms. Probably there are other oxalates which we do not know. I have often thought that the extensive modifications of organic chemistry, influenced by vitality, produced many combinations which we have never been able to procure by art. Observe the near relations of the composite proportions of *sour vinegar* and *sweet sugar;* the latter contains nearly forty-three per cent. carbon, with the residue water; four per cent. more of carbon is the only difference, as vinegar contains forty-seven per cent. carbon, the rest water. The composition of sugar and starch are nearly identical. I may here remark that I never saw a case of the evolution of sugar through the urine, but there was a copious formation of vinegar in the stomach.

Whoever takes the trouble to examine the number of chemical changes daily occurring in human urine, must be deeply impressed with this truth, that a great variety of

chemical operations proceed in our system, and that these changes are affected by the most delicate interference. This should act as a caution against the extravagant abuse of acids by some, and alkalies by others. In these investigations we are surprised by the numerous alterations of uric acid and its salts. We see that when ammonia is taken from it, by some acid, we may have the uric acid deposited in crystals, constituting stone, or gravel, and even gout.

This furnishes a proof of the necessity of chemical inquiry, before administering acids without discrimination. Or, on the other hand, the evils of an alkaline treatment may be understood, when we reflect that the *soluble* superphosphates which would escape in the urine in a liquid state, may be rendered neutral by the improper use of alkalies, and thus converted into an insoluble phosphate, liable to accumulate in concretions and calculi.

Minute analysis of the blood, and of all the secretions, would enable us to detect, and perhaps counteract the progress of many atomic transitions here alluded to, but in particular the investigation of the urine, and comparing its specific gravity, qualities, quantity, and contents, would display the results and precipitates which take place from untoward chemical reactions. If the appearance of these untoward productions were collated with the symptoms at the time, great light would thus be shed upon the signs, morbid processes, and changes. Even minute observation of the colour of the urine is an index almost as true as the different hues presented by the tongue, pointing to certain deviation, from the usual operations of nature.

Observe how high coloured is the urine in the whole class of active fevers and inflammations; how pale in the putrid stages of typhus, in dropsy, diabetes, and hysteria;

how claret red in diseases of the liver; how yellow in jaundice and biliary obstructions; how white in cases of intestinal irritations and worms; how coagulable when albumen predominates in dropsies and diseased kidneys, and how brown from alkaline reactions. We also see, when the excitations of the phlegmasiæ or acute gout, or rheumatism, begins to subside, how copious is the brick dust precipitate which the urine exhibits, and the pinky sediment it allows to settle. Altogether I am persuaded if these delicate inquiries were rigidly and industriously conducted by such chemists as I see around me, we might be able to discover certain tests of various progressions of disease, as sure as those with which we discover the presence of poisons, or the various ingredients of mineral waters.

We shall be more ready to admit the varied agencies of remedies, and the unceasing series of conversions and re-conversions progressing among the animal atoms, when we reflect that nascent evolutions are alone adapted to produce many results not otherwise attainable; for instance, we cannot unite nitrogen and hydrogen to form ammonia by art, unless one or both of these gases be in the act of formation at the instant of their junction.

In addition to other agencies, the circumstance of the minute division, which is sure to attend nascent products, must contribute in no small degree towards the mutual exertion of affinities. It is thus that platina becomes red hot and inflamed, if minutely divided, and exposed to a jet of hydrogen, at the same moment forming water by the embrace of its two constituent airs; but the hydrogen could produce no such change on solid platina itself.

In the same manner a substance thrown down from a compound may be dissolved by a third liquid at the mo-

ment of precipitation, which liquid could exert no solvent power on the same body in the state of powder, however minutely divided by mechanical means. Thus we cannot cause any affinity between the most impalpable pipe-clay and sulphuric acid, nor overcome the cohesive affinity of the atoms of alumina for each other; but if we precipitate alumina from its solution of a sulphate, by means of ammonia, sulphuric acid can then dissolve the clay at the instant of its nascent freedom. Considerations like these may explain how the same remedy may fail at one time, and succeed at another; and how infinitely the qualities and constituents of medicines may be modified by galvanism in their progress through the alimentary fluids.

With respect to the agencies of remedies, that subject is too extensive for our limited time. But as an instance of others, I may venture to remark, that when we administer a metallic oxide to patients, we may be furnishing to some of their elements such equivalents of oxygen, as may enable them to form perfect atomic compounds, and that the metal itself is only the medium of conveying the oxygen to the system. Mercury, iron, lead, and copper, are considered inactive in their pure metallic state, being incapable of exciting any chemical composition or decomposition, unless in combination with oxygen.

These reflections may not be interesting; but they would be useful, if we could advance from what is known, to what is unknown, and ascertain the pathological conditions in the various classes and orders of diseases.

This knowledge might enable us to modify such evolutions by the exhibition of remedies adapted to alter or correct untoward developments, or noxious products. In that case we could explain the modus operandi of medicine, and our profession would no longer appear a code of un-

stable contradictions, but we could fairly give a reason for the faith that is in us.

It is stated by Dr. Thomas Leslie Gregson, who was at Alexandria during the prevalence of the great plague of 1836, on duty there as surgeon in chief to the Naval, Military, and Civil Hospital, that cattle were attacked with decided symptoms of plague, sometime before the disease broke out among the human species. "Before the disease broke out," he says, "a number of the Pacha's oxen were seized with a malady, of which above one hundred died in a few days. I was sent to investigate and report on this epidemic. On examination I found gastro-enterite in the most intense degree; so much so that I have found extensive gangrene in oxen that have only been observed ill twelve hours. They had also large buboes. This I reported plague, and caused them to be interred deeply."

It is with no ordinary degree of pleasure I see confirmed in 1849, the doctrine I ventured to teach in 1832.

"The coincidence of blight with pestilence has been recorded from ancient times, and the wide-spread potato disease, which has now extended to almost every region of the globe, concurrently with the presence of the influenza and cholera poisons in the atmosphere, may possibly be a modern instance of it. At all events, it is certain that seasons which are unusually sickly to large classes of human beings, are often alike unfavourable to the health and fruitfulness of many classes of plants.—*London Board of Health, Report*, 1846.

Since the above deduction was printed in the Lancet, in 1848, it is gratifying to find the doctrine so strongly confirmed by the *able* "*Report*" of the General Board of Health, London, in 1849.

"If there be any truth in the preceding representation,

that epidemic diseases are universally and inseparably connected with an epidemic atmosphere, the question is at once decided.* Quarantine can exercise no more control over this epidemic atmosphere than over the *electricity* and temperature of the common atmosphere, and the direction and force of the wind.

"If it be true that epidemic diseases, such, for example, as influenza and cholera, traverse the globe in determinate courses or zones,† and often spread from country to country, and through the vast populations of their great cities, in single weeks, and even days, it must be futile to array such a machinery as that of quarantine, that is to say, a vessel placed at the entrance of one or two seaport towns, a line of soldiers guarding a few miles of the frontier of a particular country, against morbific agents, which pursue their course like the *blight that destroys the vegetation of a country in a night, and which extend their influence over the greater part of the habitable globe.*

If it be true that the epidemic influence *precedes* the actual outbreak of epidemic disease—that that epidemic influence is present in a country, creating a predisposition or *susceptibility* to disease *before the epidemic appears* in its true and recognised form,‡ quarantine must be futile; because, before it takes its precautions or erects its barriers, such as they are, the epidemic is already in the country busily in action, vitiating the blood of the most susceptible of the population, and preparing the way for its general attack.

"If it be true, as ancient and modern authorities are agreed, that, without the *essential preliminary* of an *epidemic atmosphere* on the spot,§ foreign contagion is inert, and that, unless both occur, no pestilence ensues, quaran-

* See pp. 13, 28, of this book. † Pp. 44, 63. ‡ P. 48. § Pp. 46, 59.

tine under any circumstances must be useless; for, in the absence of an epidemic atmosphere, it must be useless, because then no disease will spread beyond the individual affected; and with the presence of an epidemic atmosphere it must be useless, because then the disease will spread wherever the infected atmosphere goes and finds favouring conditions.

"If the preceding principle be true, it must be futile to place vessels coming from infected countries in quarantine, unless those vessels are capable of bringing with them an epidemic atmosphere, and unless quarantine can control such an atmosphere when imported; and the uselessness of this procedure will be placed in a still stronger light, when recent experience as to the comparative insusceptibility of Europeans, though resident on the spot, to plague itself is considered."

The experiments of Mr. Cooper *(see Appendix H)* agree with my own in showing the frequent states of atmospheric disturbance prevailing after the potato blight appeared. Similar manifestations have attracted the attention of eminent practitioners and sanatary boards since the above papers were read to societies. The following corroborating observations may be found in the last admirable *Report* of the General Board of Health of 1849:—

"Attention has recently been attracted to certain natural phenomena which appear to be more or less intimately connected with the first manifestation of an epidemic atmosphere in a country; among the most remarkable of which are those disturbances in the physical condition of the atmosphere which have been observed from ancient time to precede and accompany all great epidemics, and which have been witnessed generally on the occurrence of such epidemics in the present day.

"The influenza, for example, which was formerly believed to be a disease of a highly contagious nature, became epidemic in London in the week ending November 27, 1847. This outbreak was preceded and accompanied by extraordinary risings and fallings of the barometer, by violent storms of wind and rain, by great and sudden alterations of temperature, and by such a disengagement of moisture in the shape of fog as to make it dark at midday. 'No electricity,' says the Registrar-General, 'stirred in the air during that week; all was still, as if nature held her breath at the sight of the destroyer come forth to sacrifice her children.'"—*Report of London Board of Health*, 1849.

But, an individual may readily disturb the atomic electric equivalents of his own system, by excesses of various kinds. High tension of positive galvanism will follow or accompany high stimulation, either by food or drink. The positive fluid, thus set free, seizes instantly upon negative fluid from some less excited organ or neighbouring part; and thus acute or chronic ailments are easily engendered by the unequal action set up by imprudent conduct or want of care.

It may be said *again*, as was said *before*, "that if electricity can originate such endless transmutations of health, *mere health would be the exception and sickness the rule.*" But the doctrine here set forth maintains, *that natural electricity is essential to natural health*, that its due *distribution* and *agency* is conservative of sanity of body and mind, and even preservative of life itself. The same may be said of *animal heat and animal moisture:* without a due proportion of both we sicken, or we die.

Animal heat is essential to health; but too much of it burns, whilst too little permits us to be frozen. So also

nine parts out of ten of each human body is water, essential to the body; but too much water would drown us; by too little we are dried or shrivelled up.

The same may be said of electricity: perfect atomical equivalents of it, like the perfect equivalents of *heat* and *moisture*, are conducive to *perfect health*. The usual remark applied to fire and water, may as well apply to electricity—"they are good servants, but bad masters."

But these distinctions of electric power being, in such cases, partial and mild, mild effects are only produced. The agency of varieties of electric influence is generally salutary, and gives a filip to the circulation in animals and plants, both of which benefit by *a change of electricity*, if not by a change of air. Whilst, therefore, a general territorial electric action produces general epidemic classes of diseases over whole districts, so also minute partial and individual galvanic disturbance can induce individual degrees of broken health.

Such loss of *sane equilibrium* may ensue, whether the galvanic atomical balance be broken *from without*, or *from within*.

SECTION IX.

There are many other varieties of ailments, both *acute* and *chronic*, the first origin of which may be more accurately traced to *voltaic disturbance*, than to any other cause.

A paper was read by the author before the medical section of the British Association at Liverpool, of which a short outline appeared in their Reports for 1837, p. 106. The electrical theory of atomical interchanges was brought before the meeting, to account, not only for the primary

causes of disordered conditions of solid and fluid particles, but also for the extreme torture sometimes endured by reason of the nervous sensibility being preternaturally augmented, when nerves, or their adjoining membranes, are imbued or saturated with saline or other unusual secretions of liquids containing chemical results, occurring from perverted galvanic agency.

Before proceeding to the consideration of the morbific scale of epidemic complaints already set forth, it may tend to render various transmutations more intelligible, if the heads of the above paper be here submitted in reference to galvanic agency in diseases of daily occurrence, and also in reference to the *exaggerated torture* which arises from the nervous structure being rendered acutely sensitive, when their conducting power is untowardly increased, by saline fluids in contact with them. No doubt many improvements have been introduced into the pathology of nervous and other complaints, since the following paper was written; but here the objects in view are the electrical relations not only to the cause of the alterations, but also of the extra torture which human beings suffer at the same time.

The following is the paper discussed before the British Association at Liverpool. The subject is here introduced in order to explain *individual instances* of undue electric agencies in various common disorders, *not epidemic.*

"*Of Disordered Conditions of the Human Body caused by the evolution of Saline Impregnations, although not amounting to gravel or crystalline concretions.*

"No department of pathology has been more successfully cultivated since the time of Scheele, than that which explains the origin, progress, and composition of stone and

gravel, of gouty depositions in the joints, and of concretions in several other parts of the human body. The mechanical obstructions resulting from these *solid substances*, are now well understood and defined, in cases where there is an aggregation of their particles in palpable or tangible accumulation. But the object of this paper is to show, and I wish this *distinction* to be well understood, that the same acid, alkaline, or neutral products which, in some instances, constitute *sand* or *calculi*, do, in others, prevail to *excess* in the constitution, in a liquid or diffused state, and that they thus give rise to a series of nervous and other diseases of *irritation*, caused by acrimony and elementary derangements set up by the presence of salts, or other untoward impregnation in the blood and lymph. I now consider that, although English and continental chemists have accurately described the causes and effects of *actual gravel*, they have not hitherto discovered that a much more extensive train of painful diseases, or rather symptoms, continually result from the undue or *excessive impregnation* of the human system, by some of the same qualities of excretions which at other times enter into congeries of calculi and sand. These foreign or discordant elements circulate through the most minute vessels and membranes, disturb the healthy relations of animal organization, and derange the functions of the nerves and vital organs. It would further appear, from chemical analysis, that certain minute crystals lately observed in various tissues of the human body, have resulted from the deposition of soda and potass combined, so as to generate uric acid salts, when their elements have been evolved in excess at some previous period; and it would also seem that, in some cases, these crystalline particles have irritated the nerves of sensation and motion.

In disecting a testis extirpated for intolerable *neuralgia* in 1815, I found the tissues investing the principal nerves studded with a series of minute crystals, rendered visible by a microscope. At that time I considered this glistening frost work to be saline particles, resulting from the evaporation of the cellular or serous fluids, which had dried up after the previous dissection; and upon careful investigation, I found similar salts in a state of solution, imbuing the entire fluids of the gland. More lately my attention has been recalled to the subject by the observations of Professors Harrison and Apjohn, who found crystals deposited in the membranes of the alimentary canal. Similar crystals have been since found by M. Gluge, and others, in the heart, brain, stomach, and other organs and tissues. These circumstances recalling to my mind the above case of glandular neuralgia, I sought the opportunity, and was happy to find one, of dissecting the thumb of a patient long afflicted by tic-douloureux of that part. This patient started, in a violent manner, when he happened to press the under side of the thumb against his cane, pen, or any hard substance. The violent torture was not relieved by any treatment, but continued, along with other ailments, to wear out a suffering existence. Upon minute examination, by an instrument of considerable power, I found the internal surface of the true skin, the little margins of the sudatory pores or canals, the papillæ, the sides of the small absorbent vessels, and the neurilema of the capillary nerves entering the papillæ, to be all interlined by minute crystals.

The crystals examined formerly by Dr. Apjohn were composed of earthy phosphates; but those found in my dissections afforded evidence of the presence of uric or lithic salts. The occurrence of saline scales in two neu-

ralgic cases, led me to infer that their mechanical irritation in the sensitive substance, might account for the severe character of anguish which had long afflicted the unfortunate patients.

But, superadded to the mechanical irritation of minute crystalline scales, imbedded in sensitive tissues, I am certain, that excruciating pain is carried more instantly and much more severely to the sensorium, by nerves or membranes whose coats or fibres are saturated or impregnated by saline excretions, or by solutions of urate of soda or potass, even when those salts are in a fluid state.

I moistened long threads of silk with distilled water, whilst other threads were wet by an equal moisture of *uric acid salts*, dissolved in distilled water. The latter kind conducted electric passes instantly and readily, almost equal to the power of metallic conductors; whilst the threads wet by plain water conducted the passes very slowly and imperfectly, compared to those conductors imbued with uric or other saline solutions.

There is undoubtedly an energetic galvanic action exerted upon certain investing coats of cavities during the decomposing or chemical alterations of their contents; that such electric action, in many cases, determines a free transit of fluids through living animal membranes, may well be allowed, when we compare the effects of positive and negative agency, in separating and conducting acids and alkalis from their salts in solutions. All such galvanic intensity is much excited by chemical re-agents acting upon each other in disordered animal fluids or secretions.

The existence of such solid depositions would lead to the inference that the circulating fluids, at some previous period, must have been saturated by the saline ingredients which subsided in the fibres and membranes like urinary

depositions, and that such impregnations pervading the solids and fluids, must have contributed to excite these trains of constitutional irritations which never fail to precede and accompany attacks of tic-douloureux, severe rheumatism, gout, and other painful states of the muscles, joints, or nerves.

During these investigations I examined the chemical character of certain crusts settled upon the skin in cases of impitigenes, or scaly crusts, scald-head, lepra, &c., and found that the scales contained urinary salts, which seemed to have encrusted upon the surface, and deposited there, when the insensible perspiration had evaporated. I also analysed the ichor of ill-conditioned ulcers; the discharges contained several saline qualities of the urine. I observed that most of these salts were increased in the morning, or *after the urine had been long detained in the bladder*, and that the prevailing constituents of the patients' urine, at the time, were those which most predominated in the vitiated secretion upon the skin or ulcerated surfaces. I had also long observed, and it is well known, that the urine of patients subject to certain kinds of asthma, chorea, epilepsy, and hysteria, was frequently loaded with urinary deposits when the patients were comparatively well, but that when the urine flowed *pale*, like water or whey, the attacks assailed the patients, and the urine passed off copious and limpid, whilst the former kinds of sediments did not seem to be separated from the blood, but to remain in the circulating fluids. Whether this be a *cause*, or an effect, it is difficult yet to determine; but millions of trials testify *voltaic* atomical relations to precede and accompany this state of things.

These, and many similar observations, were made in cases where the functions of the kidneys were otherwise

healthy. Hence I suspected that urea, lactic and lithic acids, animal extractive, superphosphates of lime, and various acid or alkaline materials, were sometimes *absorbed out of the bladder*, along with a portion of the urine when holding them largely in solution, and that on some occasions the supplies of urea which cause gouty, neuralgic, and other pains and spasms, had been derived from the absorption or reception of urine into the mass of blood, after its saline qualities had been evolved by the kidneys, and carried into the bladder in the ordinary process of separation. Most writers on the subject of retention admit that the temporary ease which is felt when the urine is long detained in the vesica, results in some degree from the absorption of part of the urine, back again into the circulation. If some of that excretion be reconveyed into the circulation, its saline impregnations, being soluble, are *carried with it;* and if so, we know enough of the mischief which urine causes when it escapes among the serous and other membranes, to calculate the disturbance it must excite, if by any morbid process, or untoward circumstance, even a little of it be readmitted into the general mass of fluids. It is difficult to prove whether urinary salts are in all cases *negatively* left in the circulation, on account of not being separated from the blood, or whether some of them may be *positively* conducted *back again, after being severed from the circulation.* The latter would seem quite possible when we take into consideration the perpetual process of endosmose, and exosmose, the transfusion of colouring liquors, through living tunics and chemical reagents; and the circumstance, that if we tie up the urethra of a rabbit, and prevent the evacuation of its urine, the animal's skin speedily emits the smell of that liquid, and the whole system becomes saturated with its *saline impregnations.*

The process of endosmose and exosmose, or the passing and re-passing of liquors through animal or vegetable coats or tissues, is almost a galvanic process or determination. Water, *when electrified*, will flow through minute pores or orifices, *in a full stream*, but when unelectrified, the liquid will only ooze through the same membranes in minute and separate drops. I found, that by means of a zinc plate, laid on the inner side of the thigh, and a silver disc on the outer side, both plates being united by a wire, patients can be impregnated by the friction of mercury, opium, iodine, or other applications, in cases where the skin appeared incapable of absorption in the ordinary manner.

Further, there are certain relaxed conditions of the investing membranes of the vescia, in which *re-absorption* of the urine appears to take place, in considerable quantities, from that organ. When its coats are spongy, they are calculated for the transmission of its liquid contents; and this transfusion is then taken up by the abdominal absorbents. The presence of saline materials of the urine stimulates the activity of the lymphatics, and minute veins, so that some of the contents of the vesica may certainly be taken back into the general circulation.

If it be found that urine, loaded with chemical products, re-enters the circulating fluids, and that the lymph becomes saturated with the foreign ingredients, it will be easy to account for the generation of crystalline scales in the tissues, when we find that an atom of the saline particles subsides, and that others are superimposed around it. Galvanic agency always directs such depositions in symmetrical scales, as it ramifies in arborescent frost work on glass windows during congelation.

It has been long observed that in untoward evolutions of stone and gravel, digestion is deranged, and these saline

productions have been attributed to mal-assimilation. Indigestion has been assigned as the *cause* of the presence of excess of urea and other urinary qualities in the animal fluids. There is reason, however, to suspect that a reflex action is occasionally set up, that some of the urine is received back into the system, when the vesical coats are patulous or spongy. When the solids and fluids become saturated with these foreign materials, a disordered condition of the alimentary system results, chemical action and reaction are established, irritability and vitiated secretions ensue, and indigestion, with its thousand evils, advances, more as an *effect*, than as a *cause*, of those abnormal impregnations, which prevail in all the organs and juices of the body at the time, unfortunately, without being often tested or detected.

Some physiologists supposed that certain saline ingredients found in the solids and fluids were introduced along with the food; others, that the mineral elements are evolved during the processes of nutrition, and that these elements combine in the animal liquors. One thing we are convinced of, in the words of Bostock, "that whereas the lacteals seem to be capable of receiving nothing except chyle, the lymphatics, on the contrary, possess the distinguishing property of taking up, as occasion may require, every substance that enters into the composition of the body, as well as extraneous and heterogeneous matters of various kinds, that are accidentally, or intentionally, placed in contact with their mouths." Let any person examine the galvanic changes and evolutions going on during these transmutations, and conviction of that great agent's relation must ensue.

When (however it occurs) the constitution becomes impregnated by certain saline qualities, varieties of inflam-

mations, fevers, and cutaneous disorders ensue. In such cases, and in acute rheumatism and gout, the disturbance may continue a long time without the noxious excretions being discharged by urine; but when the *crisis* approaches, abundant deposits are precipitated, and the water carries off copious sediments, like pinky powder, brick-dust, brown, yellow, or white depositions, often rendering the urine thick and muddy—all electro-chemical deposits.

No doubt these favourable changes may be the result of some healthy operations previously in action; but whether these critical deposits be the *effects* of previous salutary processes, or the *cause* of the simultaneous improvements, the appearance of the discharges is a *sign* of amelioration; and whatever clears the fluids of such ingredients, must surely diminish irritation, whether constitutional or local.

But if disordered conditions are set up by influences producing such excesses of acid, alkaline, or neutral excretions, *even when they do not amount to solid accumulations, nor subside in the form of concretions*, how much more distress must they occasion when *radiating* into scaly crystalline atoms, as they have been found branching over the valves of the heart, in the brain, and other vital organs.

The presence of lithic constituents, in various parts of the body, may afford reason to suspect that, where violent pains occur, at intervals, *without inflammation, redness, or heat*, when that pain is of a twisting or boring character, and when it resists the ordinary means of cure, the anguish may be owing to the presence of such crystals, or some other saline or untoward impregnations, rendering the membranes more sensible conductors, and thus disturbing the nerves of the part. When the irritated nerves are endeavouring to expel or remove foreign atoms, the endeavours produce exaggerated paroxysms of pains.

The torture endured in certain states of the joints, of neuralgic headache, of tic-douloureux of the face, breast, bowels, or glands, may sometimes be traced to the presence of gritty sediments or acrid excretions settling in the sensitive fibres around the nervous pulp. No doubt other causes of neuralgia frequently exist, such as the pressure of bone upon the nerves, as observed by Sir Henry Halford.

There is a soluble extractive animal matter contained in urine, and often in large quantities: when it is taken back into the system, and long exposed to the agency of oxygen in the lungs, or of oxides in other parts, it becomes insoluble, and subsides, aggregated in variable quantities; it covers itself by pushing back a coat of cellular membrane, assumes various hues and degrees of consistency, and causes suppuration. Its deposition in little kernels, may as reasonably be called *tubercular*, as to suppose tubercles to be endowed with independent vitality, as had been set forth by my friend, Mr. Carmichael.

As with the urine, so it is with bile, principles proper only to the bile, are taken up by absorption from the gall bladder, and re-conveyed into the blood during jaundice. Many such extraneous products are introduced into unhealthy blood, which are not constituents of that fluid in its normal condition. Every such extraneous matter excites galvanic changes. In like manner, I think urea is sometimes acquired directly by being absorbed with urine in certain states of the bladder, because urea was detected in the blood, and upon the skin, and over ulcerations, in cases where neither the symptoms which occurred during life, nor the appearances found on dissection, afforded any proofs of disease of the kidneys having existed. A case described by Andral (vol. i., page 434) confirms, in many

respects, the theory here advanced, that part of the urine sometimes pervades the human system.

Without entering into minute details, I wish to particularize a few of the excretions, which, when in excess, cause acrimony of the fluids, irritability of the solids, and perverted combinations of various elementary atoms in the animal economy. Urea has been proved to exist in healthy urine, to the amount of nearly three per cent. Doctor Kane has shown that diabetic urine also contains urea, and that it can be detected by means of nitric acid in a freezing mixture. In some obstinate cases of lepra, of irritable ulcers, of deranged alimentary and nervous functions, and in the gouty headaches lately described by Doctors Copeland and Weatherhead, I have detected urea in much *larger quantity* than natural in the urine. It then even pervaded the blood and some of the secretions. In cases of great excess, it passes off in yellowish or nut-brown sediment; and I have washed it out of the bladder in the state of a fine powder, by a very mild injection of oxalic acid. Urea has been found in the blood, where the kidneys were destroyed or deficient; but in unhealthy conditions of animal galvanism it is likewise detected in the blood, although the kidneys may be sound.

Under abnormal fits of galvanic influence, several other agents with alkaline reactions are found to predominate in the urine, such as ammonia, silica, soda, potash, &c. &c. But a contrary diathesis frequently exists, and we have *acid excretions* in unnatural quantities, or, at all events, in *quantities exceeding the proportion of alkaline antagonists, necessary to neutralize them.* Uric acid, pure, or in combination, forms one of the most common evolutions of saline impregnations; it is sometimes passed off in the water as a red crystaline deposit. In France and Italy I

have seen the chamber-vessel daily tinged by crusts of lithic acid, and its salts, passed by persons from England who drank freely of the new ordinary wines of these countries. When uric acid is pervading and irritating the system, without a sufficient compliment of some alkaline base to neutralize it, the excess of uric acid can be detected by muriatic or nitric acid, in the usual manner. A very weak injection, containing a few drops of the solution of phosphate of soda and ammonia, precipitates the lithic acid, and washes it out of the bladder.

Other acids sometimes saturate the urine and animal liquors in excess, such as the oxalic, nitric, malic, citric, and lactic acids. These occur most frequently after the system is *disturbed* or *weakened* by *negative voltaic agency*. These two classes of bodies, *the alkaline and acid*, give rise to a long train of constitutional and local excitations in one of two ways. The first is, when one or more of them are produced, or left in the constitution, in quantities greater than natural, and when extreme sensibility is thereby inflicted. The second is, when the quantity present may be natural, but when there is not presented a sufficient quantity or equivalent of some neutralizing agent; and thus part of the base or acid is left free, and consequently in relative excess. Thus we have often a superphosphate of lime, flowing through the system and softening the bones; and it is only when the *excess* of *phosphoric acid* meets with some alkaline base, that the neutral phosphate can be precipitated and passed off innocuous. I have made many trials during the active stages of fever, and other acute diseases, from which it appears that one of the saline constituents is predominating and exciting, for want of the proper equivalent which should render it *neutral*. In like manner, certain soluble saline solutions

remain in the system, until some third body is evolved, and furnished in quantity *sufficient* to act as a precipitant to throw down the previously soluble salts, and discharge them by the water.

I therefore think it quite admissible, in a practical point of view, not only to administer either an alkali or an acid internally, in the treatment of cases where an excess of the opposite quality is demonstrated, but also locally to apply these or any other ingredients capable of precipitating or rendering effete such saline qualities as are redundant and hurtful, and to neutralize them in the bladder in bad cases (per injectionem in vesicam). During the introduction of a minute gold and silver catheter, separately insulated (in vesicam), to compare certain untoward voltaic currents in some galvanic diseases, I found it very convenient to throw up weak washes, contrived to remain some time in that cavity, and to precipitate the too copious foreign ingredients which were otherwise retained in the urine, exciting various disturbances. It may be objected, that remedies, internally, would not be able to reach the object without alteration; but the same arguments would apply against such other means of cure as are employed at present, without any defined or chemical indication. But we can impregnate the fluids with alkaline or acid qualities, and detect them in the urine, when we administer either classes of medicines by the stomach or through the skin by baths. Such practice would not, therefore, be a matter of blind chance, if sufficient care were taken to know the exact material which is in excess, and the counteracting remedy which would render it innoxious topically.

I am well aware that the mystical absurdities of pretenders, deter enlightened physicians from a true chemical examination of the constituents of urine, in disease, that

the subject is difficult, and that those gentlemen in active practice have not the time requisite to detect the many mutations which the *voltaic condition*, *specific gravity*, *and other properties of the secretions daily indicate.*

It is needless to detain the society by minute details of the practice necessary to accompany the above theory. It is obvious that the outlines of treatment must be conducted according to the indications above referred to. Where urea prevails, diluents, nitro-muriatic baths for the whole body, and the internal use of the same acids, effect the greatest good. When uric, or other acids predominate in excess, alkalies forming the most soluble salts, are best. The other ingredients above alluded to require their counteracting antidotes, the general results of which will be submitted in a future paper.

CONCLUSION OF PART I.

Having thus far endeavoured to show that *epidemics* follow *general electric disturbances*, and that *individual complaints* are owing to *particular* galvanic derangements, I wish to conclude by the following quotation from the work of one of our most enlightened philosophers.

Sir John Herschell says—"The principle once established, that there may exist in the animal economy a power of determining the development of electric excitement, capable of being transmitted along the nerves, and it being ascertained by numerous and decisive experiments that the transmission of voltaic electricity along the nerves of even a dead animal is sufficient to produce the most violent muscular action, it became an easy step to refer the origin of muscular motion in the living frame to a

similar cause, and to look to the brain, a wonderfully constituted organ, for which no mode of action possessing the least plausibility had ever been devised, as the source of the required electrical power. If the brain be an electric pile constantly in action, it may be conceived to discharge itself at regular intervals when the tension of the electricity developed reaches a certain point along the nerves which communicates with the heart, and thus to excite the pulsations of that organ. This idea is forcibly suggested by a view of that elegant apparatus, the dry pile of De Luc, in which the successive accumulations of electricity are carried off by a suspended ball which is kept by the discharges in a state of regular pulsation for any length of time. We have witnessed the action of such a pile maintained in this way for whole years in the study of the above-named eminent philosopher. The same idea of the cause of the pulsation of the heart appears to have occurred to Dr. Arnott.

"Several French physiologists affirm, that they have demonstrated a fluid in the spinal column, similar to that of electricity, although not identical with it. Aldini's experiments seem to prove that the animal pile is susceptible of energetic galvanic action, from substances, of lower conducting powers than the metals. In his trials, neither metals nor charcoal were employed; very powerful muscular contractions were excited when a part of a warm-blooded and of a cold-blooded animal were brought into contact with each other. In other experiments, the nerves and muscles of the same animal induced galvanic action; and in like manner, the nerve of one animal with the muscle of another. Aldini hereby appears to confirm the theory of his distinguished relative, Galvani, that a peculiar animal electricity is proper to the body, which does

not require any external agent for its excitation. Whether the brain and spinal column engender electricity, or an agent of similar subtle properties, it can scarcely be denied that the nerves, brain, spinal marrow, and indeed all the solids and fluids of warm-blooded animals, are subject to serious impressions from the operations of electricity."*

* Preliminary discourse on the Study of Nature, p. 342.

END OF PART I.

APPENDIX TO PART I.

A.

At page 22 reference is made to theories laid before members of government and others in 1831. Some practical remarks relating to the interchanges of animal elements, in combinations of dangerous *hydrocyanic* qualities, were laid before the *Board of Health*, at Newcastle. As an antidote to nascent prussic acid, the inhalation of weak ammoniacal gas, diluted with vapour of warm water, was proposed to Dr. Ferguson.

The heads of this proposition were presented as follows by the editor of the *London Medical and Surgical Journal*, July, 1842:—

"*Cholera—new Mode of Treatment.*

"Dr. Murray, of Dublin, whose work 'On Heat and Humidity' has proved him to be a physician of no ordinary acquirements, has favoured us with the copy of a letter, addressed to Dr. Ferguson, who was lately appointed by the Irish government to investigate the nature of cholera at Sunderland, Newcastle, &c., which contains some curious original views, well worthy of consideration. It will be seen, by the date of the letter, that the administration of ammonia by the lungs and skin, and especially over the spine and epigastrium, is an original proposition. Ammonia has been given by the mouth, since the following letter was written. When locally applied to the skin, Dr. Murray has termed it a new and cheap atmospheric blister, in his work already referred to, and which was published in 1828.

"'*To Dr. Ferguson.*

"'Dublin, January 3, 1832.

"'Sir—At this moment of dismay, I think it my duty to explain more fully the opinion I have already mentioned to you,

that whatever the remote cause of cholera may be, the proximate one seems very similar to those which would arise from the evolution of cyanogen in the solids and fluids of our system.

" ' The cold, black, and clotted blood, the progress of the malady, and the motion of the muscles after death, all appear like the effect of prussic acid, formed and circulated through the frame. A latent influence seems to produce derangement in the natural combination of the ultimate elements of our bodies, and to dispose them to combine in new and untoward proportionals, incompatible with the laws of life, or a state of health. As mentioned in my Treatise on Heat, it seems that the deleterious cause has the power to break up the healthy principles composing our blood and tissues, and to make them join in the altered and disordered atomic proportions constituting the basis of poisonous prussiates.

" ' When, therefore, some of the proximate principles of our constitution are decomposed, the alternating elements which had formed them may produce *new results*, when acted upon by some occult agency. Thus the carbon and nitrogen may be disposed to combine in proportions calculated to form prussic acid or its basis; and the oxygen and hydrogen then set free would constitute water, which fluid (as pointed out in my treatise) would account for the blackness of the blood.

" ' I have already mentioned to you, that if nascent prussic acid pervade the human system or cavities of the body during this Asiatic epidemic, an atmosphere of ammonia diffused through the air of the apartment, so as to be easily respirable, might be a manageable, economical, and beneficial antidote.

" ' The generation of warm ammonia in sick rooms would maintain and convey uniform heat to the patient, and being imbibed in hot vapour of water by the skin and lungs, might counteract the further evolution of disordered animal products.

" ' As a mode of prevention, the air of suspected or infected chambers might be deprived of malignant miasmata or passes by a proper impregnation of ammonia.

" ' The mode of procedure detailed in my dissertation would convey a continued warm vapour of ammonia and water around the patient, in bed, and also diffuse a sufficient quantity of volatile alkali through the air of the apartments.

"'After proper attention to the use of external and internal remedies, then, ammoniated spirits DULY DILUTED, might be administered internally, and even per enemata, as useful adjuvants of treatment. I am the more anxious to draw attention to these suggestions, from the result of experiments similar to those mentioned in my work, page 160, showing the great changes effected on the blood by an atmosphere in which ammonia is diffused. I refer to the work alluded to, as containing observations on the influence of æriform remedies, the detail of which would now be tedious.

"'Having mentioned the substance of this letter to some of those connected with government, I am advised to submit it to the consideration of the Board of Health at Newcastle.

"'I also request you will give these suggestions the benefit of your investigation, during the series of experiments you are about to institute on the subject of morbid poisons.

"'I am, dear Sir,

"'Yours truly,

"'J. MURRAY.'"

B.

Page 23 alludes to the general doctrine discussed at a full meeting of the Surgical Society of Ireland, November 9th, 1844, *Sir Philip Crampton, Bart.*, President, in the chair:—

"The secretary, Dr. Benson, begged to inform the meeting, before any paper was introduced, that the council had instructed him to remind them of a standing rule of the society, which was, that no discussion was to be permitted unless requested by the contributor of the communication, and approved of by the chairman. If, therefore, any paper be read, and no wish for discussion be expressed by the writer, none will be permitted by the chairman. It is also the privilege and duty of the chairman to stop the discussion at any moment he sees fit, and for this he is accountable to the council alone.

"Sir James Murray said he had been for many years engaged in investigating a subject which appeared to be little understood,

though described in so vast a variety of ways by different writers; the subject was the very wide field of the origin of the diseases said to be produced by marsh miasmata. He was aware that Dr. Cullen, and most writers on the subject, English and foreign, affirmed, that intermittents and a variety of other diseases were occasioned by emanations from marshes and wet ground; but from many opportunities of observation which he had in a very extensive marshy district, almost on a level with the sea, and near a number of factories, and in which place he had practised medicine for many years, he had come to the conclusion that this class of diseases did not ordinarily originate in miasmata, except inasmuch as these latter carried meteoric emanations. In fact, his opinion was, that marsh miasmata were not themselves the cause of fever, but that, being good conductors of electricity, they conveyed the electric fluid to the human body whenever it was superabundant in the atmosphere, or *vice versa;* in other words, that these vapours aided in producing a disturbance or want of equilibrium in the electricity of the human body. He was further led to infer that these poisonous agents, as they were called, those morbific combinations or miasms, instead of being, as reported by some of our best writers, emanations from the bowels of the earth, were not derived from the ground, or from moist places, or the atmosphere; and that the vapours so originating were not in themselves poisonous, being merely good conductors of the electric fluid, by the action of which the diseases were produced. So far from wishing to trouble them with his paper without afterwards permitting discussion upon it, his principal object in bringing it forward was to invite discussion, that he might be set right whenever he appeared to be wrong. In so wide a field it was impossible that he could have arrived at correct conclusions in all points, and therefore the discussion of the matter would, he hoped, enable him to form a correct opinion in some particulars about which he was at present undecided. He added, that the voluminous notes beside him contained the particulars which had induced him to adopt the doctrine he was now endeavouring to maintain, but they were too extended to bring before a meeting at which discussion, and not tedious reading, was desirable. He would then proceed to read a short outline for them of the reasons which had induced him to adopt this opinion, and a few of the results of the experiments

contained in the larger documents. Sir James then read the following:—

"Bacon and Newton in their all-important lessons taught us to rely on facts, and not upon hypotheses. This invaluable instruction gives certainty to many branches of science. At all times it is desirable to deduce our reasons and arguments from data of proved and established certainty. But whilst inductive philosophy should be our aim and guide, we pursue inquiries with such avidity that we often resort, at least in the first instance, to hypothetical speculations. These suggestions of the mind are not to be despised; they often lead us to institute experiments which serve to prove or disprove the ideas previously occurring to our thoughts and reflections. The mental conceptions of Columbus led to those energetic efforts which annexed a new world to the old; and the theories of alchemists opened the way to many valuable collateral facts and improvements discovered in the ardent pursuits of experimental philosophy. The subject which I have now the honour to submit to this intellectual assembly is so very extensive, so varied by many circumstances, so interwoven, tortured, and perverted by thousands of contradictory relations and descriptions, that it is beyond the power of a single individual to embrace all its details.

"The volume of manuscript notes now before you is too tedious to be read on the present occasion; I will, therefore, only submit a *summary* or *outline*, which may assist our inquiries in this immense field of philosophy, and enable us to arrive ultimately at the useful and unerring certainty of demonstration. My labours in these researches were at first derived from observations on a small scale, and have since embraced a wider range. The origin of my distrust in the general doctrine of malaria was owing to the following circumstances:—

"During many years I attended the sick of an unhealthy district to the south and west of Belfast. This was the valley of the *Blackstaff River, which flows through swampy suburbs, and receives in its course several sewers from neighbouring streets, from a house of correction, a lunatic asylum, from a great number of cotton factories, a distillery, and other extensive sources of animal and vegetable deposits and impurities.*

"Pursuant to the fatal polity so long endured, these floating collections are detained and spread over a large surface of ex-

tended *cess-pool* to the windward of Belfast. This putrescent reservoir detains the deposits of the house-drains in an immense basin or dam, which is used to turn a wretched mill. The pond is in a constant state of fermentation from the floods of refuse pent up within it, and from the accession, at every tide, of an intermixture of brackish water from the oozy Lagan, the principal river of that port.

"The substratum of this marshy district is blue clay, covered with a layer of sea shells, and a thin soil of red clay and sandy earth. The elevation of the town is only a few feet above low water mark. The land along the Blackstaff is so engorged with the pent up floods of this putrid river, that the soil of the adjoining fields and ditches is at all times emitting streams of gases. The anatomical preparations and mathematical instruments in the Royal Institution are spoiled by excessive damps.

"To add to the offensive nuisance of this great cess-pool, its clay margins are dug up in summer for bricks. Turning up this clay, with the putrid deposits from a hundred drains, excites clouds of marsh emanations, sufficient to generate miasms enough to spread illness over a whole province, were putrid miasms the cause of pestilence.

"Notwithstanding the unremitting emission of fœtid gases and emanations from that effervescing fen, they did not *always* engender sickness, although the exhalation was *constant, and although nine months of the year the offensive miasms are wafted into the apartments of Belfast by a south-west wind.* But it soon became apparent, that, if these putrid vapours were not themselves the instruments of disease, they conveyed the morbific agent; if not the plague, these filthy clouds of miasmata carried the pest, and applied it in a potent form to the unfortunate families of cotton spinners and others, who reside along this noisome morass."*

The deductions above alluded to, (pp. 52–54,) with the results of many electrical experiments in Italy, were detailed to the meeting, but need not be repeated here. The author then proceeded:—

"There are many other details connected with the outlines,

* Although this part of the present discussion has been already alluded to, yet it is here set forth entire, in order to awaken municipal authorities to demand sanatary laws.

both of the above theory and practice, but enough has been said to convey their purport until the detailed explanations and evidences are published.*

"Dr. Apjohn said he did not think the subject one which could be then fairly discussed, as it was one very difficult to be treated in a proper manner without the most mature consideration; he would, however, take the liberty of making one or two observations, as no other gentleman seemed disposed to come forward. It should be admitted that Sir James Murray had introduced a very important subject to the society, and it would, he thought, be also allowed that he had treated it in a very original manner. His (Dr. A.'s) opinion was, that electricity had most probably some connection with the origin of the class of diseases referred to. He thought chemical actions could not take place without the development of electricity; electricity must, therefore, be associated with what are commonly viewed as miasmata, and the activity of the latter may be proportioned to the amount of elementary electricity associated with them. There were a few points that, perhaps, were not quite accurately considered in the paper—for instance, it seemed to assume that the atmosphere in Italy was generally negative, and the earth positive.

"Sir James Murray—Only sometimes.

"Dr. Apjohn continued to say, that such an opinion was irreconcileable with some very elaborate experiments made at Stutgard and other places in Germany, which tended to show that the natural electric condition of the earth was negative; and this, in fact, had been so well established, that some of the German practitioners had proposed to place patients on insulated stools with a view of giving them what was called the *negative electric bath*. If the contrary were the case, and the fact such as Sir James Murray supposed, it would appear to him that disease would be the rule and health the exception, for in steady weather the usual condition of the atmosphere was positive, and that of the earth certainly negative. Another point which occurred to him during the reading of the paper was, that Sir James had probably not sufficiently distinguished between static electricity, or electricity at rest, and that in motion; he had in-

* The volume of manuscript notes above mentioned has been since put to press, and was translated into Italian last summer by Dr. Girolami, of Civita Veccia, near Rome.

deed alluded to electricity in motion, and to the necessity of preventing the animal body from becoming the channel of communication for the electric fluid between the earth and the atmosphere. He considered this proposition of Sir James Murray a very important one, and deserving of inquiry by gentlemen who directed their attention to such subjects. As a parallel case he would mention a brewing establishment in England, in which the different vats were insulated, in accordance with the generally received opinion that *thunder sours the beer*. The plan had been introduced by a Mr. Black, and it was alleged that the beer brewed according to his system was of a superior quality. There were many other points connected with the paper, and deserving of much attention, but into which he would not then enter.

"Sir James Murray said he felt greatly flattered by the general approval which his paper had met with from the learned professor. With respect to what he had stated of the earth being sometimes positive, he had qualified his remarks by confining them to localities where some chemical action was going on, or where some volcanic upheaving of the strata had caused them to send forth electricity. They were aware that in such places the earth, when moistened or in contact with water, did produce a great deal of the electric fluid, and it was only to such places that he had referred. He was aware of a hundred places in the vicinity of Rome, some of them not larger than the site of the building they stood in, which were reported to be malarious, while the surrounding localities were not so—for instance, the Monte Mario, which was four hundred feet above the city, and a place of the most exquisite beauty, was left with scarcely a house upon it from this cause. In some seasons, too, the charming Pincian Hill and Borghese Gardens were deserted during some months of the year. All these facts tended, in his opinion, to show that there was something—he would not then say what it was—in operation to produce disease in such places, and it was with a hope that a remedy might be discovered for diverting that cause to some other direction, or by which it might be warded away or neutralized, that he had brought the subject before the society.

"The society then adjourned."

Nearly five years since, on the 27th of November, 1844, this paper was published in the *Medical Press*, and yet the odious

galvanic battery, the Blackstaff *nuisance*, is yet slaying the people all around it. The following report of the Sanatary Committee of Belfast, may serve to alarm the authorities at this crisis—*See Northern Whig, July* 19, 1849:—

"*Belfast Sanatary Committee.*

"The usual weekly meeting of the Visiting Committee was held yesterday, at their room, in the Commercial Buildings, Dr. Lynch in the chair; besides whom, there were present Drs. Malcolm and Perry, and Mr. A. H. Thornton. The thinness of the attendance was accounted for, on the grounds of the great increase in the number and malignity of the cholera cases. It was remarked, that the disease was generally influenced, in its intensity, by the magnitude of the nuisances which existed in its neighbourhood. That portion of the Cromac district, lying to the *leeward of the great paper-mill dam and Blackstaff nuisance, is suffering frightfully.* This clearly points out the pressing necessity of using the most strenuous efforts to have everything removed, calculated to propagate this frightful disease.

"Mr. Thornton reported, that he had visited and examined most of the west and south-west district, from the Pound River to the *paper-mill*, and found it in a truly frightful state. The Pound River, into which a great many sewers are discharged, seldom contains a stream, except when the mill at the distillery is working. It is greatly obstructed—stones, brick, and other rubbish having been thrown into it, which obstruct the course of the water, and cause the filth to accumulate; so that, when the mill begins to work, the filthy matter is disturbed, which causes an *intolerable stench.* Those obstructions should be immediately removed.

"The refuse matters that are discharged from the *union workhouse* still continue to flow, mostly through an open channel, from that establishment, to it discharges into the *Blackstaff River*, passing through a densely-inhabited district, converting what was once a stream of pure, limpid water, into a *mass of filth, the malignity* of which must be seen and *smelled*, in order to form anything like an accurate idea of its enormity. Surely, it is not too much to expect the guardians to remove this prolific cause of disease, of their own creation; or, if they will not consent to

abate it, let its outlet be closed, that its malignant influence may be confined to themselves, and their innocent neighbours saved from its influence.

"The open ditches, into which filth is permitted to flow, to the *southward of the Blackstaff River*, are of the most discreditable character, putting their dangerous influence upon the public health entirely out of the question. The owners of these properties seem to have no idea that 'property has its duties as well its rights.' They appear to imagine 'that they have a right to do what they like with their own;' though the use they make of it should be to injure the health, or take away the lives, of the rest of the community.

"The great monster evil of all, to which all the other sources of filthy matter are tributary, 'the Blackstaff,' from above the '*saltwater*' *at Durham-street*, to the *weir at the old paper-mill;* for the quantity of filthy matter it contains, or the horrid smell it emits, could not be equalled, in the same space, *in Europe.* And because a gentleman holds a lease of the paper-mill, subject to a ruinous weight, of which he requires to be relieved, the public seems to be doomed to suffer, for years to come, all the frightful consequences resulting from its existence. It has been publicly reported that the Town Council proposed to pay a fair annual rent for liberty to open the weir, and let the water flow, by which the filth, now settled in the river course and the *dam,* would be carried down, and be lost in the sea—or even to leave the amount to be paid to arbitration. Let these matters be as they may, the time has come when the public, who are the sufferers, should move in the matter, so as to obtain protection from this dreadful scourge. They understand the magnitude of the *danger. It must be kept in mind, that the wind blows from the seat of these nuisances, direct into the town, nine months in the year, by which the foul and dangerous nuisance is wafted into all parts of the town, the effects of which may be judged of, from the present dreadful state of that part of the Cromac district which lies directly to the leeward of the paper-mill dam.*

"The following resolution was unanimously adopted:—

"'Resolved—That the large quantity of refuse matters, that flows mostly through an open channel, from the union workhouse to the *Blackstaff River, the Blackstaff River itself, the paper-mill dam, and the Pound River, together with their many tributa-*

ries, form, altogether, a body of filth, situate to the west and south-west of the town—points from which the wind generally blows—calculated to produce, and that actually have produced, the most melancholy and dreadful consequences. These nuisances require the prompt attention of the public, and the application of the most stringent means for their removal.'

"It was suggested, that it would be a very prudent exercise of discretion, on the part of the Spring Water Commissioners, in the present frightful crisis, to increase the supply of water to the town, and to provide a supply of water for the poor, about Smithfield, in place of the two fountains that have been closed up there."

C.

"THE NEW POTATO CROP.

"TO THE EDITOR OF THE FREEMAN.

"*Merrion-square, Dublin.*

"DEAR SIR,—At a moment when public attention, on public grounds, should be *speedily* directed to national objects, popular papers like yours are more expeditious channels than professional periodicals. If untoward evolution, or irregular intensity of electric action (too much or too little), if disturbed polarity or magnetism be injurious to plants, surely *Spring* is the best time to adopt some artificial means (if such there be) to conduct away unequal transits of galvanic shocks. Before the season of thunder or lightning overtakes the seed, germ, plant, or mould, we should try to carry off lethal currents by any other channels rather than by the tender vegetable stems themselves.

"There is not a shower that rains, a blink of sun that shines, a drop of water that evaporates, or of dew that falls, a bud that vegetates, a degree of heat or cold that varies, a chemical change that occurs by night or day, a cloud or streamer that mingles in the horizon, a moment of mist or an instant of moisture, that some galvanic mutation does not take place during the progress of such alterations.

"Delicate electric tests proved to me that during the last two

summers the intensity or frequency of galvanic currents, passing between the earth and air, or from cloud to cloud, far surpassed those of many previous years. One of our best authorities, Mr. Cooper, late M.P. for county Sligo, after thirteen years strict meteorological registry, read an able paper before the *Rogal Dublin society*, on the 21st November last (1846) in which he confirms the views which I had formerly published. Mr. Cooper says, page 13:—

" ' Of thunder storms there has been an enormous prevalence this year. It will be seen from the table for six months, during twelve years, that the average number has been three, and never exceeding seven; whereas during four months this year there have been ten. Every one accustomed to the sky has remarked the salmon coloured clouds, indicating a great overcharge of electric fluid; many, like myself, also, are aware of the presence of high tension of this fluid, through constitutional disturbance and headaches. These electric clouds have been observed on thirty days during the four months of this year, from 1st May to 1st September; this amount I can safely assert to be enormously beyond what is usual in this country. I cannot recollect three consecutive days exhibiting this appearance in any year preceding the last. I should add that these thirty days, on which electric clouds were noted, are exclusive of the days of thunder and lightning; thus giving observations of extraordinary tension of electricity, on an average every third day for four months.

" ' I may add, that, with the opinion I hold, that the immediate cause of the potato disease is unusual tension of electricity in the atmosphere, whether by day or night, it is my intention to make an experiment upon a future crop, by placing poles, with copper tractors attached to them, in the field, at various distances from one another, taking sixty-four to the English acre for the greatest number, leaving them ten yards apart; and trying the experiment on the other acres with a less number.'

" Now, Sir, if by metallic conductors we can protect houses, ships, and churches, from the thunder's flash, surely we may contrive some simple *lightning rods upright or horizontal*, to carry into the earth that subtle (fluid), which in its transit disturbs the nerves of human beings, and *blights the texture of moist plants.*

" The former views and trials which I had detailed in the London Medical and Surgical Journal, *July* 1832, *page* 721, and

again in the Dublin Medical Press, *November* 1844, *page* 335, have been confirmed by many writers since that time, and within the last month are published some experiments (instituted with a different object,) by Dr. Swan, and Sir Gerald Aylmer, in which the preservative power of *metallic conductors*, were *accidentally* discovered by them to have accomplished the object for which I had formerly applied wires *purposely*, viz:—protecting the potato from galvanic shocks. But as *prevention* can alone be of use in this case, I hope it may be beneficial *at this season* to repeat the following directions from the *Brighton Gazette* and *Freeman's Journal* of last August. *Alas! that publication was too late for defending last year's crop*, then already struck by those meteoric passes, which already killed the chick in the egg, soured beer in the cellar, coagulated milk in the dairy, and rendered meat and fish putrid in a single night. The simple means at that time set forth in the above journal may serve to point out the plan which I constructed in the fields of *Mr. Bourne, of Terenure*, and of Mr. Kelly, of Dublin, at the end of last August, and which ought to be arranged *now* over any land planted with potatoes, for the purpose of defending the SEED, *if it can be defended*—a similar plan which I applied in 1844 certainly appeared to save reapers in the rice marshes of Lombardy, and in other so called malarious districts of Italy.

"I am, dear Sir, yours truly,

"JAMES MURRAY."

"THE POTATO DISEASE.

"We have been favoured with the following communication from Sir James Murray on this important subject:—

"*German Place, Brighton, 18th August*, 1846.

"SIR—During a long journey to this town, I lamented to observe that the potato disease prevails far and wide.

"Having made many experiments upon the *immediate cause* of this blast, and also having proposed plans for mitigating the stroke, I am sorry to say my trials did not meet with the encouragement which I had expected in country places where the malady was most extensive. It is true, theory is seldom listened to, during an alarm; and I also confess that the practical results were necessarily too limited at first, to make much impression during a period of dismay.

"I will here merely glance at a few *outlines* of my experiments. If thought worthy of being followed up more at large, this is the time, and here is the country to bring their deductions to the test.

"Having long since (in 1832) pointed out the then unequal condition of the electric fluid over a large belt of our globe, and having shown the untoward effects of disturbed galvanic action upon the solids and fluids of delicate human beings, and well knowing (as every person has observed) the severe injuries resulting from passages of galvanism through plants, I was led to pass and withdraw electricity from living vegetables artificially, and to compare the results of plus or minus charges."

"Of all other plants, the potato suffers most in the mechanical or polar relations of its elementary parts, by the transmission or abstraction of electric influence, and it is also speedily altered in the chemical condition of its solids and fluids. When a cloud, or an excess of negative or positive electricity excites a current of its opposite element through the soft and watery stem or tuber, the texture itself, as well as the chemical atoms of the plant, are altered, and the shock is proportioned to the degree of electric disturbance excited.

"From many data, too numerous to mention, it seems that during late years some terrestrial and atmospheric changes have caused very untoward disproportion between the natural quantity of electric (matter) issuing in currents and counter-currents from the air to the earth, and the contrary. The potato stem, made up of cells and water, with pointed leaves, and succulent tubers, is most amenable to the conduction and shocks of electricity. Corn defends its stalks by a varnish of non-conducting glass, or silicious enamel; other domestic vegetables are by no means such ready electrical conductors as the stems of the potato.

"Many other points might be urged which would more easily account for the *partial, sudden,* and *curious progress of the blight,* from the above, rather than from any other.

"Having often tried the effects of artificial disturbance of electric (fluid) on the potato, I covered some stems with bottles, such as are used to carry vitriol; and I can safely affirm that all the stalks so *insulated,* escaped, whilst others were struck black, along direct lines of the same field.

"But as this remedy (if found to be a remedy) is not applicable on a large scale, I tried the plan which I had carried into

effect in the rice grounds of Italy—viz., the use of horizontal electric rods. These were small copper wires, fastened at one end of the ridge to an iron rod inserted deep into the moist ground. Similar stakes were inserted at certain spaces, till at last the copper wire attached to these iron stakes, reached the other end of the ridge. These iron rods or stakes stood about two feet above the surface of the ridge, or eight or ten inches higher than the potato stalks. Smaller wire, like hair, was twisted around the leading conducting wire, to present points, and to divert undue electric currents from the vegetable stems and leaves.

"As before observed, these trials were too limited, but extremely encouraging in their results. Ridges defended by a wire along their entire length were much more safe than those left without these horizontal lightning rods.

"Should any cultivator be inclined to try this plan, the expense is not much. The copper wire is always worth (almost) its first price, and can be stretched along, resting upon upright posts, such as bits of gas-pipes, pieces of hoops, or nail-rod iron—all being things of little cost.—Each drill or ridge would then look, on a small scale, like a single telegraph wire, extended along a railway; and if found to answer might be applicable to similar purposes for years. Should any person require further details or explanations, I send you my address, and will be glad to aid every effort to bring this theory and practice to a more general test, at a time like this.

"I remain, sir, your obedient servant,

"James Murray."

[We have extracted the above letter from the *Brighton Gazette*. Any person desirous to see the process and progress of conducting away excessive or irregular fits of impulses of electricity, may see the wires fixed on several drills and ridges of potatoes belonging to Mr. Kelly, opposite to the barracks at Haddington road, on the east side of the canal beyond Lower Mount-street. The expense is calculated not to exceed 5*s.* or 6*s.* per acre. The plan of defending each ridge by a small wire is so simple and cheap, that it merits a fair trial to ward off untoward galvanic shocks in all cases where the crop is young or uninjured. The above plan is merely suggested by the inventor as a prevention, but not as a remedy.

Drills already injured are treated in a totally different manner, by means of a slip of zinc laid in the mould at one side of the drill, and communicating by wires with a slip of copper placed on the opposite side of the diseased range of tubers.—*Freeman, August* 26.]

D.

Letter from Dr. Shrimpton.

"Paris, June 19, 1847.

"Dear Sir James—It must be now, I think, about two years since you kindly favoured me with an abstract of your paper on the discovery of the influence of disturbed electricity as the active cause of disease, particularly of intermittent fevers. I was then at Constantina; and now, after having been carried through the varied scenes and difficulties necessarily attendant on an active military life, I have settled here. . . . I must now come to the subject of my letter. You already know, probably, that a paper on the influence of electricity was brought before the *Academie des Science* on the 7th, as a new subject, by Dr. Pallas, in Paris. . . . I have told several persons who have spoken to me on the subject, that I considered you had the right of priority to the discovery; and if you wish to establish your claim, you must not delay the transmission to the academy of any printed documents you may possess, and I trust you will not think it troubling me if the little that lies in my power can be of any use to you.

"Several members of the Academy are ready to support your claim on the first occasion. . . . They all felt its right."

Effects of Electricity on the Human Organism, 1847.

"M. Pallas, chief physician of the French armies in Algeria, communicated to the Academy of Sciences, the results of his most recent researches as to the influence of atmospheric and terrestrial electricity on the organism, and as to the power of insulation in modifying its injurious effects. He concludes his researches by the following summary of results:—

" '1. The greater number of diseases, and more particularly those which involve the nervous system (belonging to the class of neuroses,) are caused by the excessive influence of general electricity, of which stormy clouds and marshy localities are the most abundant sources.

" '2. Marshes, by their geographical constitution, and their effects on the animal economy, offer the greatest analogy to the galvanic pile. Indeed, their noxious action is by so much the more formidable, as the water which exists in them holds in solution organic or saline matters; and this explains why salt-water marshes, and those near the sea-coast, are more especially injurious to the health. The drying up of marshes, or their submersion, presents us with similar conditions, as when a galvanic pile is deprived of its liquid, or totally immersed; in either way its action being rendered insignificant, or being quite annulled.

" '3. The works of physicians and physiologists have demonstrated that electricity produced by machines has a special action on the nervous system. Experience and rigorous observation of facts prove, that the maladies which are developed in the proximity of marshes are always, primarily, of a nervous type; and that when they become inflammatory, it is by the reaction of the nervous system on the heart and entire vascular system, whence arise, consecutively, local or general inflammations.

" '4. Nervous maladies and intermittent fevers being occasioned, not by the action of a miasma, which has never been detected either in the air or in the water of marshes, but by the excessive (exaggerated) influence of electricity, some means which have in view the modification of this morbid influence, should naturally and rationally be preferred.

" '5. Electrical insulation happily fulfils this indication. The insulation may readily be effected, by fitting on to the ordinary forms of beds, feet made of glass or of resin. A great number of observations have demonstrated to M. Pallas, that all the sick who have been thus insulated, have been cured or relieved of their severe diseases, many of which had previously resisted all known means of cure'

" The plan of treatment here advised, has the strong recommendation of cheapness and the avoidance of trouble; but we fear that neither the treatment, nor the hypothesis on which it is built, will bear the test of experiment and experience. The

prevalent and active source of so many diseases which infest mankind, and which M. Pallas thinks to be found in electricity, we should rather admit to be hidden at present; but judging from what we do know of the laws to which even this subtle agent, the source of fevers, &c., must conform, there is a probability against its being electricity, and in favour of its being a miasm issuing from the earth under certain conditions, and we may, perhaps, proceed so far as to predicate a peculiar electrical state, as one of those conditions. Neither is it any argument against the existence of a miasm, that it has never hitherto been made cognizant to our senses, save by its effects, as brought forward by M. Pallas."—*Lancet, June 26th*, 1847.

E.

"*Extraordinary and Important Discovery—Cholera a consequence of Deficient Electricity.*

"We think it our duty to lay before the public a translation of the following important letter, addressed by M. Andraud to the President of the Academy of Sciences, on the relations believed by him to subsist between the presence of cholera and a want of electricity in the atmosphere. The subject is of the last degree of importance, and deserves the immediate and serious consideration of all persons engaged in staying the ravages of the plague:—*Historic Times.*

"'Paris, 10th of June, 1849.

"'Monsieur the President—During the past three months, in which the city of Paris has been afflicted in greater or less degree with cholera, I have been led, in consequence of the variable intensities which characterise the disease, to make daily observations on the action of the electric machine, in order to ascertain whether a certain relation does not subsist between the more virulent seasons of the scourge and a low state of electricity in the atmosphere.

"'The machine used in these observations was a powerful one, giving, after two or three revolutions of the cylinder, sparks of five and six centimetres intensity.

"'These results belonged to ordinary weather, and to the periods which marked the first capricious appearances of the disease; but from the time the epidemic became general, I was no longer able, on any single occasion, to produce a corresponding effect. During the months of April and May sparks could only be procured after violent action, and never then exceeding a power of two or three centimetres. These fluctuations, ranging as they did through degrees of difference so important in amount, were then observed to coincide most exactly with the fluctuations of the cholera. Was extent and malignity of the disease wide and fatal, the electricity of the atmosphere was observed to be in an inverse proportion, weak and uninfluential. These striking results afforded me strong presumption that I was on the eve of making the discovery I had long before suspected. Nevertheless, I was afraid of at once coming to the conclusion to which the experiments pointed, lest the irregularities of the electric machine should have been occasioned by the hygrometic state of the atmosphere.

"'Thus warned, I waited with impatience the arrival of fine weather, and the heats of the summer day, to enable me to continue my observations. At length these requisites were granted. But, far from the previous indications of the machine showing any signs of diminution, they only became stronger; for, although with the improved weather an augmentation of electricity might have been expected, in a few days the signs of its presence ceased altogether. On the 4th, 5th, and 6th of June, it was only possible to obtain a slight "crepitation," without sparks; and on the 7th the machine became "dumb." This singular decrease in the electric element fatally accorded with a consentaneous increase of the cholera. As the one subsided the other increased. My surprise in making this discovery was only equalled by the solemnity with which I regarded its consequences to mankind. The conviction of the moment was irresistible. With the cause, I had possibly found a clue to the cure of the most dreadful of maladies. It may be comprehended with what anxiety I continued to watch the indications of the machine—sad and faithful interpreter of a great calamity. On the 8th, in the morning, some feeble sparks reappeared, and from hour to hour their number and intensity increased. I regarded the symptoms with joy. I felt that the vivifying fluid was once more returning to

give life and health to the air we breathe. I was not mistaken, for in the course of the day a storm announced to plague-stricken Paris, that electricity had once more entered on its dominion. The phenomenon, terrible to the ignorant, had no fears for me. To my apprehension, the loud thunders seemed to proclaim that cholera was disappearing before the power whose absence had first evoked its existence.

"'On Saturday, the 9th, I returned to my observations. Disturbed nature had recovered its equilibrium. At the slightest touch the machine gave forth sparks in such abundance that, in moments of grateful excitement, I could almost have imagined them to rejoice in the good news of which they were the bright exponents. Meantime, the cholera was rapidly subsiding.

"'Under these deeply interesting circumstances, I have thought it my duty to make known to the Academy the simple facts on which the discovery rests. It seems to admit of demonstration that the Creator has mingled with the atmosphere an amount of electricity which is essential to the maintenance of health and life; and it appears to be equally capable of proof, that from the operation of some unknown cause, this vast circumambient fluid becomes occasionally subjected to decrease or exhaustion. What happens in such a case? Everybody suffers. Those who carry within them a sufficient stock of "personal electricity" resist the fatal influence; but those who only find existence in drawing the vital element from the common atmosphere—that atmosphere no longer containing it—perish.

"'The discovery which I have thus had the honour of bringing under your notice may not only indicate the cause of cholera, but also that of every other epidemic which afflicts humanity. If this were recognised to be the fact—as in all probability is the case—medical science would at once be armed with a means of combating their further progress. The cholera is for the present stayed, but should it return, the galvanic battery may be found its best antidote. Meantime, I may hope you will cause attention to be given to the subject.

"'(Signed), ANDRAUD.'"

"*Electricity the Cause of Epidemics generally.*

"TO THE EDITOR OF THE NORTHERN WHIG.

"SIR—I have seen, this day, an extract in your paper, from *the Times*, of Monday, containing the letter of M. Andraud, to the French Academy, in which he gives some corroborative statements that electricity is the exciting cause of cholera, and he therein claims, to a certain degree, the merit of having made this discovery. I am induced, from a sense of what is due to others, as well as to myself, to address a few lines to you, for insertion in your widely-circulated paper. Though M. Andraud has done much to deserve praise, for his clear and convincing experiments, he, nevertheless, cannot be considered as the person who has discovered the wonderful effect which electricity exercises over the animal economy—in fact, this is a circumstance which has, long since, attracted the attention of medical men, not only in England and Ireland, but on the Continent. So far back as the last epidemic of '32, several gentlemen published papers in the medical journals of the day, taking this view of the epidemic. However, the chief praise is due to Sir James Murray, of Dublin, and a Mr. Atkinson, of London. The former of these gentlemen, published in 1832, and again, in the month of August, of last year, a series of essays in *The Lancet*, in which, in the most convincing manner, he has proved, by a number of experiments, that electricity gives rise not only to cholera, but to several other diseases and epidemics. Mr. Atkinson, also, has been a very laborious investigator in this science. I myself have long since adopted this view of the production of epidemics, and, on the first Monday of March, of this year, I read a paper on the 'Influence of Electricity over the Animal Economy,' before the Lurgan Literary Society, in which I gave a *resume* of the various experiments bearing on the point, and general directions as to the measures which should be pursued to keep up a sufficient supply of electricity in the human body. My views were, many of them, considered visionary, and, as one gentleman expressed them, absurd. I am, therefore, pleased to find that the subject is now heing investigated more fully, by persons better capable of arriving at proper conclusions than I could at all

expect to attain to. I would here take this opportunity, as I regret to find the epidemic considerably on the increase, in my neighbourhood, of recommending, as a preventive, a medicine which, from experience in my own person, and from the testimony of numbers who have used it, on my recommendation, I have no hesitation in declaring (that if more generally known and employed) would save numbers from an attack of the disease—it is camphor mixture, taken in the quantity of a wine glassful two or three times a day—*the rationale of which is very simple, namely, that of all the known substances employed in the treatment of cholera, it is the one most capable of supplying the electricity which is passing off from the patient during the stage of collapse. It is, as is well known, one of the most highly electrical substances as yet discovered.* A very nice form of it can be obtained, under the name of Murray's Fluid Camphor.

"I remain, Sir,

"Your obedient servant,

"R. J. MacCormack, M.D.

"Portadown, June 28, 1849."

The following is the paper of Mr. Atkinson, alluded to by Dr. MacCormack. The results differ from those of the author in some respects.

From J. C. Atkinson, Esq.:—

"I am desirous at the present moment of directing the attention of your numerous scientific readers to a very interesting phenomenon, more or less present in the collapse stage of cholera, which seems to have hitherto escaped the observation of medical men—viz., animal electricity, or phosphorescence of the human body. My attention was first attracted to the subject during the former visitation of that fearful disease in the metropolis. It was indeed singular to notice the quantity of electric fluid which continually discharged itself on the approach of any conducting body to the surface of the skin of a patient labouring under the collapse stage, more particularly if the patient had been previously enveloped in blankets; *streams of electricity*, many averaging *one inch and a half* in length, could be readily educted by the knuckle of the hand when directed to any part of the body, and these ap-

peared, in colour, effect, crackling noise, and luminous character, similar to that which we are all accustomed to observe when touching a charged Leyden jar. I may remark the coincidence, that simultaneously with the heat of the body passing off, the electricity was evolved; and I am therefore led to ask the question—Are not heat, electric and galvanic fluids, *one* and the same thing? Does not the fact of the passing off of both imponderable substances at one and the same time strengthen this conclusion?

"Again: are not the whole of what we call *vital* phenomena produced by certain modifications of the electro-galvanic-magnetic matter and motions? and do we not find that these *vital* phenomena are continuously affected by the relative state of the surrounding electric medium? To what can we attribute the present fluctuating condition of the barometer, if not to it?

"We *know* what wonderful *decomposing* action galvanism had on alkalies, under the hands of the illustrious Humphry Davy; but we do *not know*, nor have we any conception in the present state of knowledge, of the *decomposing* action of the electric matter of the atmospheric air, in various conditions, on the fluids generally of the animal body. Chemistry has failed in pointing out any ponderable material as the exciting cause of epidemic diseases.

"In the treatment of cholera all are agreed that *non-conducting* substances on the surface of the skin aid essentially the cure; and during the disturbed state of the atmosphere, for the purpose of retaining the electricity continually eliminating in the system, we are told to wear woollen bandages, flannel, and gutta percha soles, so as to insulate as much as possible the body, to prevent the heat —the electric fluid—from passing off."—*Lancet, Nov.* 4, 1848, *p.* 504.

F.

THE ASIATIC CHOLERA TRACEABLE TO CERTAIN ELECTRIC INFLUENCES.

To the Editor of the Boston Medical and Surgical Journal.

Sir,—Since the publication of an article written by me, which appeared in your Journal of the 29th of November, 1848, an ela-

borate paper by Sir James Murray, entitled "Deductions from Experiments on the Nature of Cholera and other Epidemics," has reached this country in the columns of the London Lancet; and you may imagine the gratification with which I find my views of the causes, nature, and treatment of the Asiatic Cholera, fully sustained by the observation and deductions of this writer. Sir James has completely exploded the antiquated theory of miasmatic influences, and says that experience has led him to adopt the "*electric* doctrine."

Doubtless you will lay before your readers as copious an abstract of this admirable article—of itself containing material for a large treatise—as your space will admit; but in the mean time permit me to quote a few sentences expressive of the decided views which Sir James entertains in favor of that theory which I had—at a great distance, both as regards place and ability—humbly ventured to offer to the consideration of your readers. Sir James says:—

"Being satisfied, by many *trials* and *observations*, that electro-galvanic disturbance, or want of equilibrium, was at least a *principal exciting cause* of periodical or symmetrical diseases."—"Next, it may be supposed from the accumulation of black, magnetized blood in the veins, and the disordered signs of shocks in the eighth pair of nerves, and from other pathological appearances, that severe electric commotions were at work, producing cholera."—"Here I may briefly remark, of imitative and infectious diseases, that they are much more probably owing to electric disorders."—"Were this doctrine of *electric equivalents* to displace the theory of infection, *odious quarantines would cease to punish the innocent, and relatives would not abandon their helpless friends in time of need.*"—"The definite proportions of derangement of natural electricity, occasion definite proportions of epidemic diseases."—"The intensity of the globe's magnetism, varies at different points of its surface."—"It is said, however, that the needle *did not obey these natural attractions in Russia*, during the late awful visitation of the cholera."—"Hence we must suppose currents of electricity to circulate *within the earth*, more especially near its surface, and to be constantly passing from east to west."—"For all these reasons, and many others, I hope I am justified in attempting to point out physical relations between epidemic diseases and disturbed electricity or magnetism."

It is to be concluded, that the judicious use of long-continued galvanic passes through the respiratory and spinal nerves, is one of the most essential adjuvants that can be employed during collapse," &c. &c.

"Throughout the whole paper, Sir James triumphantly demonstrates the connection between pathological disease and electrical disorder. Every reader must be convinced by this demonstration. Meanwhile, commending this vast subject to your attentive consideration and that of your readers, I am, &c.

"A. C. CASTLE, M.D.

"*New York, Jan.* 9, 1849."

Whilst this Appendix is passing through the press, the last *Lancet*, July, 1849, furnishes the following proofs that (although disagreeing with the views of the able editor) public attention is beginning to turn to the all-pervading powers of *electricity*, which I hope yet to see *extended to my doctrine of pathological changes, caused by changes of atomic galvanic proportions or equivalents among living elements and atoms.*

"The connexion of cholera with an altered electric condition of the atmosphere has long been a favourite idea with speculators on the causes inducing the disease. According to Dr. Chambers—

"'The air in every country which has been scourged by the disease has been unusually charged with electricity, as has been evinced by the extraordinary occurrence of thunder-storms and hurricanes, at unusual seasons, and of frequent and severe earthquakes in the countries where such phenomena are common:' and according to Mr. Orton, who published an essay on the epidemic cholera of India about the same time, and of whom Dr. Chambers makes honourable mention, 'the air most favourable to the production of cholera is in a highly rarefied state, and with respect to its electricity is negative, a phenomenon which is in ordinary times a sure prognostic of storms.'

"Mr. Ambrose Blacklock, of the Madras Medical Establishment, tells us, in his pamphlet on cholera, [which we noticed in No. 1 of the present volume,] that 'there is abundance of electricity in the air at such times, but it is not free electricity, and cannot, therefore, act as a healthy stimulant to the respiratory surfaces, nor excite the spinal respiratory bodies;' and,

further on, he says, 'to me it appears clear that Asiatic cholera is the result of high excitation of the ganglionic system, owing to moist air with latent electricity acting on the human body deficient at the time in forming sulphuretted hydrogen; and that the immediate cause of its occurrence is the want of excitability in the spinal respiratory bodies, from there being no free electricity in the atmosphere, at the moment, to excite the respiratory surfaces.'

"Mr. T. Weeden Cooke, in a letter to the Editor of *The Times*, stated that—

"'One of the Tooting children was seized with cholera in the Royal Free Hospital. The patient was a girl about eight years old, under Dr. Peacock's charge. In about four hours she became completely collapsed, the power of deglutition had ceased, and consequently all internal remedies were useless. Dr. Peacock applied one pole of the galvanic machine over the heart, the other over the region of the stomach, or rather of the solar plexus. In half a minute the child began to rally, some strong beef tea was got into her stomach in less than ten minutes, and ultimately the resurrection was complete.'

"Mr. Blacklock asserts in his pamphlet (p. 37) that—

"'The sure method of restoring vital heat is to excite the respiratory muscles by sending an electro-magnetic current from the spinal respiratory bodies to the diaphragm. To accomplish this, have each wire of the machine furnished with a thin, circular, very soft metal plate—one plate two inches square for the positive wire, the other at least six inches square, for the negative wire, and attached to the end of the wire by a small eye, like the eye on the reverse of a button. Bandage the positive plate to the upper part of the nape of the neck, and the negative plate to the upper part of the epigastrium; and then imitate the natural respiratory current by having the battery well charged, and the break of the machine so arranged that the succession of shocks will occur at the most about twenty-five times in a minute.'

"He adds, in a marginal note, that—

"'Oxygen has often been recommended as a remedy in cholera; but it is not nearly so much required as stimulation by electric impulsion. There is enough of oxygen in the air at the worst cholera periods; but there is no free electricity then to

cause it to be combined intimately with carbon.'"—*Lancet, July*, 1849.

"*To the Editor of the Evening Mail.*

"Limerick, June 27, 1849.

"Sir—As the connexion of cholera and electricity is at the present moment engaging much attention in scientific circles, perhaps you will allow me to state a fact of no little interest. About the time of the decrease of that fearful epidemic in this city, I had a magnet mounted to test the matter; but before it was properly arranged the disease declined. The magnet carries 70lbs. On cholera appearing in Dublin, the magnet quite suddenly lost its power, and the instrument only carried about 10lbs. Since then it has been gradually going back to its former condition. There seems, in fact, some very evident connexion, notwithstanding the distance. My electric friends in the University will see, however, the distance is nothing; the same thing has been observed in Petersburgh and in Paris, but stoutly denied the other day in Brussels. As Dublin has been celebrated for its electrical discoveries, perhaps you will excuse my troubling you.

"Yours very truly,

"Charles Kidd."

Last year the curious and interesting remarks of *M. Brydone* were brought to the author's notice. Had Mr. Brydone been aware of the relation between the *definite atomic equivalents* of *electricity* of every living thing, or every particle of living things, his reasoning might long ere this have been listened to.

The author's experiment on elevated places in Italy confirms in many particulars the interesting letters of P. Brydone in his Tour through Sicily and Malta.

"I found the magnetical needle greatly agitated near the summit of the mountain, (the Padre della Torre told me he had made the same observation on Vesuvius); however, it always fixed at the north point, though it took longer time in fixing than below. But what Recupero told me happened to him was very singular. Soon after the eruption, 1755, he placed his compass on the lava. The needle, he says, to his great astonishment, was agitated with much violence for some considerable

time, till at last it entirely lost its magnetical power, standing indiscriminately at every point of the compass; and this it never after recovered, till it was again touched with the loadstone.

"I found that round Nicolosi, and particularly on the top of Montpelieri, the air was in a very favourable state for electrical operations. Here the little pith-balls, when isolated, were sensibly affected, and repelled each other above an inch. I expected this electrical state of the air would have increased as we advanced on the mountain, but at the cave where we slept, I could observe no such effect. Perhaps it was owing to the exhalations from the trees and vegetables, which are there exceedingly luxuriant, whereas about Nicolosi, and round Montpelieri, there is hardly anything but lava and dry hot sand. Or perhaps it might be owing to the evening being farther advanced, and the dews beginning to fall. However, I have no doubt, that upon these mountains formed by eruption, where the air is strongly impregnated with sulphureous effluvia, great electrical discoveries might be made. And, perhaps of all the reasons assigned for the wonderful vegetation that clothes the mountain, there is none that contributes so much towards it as this constant electrical state of the air; for, from a variety of experiments it has been found, that an increase of the electrical matter adds to the progress of vegetation. It probably acts there in the same manner as on the animal body; the circulation we know is performed quicker, and the juices are driven through the small vessels with more ease and celerity. This has often been proved from the immediate removal of obstructions by electricity; and probably the rubbing with dry and warm flannel, esteemed so efficacious in such cases, is doing nothing more than exciting a greater degree of electricity in the part; but it has likewise been demonstrated, by the common experiment of making water drop through a small capillary syphon, which the moment it is electrified runs in a full stream. I have, indeed, very little doubt, that the fertility of our seasons depends as much on this quality in the air, as either on its heat or moisture.

"Electricity will probably soon be considered as the great vivifying principle of Nature, by which she carries on most of her operations. It is a fifth element, distinct from, and of a superior nature to, the other four, which only compose the

corporeal parts of matter: but this subtile and active fluid is a kind of soul that pervades and quickens every particle of it. When an equal quantity of this is diffused through the air, and over the face of the earth, every thing continues calm and quiet; but if by any accident one part of matter has acquired a greater quantity than another, the most dreadful consequences often ensue before the equilibrium can be restored. Nature seems to fall into convulsions, and many of her works are destroyed: all the great phenomena are produced—thunder, lightning, earthquakes, and whirlwinds; for I believe there is little doubt that all these frequently depend on this sole cause. And again, if we look down from the sublime of nature to its minutiæ, we shall still find the same power acting, though perhaps in less legible characters; for as the knowledge of its operations is still in its infancy, they are generally misunderstood or ascribed to some other cause. However, I have no doubt that in process of time these will be properly investigated, when mankind will wonder how much they have been in the dark. It will then possibly be found, that what we call sensibility of nerves, and many of those diseases that the faculty has as yet only invented names for, are owing to the body's being possessed of too large or too small a quantity of this subtile and active fluid—that very fluid, perhaps, that is the vehicle of all our feelings, and which they have so long searched for in vain in the nerves; for I have sometimes been led to think that this sense was nothing else than a slighter kind of electric effect, to which the nerves serve as conductors, and that it is by the rapid circulation of this penetrating and animating fire that our sensations are performed. We all know that in damp and hazy weather, when it seems to be blunted and absorbed by the humidity—when its activity is lost, and little or none of it can be collected—we ever find our spirits more languid, and our sensibility less acute: but in the sirocco wind at Naples, when the air seems totally deprived of it, the whole system is unstrung, and the nerves seem to lose both their tension and elasticity, till the north or west wind awakens the activity of this animating power, which soon restores the tone, and enlivens all nature, which seemed to droop and languish during its absence.

"It is likewise well known that there have been instances of the human body becoming electric without the mediation of

any electric substance, and even emitting sparks of fire with a disagreeable sensation, and an extreme degree of nervous sensibility.

"About seven or eight years ago, a lady in Switzerland was affected in this manner, and though I was not able to learn all the particulars of her case, yet several Swiss gentlemen have confirmed to me the truth of the story. She was uncommonly sensible of every change of weather, and had her electrical feelings strongest in a clear day, or during the passage of thunder-clouds, when the air is known to be replete with that fluid. Her case, like most others which the doctors can make nothing of, was decided to be a *nervous* one; for the real meaning of that term I take to be only that the physician does not understand what it is.

"Two gentlemen of Geneva had a short experience of the same sort of complaint, though still in a much superior degree. Professor Saussure and young Mr. Jalabert, when travelling over one of the high Alps, were caught amongst thunder-clouds, and, to their utter astonishment, found their bodies so full of electrical fire, that spontaneous flashes darted from their fingers with a crackling noise, and the same kind of sensation as when strongly electrified by art. This was communicated by Mr. Jalabert to the Academy of Sciences at Paris, I think in the year 1763, and you will find it recorded in their memoirs.

"It seems pretty evident, I think, that these feelings were owing to the body's being possessed of too great a share of electric fire. This is an uncommon case; but I do not think it at all improbable that many of our invalids, particularly the hypochondriac, and those we call *malades imaginaires*, owe their disagreeable feelings to the opposite cause, or the body's being possessed of too small a quantity of this fire; for we find that a diminution of it in the air seldom fails to increase their uneasy sensations, and *vice versa*.

"Perhaps it might be of service to these people to wear some electric substance next their skin, to defend the nerves and fibres from the damp or non-electric air. I would propose a waistcoat of the finest flannel, which should be kept perfectly clean and dry, for the effluvia of the body, in case of any violent perspiration, will soon destroy its electric quality. This should be covered by another of the same size of silk. The animal heat,

and the friction that exercise must occasion betwixt these two substances, produce a powerful electricity, and would form a kind of electric atmosphere around the body, that might possibly be one of the best preservatives against the effect of damps.

"A good strong head of hair, if it is perfectly clean and dry, is probably one of the best preservatives against the fire of lightning. But so soon as it is stuffed full of powder and pomatum, and bound together with pins, its repellent force is lost, and it becomes a conductor.* But I beg pardon for these surmises; I throw them in your way only for you to improve upon at your leisure, for we have it ever in our power to be making experiments in electricity. And although this fluid is the most subtile and active of any we know, we can command it on all occasions; and I am now so accustomed to its operations, that I seldom comb my hair, or pull off a stocking, without observing them under some form or other. How surprising is it, then, that mankind should have lived and breathed in it for so many thousand years, without almost ever supposing that it existed. But to return to our mountain.

"So highly electric is the vapour of volcanoes, that it has been observed in some eruptions both of Ætna and Vesuvius, that the whole track of smoke, which sometimes extended above a hundred miles, produced the most dreaded effects —killing shepherds and flocks on the mountains, blasting trees, and setting fire to houses, wherever it met with them on an elevated situation. Now, probably the flying of a kite, with a wire

"* Since the writing of these letters, the author has made some experiments on the electricity of hair, which tend still to convince him the more of what he has advanced. A lady had told him, that on combing her hair in frosty weather, in the dark, she had sometimes observed sparks of fire to issue from it. This made him think of attempting to collect the electrical fire from hair alone, without the assistance of any other electrical apparatus. To this end he desired a young lady to stand on a cake of bees' wax, and to comb her sister's hair, who was sitting on a chair before her. Soon after she began to comb, the young lady on the wax was greatly astonished to find her whole body electrified, darting out sparks of fire against every object that approached her. The hair was extremely electrical, and affected an electrometer at a very great distance. He charged a metal conductor from it with great ease, and in the space of a few minutes collected as much fire immediately from the hair as to kindle common spirits; and by means of a small phial, gave many smart shocks to all the company. A full account of these experiments was lately read before the Royal Society. They were made during the time of a very hard frost, and on a strong head of hair, where no powder or pomatum had been used for many months."—*Brydone's Tour through Sicily and Malta, p. 33, Edition*, 1849.

round its string, would soon have disarmed this formidable cloud. These effects, however, only happen when the air is dry and little agitated; but when it is full of moist vapour, the great rarefaction from the heat of the lava generally brings it down in violent torrents of rain, which soon convey the electrical matter from the clouds to the earth, and restore the equilibrium."

At page 75 some communications to Dr. Simpson, of London, and subsequently to the philanthropist, G. Alfred Walker, Esq., were alluded to.

The following are the natural objections to *intra-mural interments*, as a devastating source of exhausting the vital electricity of the *living* during the decomposing galvanism of the *dead*.

The annexed remarks were sent by the author to G. A. Walker, Esq., of London, in order to aid his humane efforts to arrest the baneful practice of *intra-mural* interments.

"Sir James Murray gladly sends the annexed notes to Mr. Walker, in the hope they may aid his humane efforts in the cause of the most needful sanatary reform.

"The best explanation of the doctrine, first promulgated by the writer—That the severity and danger of epidemic diseases are in the direct ratio of the derangement of the electrical equivalents, proper to living bodies, will be more clearly understood by a perusal of experiments on that topic, now in the press.

"The exertions which you have made to prevent depositing the dead among the living, entitle you to every suggestion capable, even in the smallest degree, of assisting you to terminate the revolting practice of interments in towns.

"If the love of *common decency* cannot shame our municipal authorities, the fear of *common danger* ought to awaken them to a sense of respect for Christian burial and public safety. Should other considerations fail to reform the odious habits of cities and towns, the light of science should be made to shine upon selfish and slovenly officials in such a manner as to expose them to merited odium for their obdurate persistance in hateful errors. Let any of the advocates of inter-mural grave-yards employ accurate electricians, with delicate instruments, to measure the terrible galvanic derangements of fermenting churchyards; then they must be convinced of their fatal practices. Every decomposing human body deposited there, is hourly altering and disordering the electric fluid of that locality, which otherwise ought to be, in its

normal integrity, fit to maintain the natural proportion of the same fluid in living beings, in the vicinity. When the organic elements of dead animals are resolving into kindred dust, that decomposing mass acts as a feeder for a vast display of galvanic actions in the moist grave, as certainly as an acid liquor sets loose a flood of electric fluid in a galvanic battery. As an untoward generation of disturbed electric agency is constantly at work in the continuous cauldron of dissolving graves, its action must be felt by the living, in proportion to the vicinity and intensity of the galvanic disturbances. I had long since communicated to your friend *Dr. Simpson*, the result of my observations on the direful consequences resulting from an effervescing Golgotha, long kept in active fermentation in Belfast, near the quays, and on a level with low water mark. This grave-yard was bounded on three sides by streets and lanes, and the houses adjoining opened into it. I was for many years the medical attendant chiefly employed by the residents of that district, and can safely affirm that they were generally unhealthy and liable to bowel complaints, influenza, fevers, English cholera, scrofula, and other diseases of debility, whilst the people on the opposite sides of the same lanes or streets were comparatively healthy, and exempt from the continual scale of epidemic disorders, which merged into each other, according to the lethal activity of the galvanic passes in continual operation by the accession of new bodies, and by being in actual contact with the communicating tenements adjoining the churchyard. During all these years I had many proofs demonstrating, that persons in these tenements could not be efficiently electrified, because the best machines could seldom produce sparks of any intensity. During these years I often noticed, that a magnet capable of sustaining fifty pounds with ease in other situations could not for a moment suspend an iron of ten pounds in the habitations built on the devastating place of interment. From these, and many other observations, it was plain that negative electricity pervaded this vast swamp, and drew away the positive electricity from the living creatures in immediate contact with the damp earth and air of that fatal and extended trough, or galvanic battery. On such practical trials, experiments, and facts, were founded the deductions which were laid before the public in 1832, showing that, as the proximate principles which constitute animal mater, are composed of ultimate essential elements, and as

these elements combine in certain *specific proportions*, so every such atom is endowed with, perhaps surrounded by, a film of electricity also in *definite proportions*, and that whilst the natural balance remains in the atomic integrity, the union, functions, and normal health of our constituent principles is maintained, and the molecules of which our fabric is constituted are sustained in the right relations of life. But, on the contrary, where a resolving mass of organic matter is disturbing the natural store of galvanism, either in the earth under us, or in the air around us, our natural stock of vital electric fluid is disturbed directly as the distance decreases—we suffer in proportion as we are deprived of the due share of that element that preserves our health. Persons enjoying abundance of electric energy may escape these lethal passes of it for a time; others, reduced by bad diet, bad air, bad clothes, or bad locality, cannot endure a loss of any electric atoms without a proportionate loss of power, bodily or mental. As I observed in the *Lancet* last year, the galvanic influence of which they are deprived, occasions gradations of ailments or epidemics which assail living beings, and these epidemic gradations run from bad to worse, in proportion to the electric derangements of the atomic equivalents of that all pervading fluid. In these damp and sunless islands we have already too many *foci*, generating broken balance of electricity both in the swampy ground and the misty air. Filthy lanes, hovels, and factories, crowded cellars, wet floors and walls, bad drains and cess-pools, and pent-up gases and exhalations in obstructed sewers, create quite enough of one kind of galvanic element to rob weakly plants and animals of the other kind. We have evils enough without adding vast *troughs* of fermenting *cemeteries* in the *heart of towns*, to decompose and deprive us of that living principle and *true vital fluid* or agent, that, in its allotted perfection and equivalent proportions, maintains and regulates the equivalent proportions composing all living beings. Whilst so many vast generators of disturbed galvanic action are everywhere in energetic operation, creating and conveying unequal electric passes, and exhausting vital electricity, it is inhuman to permit wide-spread artificial PILES of INTENSE VOLTAIC ACTION to be *charged* every hour under our doors and windows.

"It is monstrous to keep the *receptacles of the dead*, emitting misty torrents from their decomposing cells, to rob the living of

their natural stock of *that fluid which preserves their nerves and entire systems in due tone and energy.* Here I may mention, that the pestilences and galvanic malaria, generated by the extensive cemetery in Belfast, has long since ceased its voltaic emissions. The spirited inhabitants of that enlightened town closed up the horrid reservoir, and the vicinity is now comparatively healthy.

"As remedial measures for warding off the unequal intensity of disturbed electricity in existing cemeteries, the *equilibrium* of galvanism will be best restored and preserved, by the erection of numerous *copper pipes* or *wide tubes*, reaching high into the air, as set forth in the *Lancet*, September and October, 1848. These pipes are intended to convey positive electricity from the air above, where it abounds, to the earth below, where it is deficient. They are easily affixed, perpendicularly, to walls, posts, or monuments, like spouts to houses. By such means I was able to balance and restore the equilibrium of galvanism in the rice grounds of Lombardy, and the fens and marshes near the shores of Tuscany.

"With every wish for the success of your endeavours, I remain yours truly,

"J. Murray."

INDEX TO PART I.

INFERENCES DEDUCIBLE FROM PRECEDING NOTES.

Browne & Nolan, Printers, 21, Nassau-street.