No. VI.

Memorandum on Asiatic Cholera and other Epidemics as influenced by Atmospheric Impurity. By Dr. Arnott.

1. In the year 1817, a destructive pestilence, now called Asiatic Cholera, sprang up near the mouths of the Ganges, and, spreading by human intercourse or otherwise, at last visited almost every country on earth, remaining in any one locality however only for a limited time, proportioned generally to the size or the population, but repeating its visits after irregular intervals of years. Because in its modes of attack and diffusion it differed much from other known epidemics, it at first excited unusual consternation, but observation has now clearly ascertained that the travelling morbific cause, whatever it be, can no more produce a true pestilence, unless it meet with much filth of decomposing animal and vegetable matters —of which air which has served for respiration is one kind—than coal gas can produce an explosion without being mixed with many times its volume of common air, or than sulphur alone can produce the effects of gunpowder when not mixed with the certain known proportions of nitre and charcoal. It thus appears that the ravages of Cholera may be prevented, by preventing local accumulations of organic impurities.

2. To many persons hearing this statement for the first time the reflection will occur that the laborious researches of medical men and others, in regard to Cholera, have detected many other things or conditions besides filth which exert powerful influence on the spreading and destructiveness of the disease; but a careful analysis of these particulars shows them all to belong to two classes, of which the one is of things which favour the accumulation of filth and its rotting or decomposition into foul effluvia, and the other is of agents which weaken the living system, and render it more susceptible of harm from filth or other cause. Of the first class are—

1. Whatever gathers filth or impedes its removal, as cess-pools and imperfect drains.
2. Warmth (favouring decomposition).
3. Damp or moisture (with similar effects).
4. Hot, wet seasons.
5. Low river sides and sea shores; marshy levels.
6. Sea ports.
7. Crowds of people in houses, ships, &c.
8. Enclosed places without ventilation.
9. Calm weather, &c.

Of the second class, which weaken the system, are—

1. Intemperance of all kinds.
2. Debauchery.

3. Fatigue of body or mind.
4. Deficient food or long fasting.
5. Bad food, or drink, or air.
6. Depression of mind.
7. Uncomfortable dwellings.
8. Poverty, &c.

None of the particulars of either class, alone or combined, are in this country sufficient to cause Cholera, unless the epidemic influence which travels be also present.

3. Now the principal and in many cases the only source of the noxious impurities, above referred to, is the living body itself, converting into poisonous refuse the whole amount of the animal and vegetable substances which it takes as food. No portion of these substances is, according to the vulgar notion, altogether consumed or annihilated, but the whole is again, after a certain time, discharged from the system as excrementitious matter, solid, liquid, or aeriform, all these being then pernicious to health if used a second time. The fact is by many persons little suspected, that a very large part of the solid food swallowed is discharged from the lungs as invisible carbonic acid gas and other exhalation; the quantity of the solid carbon or charcoal element of food so escaping in twenty-four hours from a healthy man being from eight to twelve ounces. Now, even brutes, moved by instinct or annoyance to their senses, fly from or hide the refuse of their bodies, and men living together in civilized communities soon come to employ scavengers, drainage, &c., and other means to remove the more obvious impurities, while the wind, the warmth of the breath, and occasionally some artificial ventilation, aid in removing what is aeriform. In few instances, however, as yet have these means been rendered perfect.

4. The department of the art of cleansing, which remains the most imperfect, is that of ventilation. The reasons of this are,—that air, under common circumstances, is invisible; that scarcely 200 years have passed since scientific men suspected that air was at all a ponderable space-occupying substance, and only in our own day, since air has been used as stuffing for air-pillows, and one kind, with the name of coal gas, has been sold by measure from pipes, as water is, have people generally conceived of it as being truly a *thing;* that only about 100 years ago had even chemists learned that air or gas is not one unchangeable substance, but is one of the three forms called solid, liquid, and aeriform, which certainly many and probably all substances may assume under different degrees of heat, compression, and combination; that the particular substance, for instance, to which the name of *oxygen* has been given, since it was discovered by Dr. Priestly in 1783, which, in its separate state at the temperature of our earth, exists only as an air with which air-cushions may be stuffed, yet constitutes eight-ninths by weight of all the water on our globe, about a fourth of all the earth and stones, and a large proportion of the flesh and other parts of animals and vegetables; then men had not until lately reflected that solid or liquid filth in a house, if not swallowed in food or

drink, can be noxious only when it gives out part of its substance as foul effluvium to be breathed; and, lastly, men knew not that expired ordinary breath, which if inhaled again alone when recent or fresh may only suffocate by excluding fresh air, becomes, when stagnant or long retained in a place, in part, truly putrid or corrupt, as turtle soup or venison might change, and may then assume the forms of the different poisons which produce the gaol, the hospital, or the ship fevers, and other spreading diseases, or of that which, when joined with the peculiar morbid agents of small-pox, measles, scarlatina, or cholera, cause these to rage. Acquaintance with such facts, however, being once obtained, men can understand that ventilation is not of ordinary, but of paramount importance, for it can remove not only the breath poison of inmates, but also the foul air arising from all other sources, and so may act as a substitute for good drainage until there be time and opportunity to establish that. There is no liquid poison which may not be rendered harmless by copious dilution with fresh water, so there is no aerial poison of which the action may not be similarly influenced by dilution with fresh air.

5. It is important also here to remark that modern houses, since the introduction of close-fitting glass windows and of chimney flues with low openings for fire-places, have been rendered what persons ignorant of the nature of air could not suspect, namely, singularly efficacious traps for catching and long retaining all impure air or effluvium which may enter them from without, or be produced within them. Such airs, the exhaled breath for instance, being generally warmer and specifically lighter than the external air, are buoyed up towards the ceiling of rooms, where, if there be no outlet, they stagnate long, like oil floating on water, and are little disturbed by even copious streams of fresh colder and heavier air gliding along the floor from doors and windows to pass up the chimney flue. This truth is strikingly confirmed by such facts as the following:—the long time during which tobacco smoke, smell of dinner, and other odours remain in ordinary rooms; the fact that an ordinary bedroom, occupied by one or more persons, is, in the morning to a stranger entering it from the fresh air—a medical man, perhaps, called in urgency—always very offensive; that all sick rooms are usually thus offensive; that a person who in the early morning, before doors and windows have been opened, enters almost any house under the roof of which have been placed the foulest receptacles in nature—a closet with its cesspool and its drains, is forcibly struck by what is called the close disagreeable smell; the fact that many attacks of Cholera have occurred suddenly in the night, and even after calm sleep, in such closed houses, to persons who were apparently well when they went to rest; and, lastly, the important fact that the offensive atmosphere in all such cases is almost entirely prevented, or is quickly dissipated by an open window which admits fresh air to dilute the impurity, or better still by having an opening from the ceiling of the room into the chimney flue of a well-constructed fire-place, such as described in the paper on the smokeless

fire, lately published in the Journal of the Society of Arts, so that the strong chimney draught shall act as a constant air pump, withdrawing impurity from where it tends to accumulate. It may be remarked, that as a common gas pipe leaking into a close room, if undiscovered, soon converts the air of the room into the mixture of one part of gas and ten parts of common air, which in mines is called fire-damp, and is ready to explode at the instant of contact with a lighted candle, so a leak or source of impurity from drains, or crowded inmates in a close or unventilated room during a Cholera epidemic, may soon produce there what might be called Cholera-damp, ready on some accident to cause the outbreak of Cholera disease.

6. Effluvium from such filth as cesspools contain has, in past inquiries, been that most attended to, but there are many facts to show that the impurity of retained and corrupted breath, scarcely heeded in general, has been the chief element of the foul atmosphere which has led to numerous Cholera outbreaks. Thus, in England, it has been, in public institutions, clean to the eye, not very offensive to the nose, and where the inmates were well fed and well clothed, and otherwise well cared for under frequent public inspection, but where ventilation was overlooked and defective, that some of the most shocking scenes of destruction from Cholera have occurred; such was the school at Tooting, of 1,000 parish children, among whom about 300 cases of Cholera suddenly occurred, and killed more than half of those affected before the crowd was dispersed; and various union workhouses, lunatic asylums, prisons, &c., in London and elsewhere, were similarly visited; such places, in the end of 1849, produced more than half the cases of Cholera which then occurred, as is set forth (at page 37) in the very valuable Report on Cholera, drawn up by Dr. Baly and Dr. Gull, and issued by the College of Physicians. The very crowded school of the union-house at Taunton became a remarkable example, where thirty cases suddenly appeared in the room of the girls in which the glass of the windows remained entire, while in the adjoining room of the boys, where panes of glass were broken and fresh air was admitted, not a single case occurred; and there was only one other case in the whole town.

7. A large proportion of the facts set forth in the Report on Cholera above referred to, give strong support to the views here taken, as do also the details of other histories of Cholera wherever occurring. From the allied fleets in the Black Sea, late accounts have shown that Cholera had been much more destructive in the great three-decked ships, where the ventilation was more difficult, than in the ships of smaller size. In India, it has been found on several occasions, that in encampments where there was scanty accommodation, the putting an additional man into every tent has increased strikingly the mortality from Cholera. And almost everywhere, during attacks of Cholera, it has been found that the removal of persons from unventilated dwellings, in or about which were cesspools or other foul receptacles, to tents or other clean shelter on dry open ground has at once arrested the spread of the disease. The remarkable

fact, that scavengers and night-men, whose common work is among the rankest filth, but almost always in the open air, have rarely been affected by the disease, indicates the power of dilution of a poison to render it harmless. Some of these men, however, occasionally, on penetrating into close unventilated drains, have narrowly escaped suffocation, and, on coming out, have been attacked with violent vomiting and purging. This fact proves how rapidly aerial poison can enter the system to affect the intestinal canal, somewhat as in Cholera. Showing again, that even in the open air there may be concentration of poisonous effluvium sufficiently powerful to operate, Sir John Pringle, in his valuable work on the diseases of the English army which served in the Netherlands during the middle of the last century, narrates that in the camps and in warm weather destructive dysentery broke out among the men whenever they remained long in one place, and the privies became very foul; and that when fresh troops came to such a locality, great numbers were affected in the very first days.

8. With such facts in view as are set forth in the preceding paragraphs, all must perceive both the close dependence of men's health and well-being on the maintenance of purity of air within and about their dwellings, and the lamentable extent to which this object is missed in present ordinary procedure. The question, therefore, arises, Whether means can be placed within common reach of so diluting with fresh air and dispersing the copious aerial poisons generated wherever men live and work, as to render these impurities harmless? The answer to this question, it is hoped, may be given, that such means do exist, and that they are simple and inexpensive.

9. It might have been expected that the scientific men who first discovered the true nature of airs and their relations to the animal economy, would have been also the first to direct important applications of their knowledge to the preservation of the public health; but it has not been so. In this field of human exertion, as in many others, the tasks of purely scientific research and of the subsequent application of science to art, have been chiefly with different parties. It was not the chemist who first exhibited a jet of coal gas burning in his laboratory who also conceived and effected the noble feat of lighting up cities with gas, so as almost to convert night into day. It was not the persons who, ages ago, observed the expansive force of steam, and the sudden condensation of steam into water, effected by cold applied, who thought of turning its force to use, but it was left for James Watt, almost in our own day, to devise that wonderful combination of parts constituting the modern steam-engine, which has already spread a higher civilization over the earth. Then, for many a day, was the fact widely known that a shock of electricity travelled along a wire with the speed of lightning, before Wheatstone and others, who are still witnesses of their work, had constructed the electrical telegraph, which, with like speed, can deliver at any distance, and even make perfectly visible in writing or printing, any set of words forming a message committed to it. The application of

scientific knowledge to the effectual ventilation of human dwellings has yet to be rendered general.

10. To form just conceptions of what complete ventilation is, and of how it is in general to be accomplished, an inquirer has to consider that the ocean of air, called the atmosphere, which rests on the surface of the earth, and at the bottom of which men live, as certain aquatic animals live at the bottom of the sea, is about fifty miles high or deep, and that the portion of this ocean which can be contaminated by any process of animal or vegetable life, or by the decomposition of organic bodies when dead, may be regarded as less deep generally than the fiftieth part of one mile, estimated from the surface of the earth. This comparatively insignificant layer or stratum, therefore, may be regarded as the home or lurking-place of all epidemic and insalubrious influences, the more exact statement, indeed, being that these are generally confined to the still much smaller portions of air contained in houses or other enclosed places. Then the fact is to be kept in mind, that the whole mass of atmosphere at any moment over a city or other place is always travelling away to leeward with the speed of the wind, and is carrying with it whatever impurity may ascend from below, which impurity is then resolved quickly into the pure elementary oxygen, carbon, &c., of which all effluvia consist. Man can no more contaminate permanently the deep atmosphere over him by his proceedings at the bottom of it, than he can contaminate the Atlantic Sea by what he may do on its shores. Then he has to learn that with the same mechanical certainty as he can substitute the pure water of a passing tide or river stream for defiled water near the shore, he may substitute pure air from the atmosphere for any air near him that has become unfit for his use.

11. The incidents of the professional life of the writer of this Report, drew his attention early to the sanitary importance of ventilation and the regulation of temperature, and a familiarity with mechanical arrangements, increased while he was composing his "Elements of Physics or Natural Philosophy," suggested to him simpler and more effectual methods than had previously existed of obtaining, in many cases, the object sought.* The chief of these particulars, some of which are altogether new, and some are modifications of things or processes previously known, are—

1. That every house possesses in its common chimney flue, properly used, an admirably strong ventilating agent, which can establish sufficient communication with the free atmosphere above.

2. That for larger enclosed spaces, as public buildings, ships, &c., an air pump of great simplicity can be made, by which, at very

* For part of these methods, since this Report was originally written, and in part read in the Medical Council of the General Board of Health, the Council of the Royal Society has awarded the author one of their medals. These methods are all in use, some of them extensively, with the expected results.

trifling cost of hand labour or other power, pure air may be supplied in any quantity, and by exact measure if desired, and with the same certainty and regularity as coal gas is supplied anywhere from ordinary gas works.

3. That in cold climates or seasons, hot foul air of any sort, in being discharged or pumped away from an enclosed space, can be made to give up pure warmth to the fresh air entering in its stead, one operation then accomplishing the two objects of ventilating and warming.

4. That for many purposes combustion within a closed stove may be rendered self-regulating and uninterrupted through nights and days, so as to diffuse all the heat obtainable from a given quantity of coal as uniformly as the contrivances of the candle or lamp diffuse the light which wax or oil can give; the stove referred to being also singularly economical or saving of fuel.

5. That by new and better arrangement of open fire-places, the common fire may be rendered smokeless, and be caused to save about half the fuel, although warming the room better than before, and further, may be insuring the complete ventilation referred to as the first of these five particulars. These advantages are obtained also with diminution of the danger, inconveniences, and watching service required about common fires.

12. In enumerating these improvements, the writer does not arrogate to himself greater penetration than other members of the profession to which he has the honour to belong, but attributes his success chiefly to the favouring accidents of his life. Dr. Jenner would not have left his name connected with vaccination if he had always lived in the centre of a great city, where fields and cows and dairy servants were not to be seen.

13. It remains to be observed, that even after practical applications of scientific principles have been devised, and their utility tested to the satisfaction of impartial judges, there is often much difficulty for a time in bringing the public to accept them. To agree in this, the reader needs only to recollect the ridicule at first, and then the more active resistance with which the early announcements of nearly all the important improvements of modern times were received; for instance, agricultural machines of various kinds, as the thrashing machine driven by steam, spinning and weaving machines driven by steam, gas lights, railways, steam navigation, the penny postage, and so forth, against all of which were brought to bear the attachment of men to the established customs of ages, popular ignorance of Nature's laws, strong misconceptions or prejudices directly opposed to the truth, narrow individual or class interest, &c., and if any failure occurred in early trials from the awkwardness or unskilfulness of workmen employed about what was new to them, it was charged as proof of errors in the principle. When at last, in spite of such opposition, a novelty was proved to be good, then, almost as certainly as flies collect about a little spilt honey, did a

host of dishonest men fall upon the novelty and its proposer, trying first to discredit the proposer, by saying the asserted novelty was not new and could not be the subject of a patent, and then often pretending that they had themselves invented improvements which might be so protected. By such opposition the full introduction of Watt's steam-engine was long delayed, and he had to defend his right by repeated suits in the law courts. Enlightened men, owing to the mass of absurdities, called new inventions and discoveries, which are constantly obtruded on public notice by ignorant and foolish projectors, have to use a cautious hesitation before acknowledging value in proffered novelties, but some of them even, have at first believed to be impossible certain new applications proposed of known means or principles, which have in the end been usefully established; for instance, Watt, Wollaston, and Davy at first gave it as their opinion that coal gas could not be safely applied to the purpose of street lighting. Others said that steam boats or ships could not safely navigate the great ocean. When Dr. Desaguliers, Dr. Hales, and others, a century ago, before oxygen and the nature of gases were known, proposed to ventilate houses and ships by mechanical means of certain action, instead of only by open windows and ports, they were regarded by honest persons in authority as visionaries. It is a curious and mixed instance, as related by writers of the time, that after Dr. Harvey published his discovery of the circulation of the blood, no medical man who had then reached the age of forty ever avowed his belief that Harvey was right.

Considering such facts, the writer of this, who has not restricted the public use of any of his devices by reserving patent rights, is of opinion that time will be saved and much public good effected, if the enlightened President of the General Board of Health, by his own authority, or by the direction of Government at his request, institute a commission of scientific men of known ability in regard to the matters here treated of,—medical men, chemists, and engineers,—to inquire and then advise specific procedure respecting them. Special scientific aid has already been afforded to the members of the medical council for other special objects. The award of the Royal Society above referred to will draw some public attention to the subject. The writer's own account of the new means soon to be published, will also have its effect, but a report and recommendations from such a special commission as referred to, if favourable to the measures proposed, would exert almost at once the influence of a law in securing willing obedience to any advice given.

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