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THE

SANITARY JOURNAL.

DEVOTED TO

PUBLIC HEALTH.

VOL. IV.] NOVEMBER AND DECEMBER, 1879. [No. 2.

PRACTICAL HYGIENE.

SECOND PAPER.

CHAPTER II.

AIR IN ITS RELATIONS TO HEALTH.

SECTION I.

GENERAL AND INTRODUCTORY REMARKS.

In the previous chapter we studied hereditary diseases and predispositions to disease, and also moral and social causes of disease, and we now come to the study of the material causes of disease—causes connected with the essentials of life—air, water, food, exercise, rest, etc. Air being regarded as the first essential of life, we will consider it first.

PURE ATMOSPHERIC AIR consists of nearly 21 parts, by volume, of oxygen, about 79 parts of nitrogen, .035 parts of carbonic acid gas, with minute traces of ammonia and sodium salts, and, usually, traces of ozone, together with watery vapor—which varies much in quantity—and, usually more or less organic matter in the form, probably, of both dead and living structures.

The amount of oxygen varies from 20.98 per cent. in pure mountain air, to 20.90 per cent., or even less, in the air of cities. The amount of carbonic acid ranges from .02 per cent. in certain localities, to .05 per cent. in the denser parts of cities.

The watery vapor varies greatly in quantity in different countries and at different periods, from complete saturation, to about 40 per cent. of saturation; or from 1 to 11 grains in a cubic foot of air, according to temperature. The amount most favorable to health is believed to be that of from 65 to 75 per cent. of saturation.

AS AIR IS THE FIRST ESSENTIAL OF LIFE, pure air is the first essential of health. Dr. Parkes observes: "It might be inferred from the physiological evidence of the paramount importance of proper aeration of the blood, that the breathing of air, rendered impure from any cause, is hurtful, and that the highest degree of health is only possible when to the other conditions is added that of a proper supply of pure air. Experience strengthens this inference. Statistical inquiries on mortality prove beyond a doubt that of the causes of death which are usually in action, impurity of the air is the most important. Individual observations confirms this. No one who has paid any attention to the condition of health, and the recovery from disease of those persons who fall under his observation, can doubt that impurity of the air marvellously affects the first, and influences and sometimes even regulates the second.

The supply of air is practically without limit; an immense ocean of it, many miles in depth, surrounds the entire earth. Perhaps it is largely by reason of its very abundance that man so commonly overlooks or disregards its great value; and in the higher civilization which he creates, and which carries him onward and forward, he neglects frequently to seek, in the first place, localities in which the air is naturally most pure, and most favorable to health and life; or by surrounding himself with elegant but almost impervious walls, he shuts out the pure air and breathes over and over again the small measure he has so closely imprisoned; or he makes foul that near his dwelling, by waste excremental matters, chiefly from his own body, or by the products or refuse of the occupations by which he lives, or too often but partly lives.

THE IMPURITIES WHICH FIND THEIR WAY INTO AIR are very numerous—gases, vapors, and solid particles: but a wonderful series of processes goes on continually in the outer atmosphere which preserves the air in most localities in a state of sufficient purity. It is for the most part in enclosed spaces, rooms, schools, shops, factories, and close yards, where these purifying processes are not and cannot be in full operation, that the air becomes impure, and too frequently quite unfitted for the purposes of respiration; as it does, too, near collections of decomposing waste organic matters, which rapidly foul the air.

In a hygienic point of view, the habitations and works of man furnish the most important impurities in the air: such as the products of respiration and perspiration, and of lighting and warming, effluvia from excremental waste matters—sewer gases—and emanations from work in various factories.

Many of the impurities in air cannot be detected by the sense of smell nor of taste, and hence they may be inhaled without any knowledge of it on the part of those who breathe them. Other impure substances may be smelt or tasted at first, but after a little time if they remain in the air the nerves of smell and taste lose their delicacy and do not recognize the impurities. Hence it often happens that no warning is given, or only slight warning, of the presence of atmospheric impurities.

Air may be rendered practically impure, or unfit for the purposes of respiration, by a change in the proportion of its natural constituents: as by an excess of carbonic acid, or a deficiency of oxygen.

The impurities in air may, for convenience, be roughly divided into suspended matters, which float about in the air and are wafted hither and thither by winds or currents of air; and gaseous matters, which quickly mingle with the air.

OF THE SUSPENDED MATTERS, some of the particles reflect and scatter rays of light, and thus frequently become visible and are familiar to every one: as when seen like fine moats in the course of a ray of light passing through a dark room. These fine countless particles, which are so light as not to subside in air, and which we thus see frequently in a ray of light, are almost universally diffused, everywhere: as has been shown by Tichborne and Tyndall.

In the external air are particles of calcium carbonates and phosphates, of salts of iron and alumina, and of silicates and every constituent of the soil, lifted and carried about by winds; minute vegetable particles, as cells, seed capsules, fibres and hairs, and parts of flowers; portions of animals, as scales from wings and bodies of insects. Besides all these, there are numerous living creatures in the atmosphere, and it is said 200 forms have been discovered—germs of vibriones, spores of fungi, bacteria and monads. In towns and manufacturing districts are particles of carbon, wool, and cotton, etc., and dried particles of the excreta of animals, as horses, and even of man. In this way it is believed that some diseases, as cholera and typhoid fever, may be spread.

In inhabited and enclosed spaces are found round cells, bits of hair, scales of cuticle, starch cells, bits of coloring matter from wall paper, etc. In the air of shops and factories are particles derived from the materials or fabrics used or worked, as of grains, wool, cotton and metals.

THE GASEOUS SUBSTANCES which pass into the atmosphere, both from natural sources and from the habitations and works of men, are numerous. Among others is carbonic acid (when exceeding 4 or 5 parts in 10,000), carbonic oxide, carburetted, phosphoretted and sulphuretted hydrogen, ammonium sulphide, carbon bisulphide, and other compounds, as of chlorine, nitrogen, sulphur, etc. Besides these there are organic vapors, arising from the decomposition of animal matters, of the precise composition of which little is known. The vapors of sewage are carbo-ammoniacal.

THE EFFECTS OF BREATHING IMPURE AIR may be either local or general, or both. The local effects involve the air passages and lungs, and are most marked in millers, potters, flax and shoddy workers, steel grinders, and miners, who are all very liable to bronchitis, consumption and asthma. They are caused by the direct mechanical irritation of the parts by the fine particles of steel and other dust produced by these occupations. In the general effects the entire organism is more or less implicated, and in this country, in a hygienic point of view, these are of much the greater importance. They arise from breathing air containing poisonous gases and fumes. The poisons pass through the delicate lung tissue into the blood and pervade the whole body. The breathing of air containing effluvia from decomposing excremental matters, besides not unfrequently giving rise to some specific disease, such as diarrhœa, cholera, or perhaps typhoid fever, produces a sort of 'putrid' condition of the blood and other bodily fluids, which predisposes the system, or renders it more liable, to various other diseases, often of a most serious character.

The effects of breathing impure air are not usually, any of them, of such a character as to speedily overwhelm the organs and functions of the body, or even to produce marked immediate symptoms, but they are frequently cumulative, and while necessarily, from the first, interfering with or preventing in a greater or less degree, healthy vigorous action, they eventually give rise to the most serious and even fatal consequences.

CLASSIFICATION OF THE WHOLE SUBJECT.—Obviously the subject of air in its relations to health is a very wide one, and constitutes indeed a very large proportion of the entire subject of hygiene. It involves the consideration of climatology, locality, drainage, and the situation and general construction of dwellings and all buildings intended for habitations, of ventilation and warming, the removal or disposal of all waste or excremental matters—sewage, etc., and disinfection. For example, dampness of soil or want of drainage renders the air above damp, misty and cold, which condition of it is believed to predispose the system to rheumatism, neuralgia and catarrh ; the diseases arising from badly located and badly constructed habitations, are for the most part the diseases of impure air, from want of ventilation, or of too great humidity of the air, from damp walls ; while all collections of excremental or waste matters soon contaminate and poison the air in the vicinity.

We will therefore study the impurities in the air and their effects upon health, under the following divisions :

1. Air near marshes and on damp, undrained soil—malaria, and the effects of such air upon health.

2. Air vitiated by exhalations from the lungs and skin, and its effects upon health.

3. Air vitiated by other excremental, waste matters—from sewers, privy vaults, etc., and its effects upon health.

4. Air from decomposing animal matter, as from manure heaps and grave yards, and its effects upon health.

5. Air rendered impure by combustion—warming and lighting—and by certain occupations, trades and manufactories, and the effects of such air upon health.

We will then consider the means of purifying the air, and of preventing impurities in it, under the following heads :

1. Climatology, locality, soil and drainage.

2. Construction of habitations, ventilation, warming and lighting.

3. Removal and disposal of all excrement or waste—sewerage, dry methods of removal, etc.

4. Disinfection.

SECTION II.

AIR NEAR MARSHES AND ON DAMP SOIL, AND THE EFFECTS OF SUCH AIR UPON HEALTH.

THE AIR FROM MARSHES usually contains an excess of carbonic acid and of watery vapor ; the carbonic acid may amount to 6 or 8 per 10,000 volumes. It also frequently contains carburetted and sulphuretted hydrogen, and some times free hydrogen and ammonia and perhaps phosphoretted hydrogen. A peculiar organic matter is also found, in considerable quantity, besides various vegetable matters, as the debris of plants, and infusoria and insects. The ascentional force given by the evaporation of water seems to be sufficient to lift into the air insects of comparatively large size. Spores and sporangia of a little algoid plant exists abundantly in the water of the marshes near Rome, and has been found in the air of Rome and its vicinity. Balestra is inclined to attribute marsh fever to this widely diffused "microphyte granule."

The peculiar organic matter referred to, found in the air of marshes, blackens sulphuric acid when such air is drawn through it; it has a flocculent appearance and sometimes a peculiar marshy smell. It is said that ozone lead through a solution of it did not destroy it, and that it destroys quinine: this would be the case, probably, only when in its concentrated form.

Dampness of soil may affect the health, through the air, in two different ways: First, simply by the effect of the water, *per se*, causing, with a cold soil, a damp, misty air; and second, by favoring or aiding in, the evolution of organic emanations—of miasmata, of a more or less poisonous nature, which pass into the air and contaminate it. When the damp soil is strongly impregnated with organic impurities—animal or vegetable—the contamination of the air by organic effluvia is greater. The effects of these impurities are modified or lessened by vegetation. Hence, in the preparation of sites for camps, for military purposes, Parkes recommends that, in clearing away brushwood, the ground, in the tropics especially, should be disturbed as little as possible; and if it can be done, all cleared spots should be soon sown with grass seed.

MALARIA—BAD AIR.—By this term is usually understood the effluvia from the marshy soil which give rise to paroxysmal fevers; such as, in this country, intermittent (ague), and remittent. The cause of these fevers appears to be some special and constant agent, produced by some kind of decomposition or fermentation going on in the soil; and for the production of which the following appear to be essential conditions: organic matter in the soil, moisture, heat, and limited access of air. It may prevail on chalky, limestone, sandy, and even granite soils.

Malaria is given out abundantly by alluvial soils, especially by those most recently formed. Mud banks on the sides of large streams, when only occasionally covered with water, may be highly malarious.

Some sands which appear to the eye to be free from organic matter, contain much of it, and may, under the other favorable conditions mentioned, give rise to malaria. The draining of ponds and lakes, and digging of canals, and the submerging of meadows, have each and all of them been followed by the development of marsh fevers. A long continuance of dry warm weather followed by rains favors the evolution of malaria.

Malarial fevers may be produced from conditions quite localized, and unconnected with the nature of the soil. Parkes gives the two following instances, which illustrate this:

In a marine hospital, near Stettin (Friedel, Ost. Asiens, Berlin, 1863), a large day ward was used for convalescents. When any man had been in this ward two or three days he got a bad attack of ague. This did not occur in any other ward, and the origin of the fever poison was a mystery until, on close inspection, a large rain cask full of rotton leaves and brushwood was found; the water in this had overflowed and formed a miniature marsh close to the doors and windows of the ward, which, on account of the warm weather, were kept open.

On board a ship at sea (Dr. Holden, American Jour. of Med. Sci., Jan. 1866), eight cases of ague occurred from the effluvia from a large quantity of mould which had grown in some closed store-rooms, and which was exposed to the bilge water.

DISEASES CAUSED BY MALARIA AND DAMP SOIL.—The following are the diseases which have been attributed to malaria and to dampness from the soil:

Intermittent Fever.	Yellow Fever.
Remittent Fever.	Typhoid Fever.
Bilious Remittent Fever.	Dysentery.

In this country the diseases especially attributable to marsh miasmata are INTERMITTENT FEVER (ague) and REMITTENT FEVER. It is believed that DIARRHŒA and DYSENTERY, and other GASTRIC DERANGEMENTS, may also be caused by such effluvia. Furthermore, those living in the vicinity of marshes are usually enfeebled and present a pallid appearance, though they may not suffer from any marked or special disease.

Damp, undrained, and consequently cold soil, has long been known to be unfavorable to the growth of good crops of grain, vegetables, etc., and it might naturally and readily have been supposed that such would be unfavorable to the health of men and animals living upon it. But it was only at a comparatively recent date that the effects of dampness of soil upon human health received special attention; when it was found that these effects were of a most marked and decided character.

Experience proves that most persons enjoy better health on dry than on wet soil. Air containing an excess of moisture acts injuriously upon the system by not readily receiving the perspiration from the skin and moist vapor from the lungs. This gives rise to the feeling of oppression and languor which is so common during damp, sultry weather. By this obstruction to the insensible perspiration, the worn out, waste matters produced in the body are unduly retained, and accumulate in the blood, rendering it impure; while any miasmata introduced into the lungs by inspiration are not so readily thrown off by expiration. This would lead us to expect, what we actually find, by experience, a greater prevalence of epidemic diseases in moist than in dry localities; as along the banks of rivers and in low, damp places. Moist, warm air has a relaxing and debilitating effect upon the system. A moist, undrained soil is generally believed to give rise to, or, at least, to predispose to, RHEUMATISM, NEURALGIA, and CATARRHAL AFFECTIONS. It undoubtedly favors the development of the specific poison, whatever it may be, which gives rise to ague and remittent fever—the fevers produced by marsh miasmata.

A case is mentioned by Pettenkofer, illustrating the effects of ground water and want of drainage on some sort of fever in the horse. Two royal stables near Munich, containing the same class of horses, and with the same arrangements as to stalls, food and attendance, suffered very unequally from fever. The difference between the two places was found to be that, while under the healthy stables the ground water was 5 to 6 feet, under the unhealthy it was only 2½ feet, from the surface. The latter stables were made as healthy as the others by draining and lowering the ground water.

An obstructed outflow, raising the level of the ground water, has been known to cause the spread of malarial fevers; and by thorough drainage, very malarious places have been rendered quite healthy.

It has been supposed that TYPHOID FEVER is connected in some way with the rise of ground water to near the surface and its subsequent fall. At Munich and at Paris, outbreaks of typhoid fever have been observed to occur, or to be most fatal, when, after the ground water had risen on account of rains, to unusual height, it had fallen low.

But besides the above named diseases, and perhaps most important of all, moisture from the soil seems in some way to produce an unfavorable effect upon the lungs and mucous membrane of the air passages, giving rise to CONSUMPTION. Investigations and observations during the last eighteen years show that there is a close connection between this disease and dampness of soil.

In 1862, in an address delivered to the Massachusetts Medical Society, Dr. Bowditch, of Boston, stated that, "medical opinion in Massachusetts, as deduced from the written statements of resident physicians in 183 towns, tends strongly to prove, though perhaps not affording perfect proof of, the existence of a law in the development of consumption in Massachusetts, which law has for its central idea, that dampness of the soil of any township or locality is intimately connected, and probably as cause and effect, with the prevalence of consumption in that township or locality." Near about the same time, Dr. Middleton, of Salisbury, England, noticed that when the ground had been rendered drier by drains and sewers, there had been a diminution in the death rate from this disease.

Soon after this, the investigations of Dr. Buchanan, Health Inspector for the Privy Council, Great Britain, established, seemingly beyond doubt, as a general law, that there is a connection between the causation of consumption and dampness of soil. These investigations were made public in a report to the Privy Council, by Dr. Buchanan, "On the Distribution of Phthisis as Affected by Dampness of Soil." He had found that wherever the subsoil had been thoroughly dried by a complete system of drainage, the mortality from consumption decreased from near 50 per cent. downward. In Salisbury, the mortality from this disease had fallen 49 per cent. after thorough drainage; in Eby, 47 per cent.; in Rugby, 43; in Banbury, 41; and in thirteen other towns it had fallen in a marked degree. On the other hand, in certain towns where the soil had not been dried by a system of pipe-drains, though means were used to remove all excrement and filth, there had been no marked reduction in the death rate from consumption.

After observing these facts, Dr. Buchanan made further inquiries, adopting two separate lines of investigation, and established, as a scientific certainty, a connection between dampness of soil and consumption. It must be observed that dampness or dryness of a soil depends on various conditions. Aside from artificial drainage, the topographical relations and the physical qualities of different soils must be considered, in making inquiries. In Dr. Buchanan's report, he gave the following general conclusions :

"1. Within the counties of Surrey, Kent, and Sussex, there is, broadly speaking, less phthisis among populations living on pervious soils than among populations living on impervious soils.

"2. Within the same counties there is less phthisis among populations living on high-lying pervious soils than among populations living on low-lying pervious soils.

"3. Within the same counties there is less phthisis among populations living on sloping impervious soils than among populations living on flat impervious soils.

"4. The connection between soil and phthisis has been established in this inquiry—

"*(a)* By the existence of general agreement in phthisis-mortality between districts that have common geological and topographical features, of a nature to affect the water-holding quality of the soil;

"*(b)* By the existence of general disagreement between districts that are differently circumstanced in regard of such features; and

"*(c)* By the discovery of pretty regular concomitancy in the fluctuation of the two conditions, from much phthisis with much wetness of soil to little phthisis with little wetness of soil.

"5. The whole of the foregoing conclusions combine into one—which may now be affirmed generally, and not only of particular districts—that wetness of soil is a cause of phthisis to the population living upon it."

SECTION III.

AIR VITIATED BY EXHALATION FROM THE LUNGS AND SKIN, AND ITS EFFECTS UPON HEALTH.

AIR VITIATED BY RESPIRATION AND PERSPIRATION, in rooms, schools, shops, and all enclosed spaces, through want of free ventilation, is a fruitful cause of a serious class of diseases.

The effete matters in expired air—thrown off in respiration, are carbonic acid gas, watery vapor, and certain 'organic' matters, partly vaporous and partly suspended. The excreta from the skin is chiefly watery vapor, with some salts dissolved in it, and small quantities of carbonic acid and organic matter. For all practical purposes, the two excretions—from the lungs and skin—as they are practically inseparable, may be considered together.

An adult man, in ordinary work, gives off from the lungs in 24 hours, from 12 to 16 cubic feet of CARBONIC ACID GAS; besides an undetermined quantity of the same gas by the skin. On an average, when not at hard work, he will give to the atmosphere more than six-tenths of a cubic foot of the gas every hour. According to Dr. Carpenter, a man gives off by the lungs alone, 160 grs. of pure carbon every hour. The amount in both sexes gradually increases to about the thirtieth year of age. After the eighth year the male exhales somewhat more than the female. Women and children, therefore, and also old people, give off a smaller quantity.

The amount of WATERY VAPOR which passes off by the skin and lungs varies according to circumstances; especially is this the case with that from the skin, which varies immensely, as we all know. When the air is damp, less is given off. The average amount has been estimated at from 24 to 40 oz. in 24 hours. This amount of moisture requires, on an average, over 200 cubic feet of air per hour to retain it in a state of vapor.

The amount of ORGANIC MATTER given off by these channels has never been accurately determined; nor is it possible, at present, as Parkes says, to estimate it correctly. It has a very disagreeable smell, and the fœtid odor in unventilated bed-rooms and crowded rooms is owing to this impurity. That from the lungs, when drawn through potassium permanganate, decolorizes it; and through pure water, renders it very offensive. It yields ammonia, and is therefore nitrogenous; and it is oxidisable, though oxydised but slowly, as the fœtid smell from it is sometimes retained in a room for a long time, perhaps for hours, even after free ventilation. Parkes says it is probably not a gas, but is 'molecular.' The odor is evidently not always equally diffused through a room, but seems to float in clouds, somewhat like tobacco smoke. It is believed to be in connection with water, as hygroscopic substances absorb it most readily. It is absorbed most by feathers, wool, damp paper and damp walls, and least by horse-hair and straw. As to the color of substances, it is absorbed most by black, then blue and yellow, and least by white.

The injurious effects upon the health caused by rebreathing breathed air, are believed to be due chiefly to the presence of this peculiar organic matter. From experiments on animals, in which the carbonic acid and watery vapor were removed, and the organic matter alone left, this has been found to be highly poisonous. A mouse died in it in forty-five minutes. On the other hand, carbonic acid, in itself, within certain limits, has been found by experiment, not to be an important impurity, nor to have a very injurious effect upon the health, except when in great excess. Dr. Angus Smith experienced no discomfort in a soda-water manufactory where the carbonic acid amounted to 2 volumes per 1000 (more than 5 times the amount in ordinary air—.35 per 1000). Doubtless its presence in the air in any great excess, however, would lessen the elimination of carbonic acid from the lungs, and thus the gas would be retained in the blood, and in a little time produce serious alterations in nutrition.

The carbonic acid gas is practically in a constant ratio with the organic matter in expired air, and as the quantity of the gas is readily enough determined, it may be conveniently taken as an index to the amount of the more important impurity in such air.

In expired air there is LESS OXYGEN than in ordinary atmospheric air, as a certain amount of oxygen is consumed in the body at every breath: hence in an inhabited room which is not well ventilated, this life giving element is gradually and materially lessened. Dr. Angus Smith's experiments showed that while the percentage of oxygen in the open air of a suburb of Manchester amounted to 20.96, in a sitting room it was only 20.89, in the pit of a theatre, 20.74, and in the Court of Queen's Bench, 20.65. By a reduction of the proportion of oxygen, therefore, as well as by accumulation of impurities, the air in unventilated living rooms is soon unfitted for the purposes of respiration and the support of life.

By the EXHALATIONS FROM THE SICK, the air is vitiated more rapidly, and rendered still more noxious, than by those from persons in health, which we have been considering. This is true as regards all diseases, but more especially the specific eruptive fevers, which implicate the skin and mucous linings of the air passages, as in small pox, scarlet fever, measles, and the like; and also as regards diphtheria, erysipelas, and some diseases of the lungs. The specific contagiums of other contagious diseases are doubtless given off by the skin and lungs, and pass into the air; which then acts as a medium by which others receive the disease. In diseases with certain purulent discharges, putrefying particles and pus-cells are thrown off into the atmosphere, and may give rise to most serious specific disease in those inhaling them.

Effects of breathing breathed air.—The effects of breathing air which has become decidedly offensive to the sense of smell from containing the fœtid organic matter, carbonic acid, and excess of watery vapor exhaled from the lungs and skin, are very marked in most persons; they are frequently languor, heaviness, headache, and sometimes nausea and febrile symptoms, which may continue for a day or two. When the air becomes still more impure from this cause, it soon destroys life, or if the persons survive, they suffer from a sort of 'putrid fever,' with boils and other evidence of affected nutrition.

Effects speedily fatal from breathing air vitiated by the exhalations from the human body are familiar enough. In a Shetland trading vessel at Leith, a number of years ago, the master and mate went to sleep at night in the cabin, with the companion and skylight shut, and were found the next morning 'almost dead,' from breathing over and over again the exhalations from their own bodies. The captain died in about 24 hours, but the mate recovered. The captain and mate of a French ship, at Jersey, both died under like circumstances. Most persons are familiar with the history of the Calcutta 'black hole,' in which 123 out of 146 prisoners died in 11 hours, from breathing the exhalations from their own bodies; with that of the Austerlitz prison, in which 260 of 300 Austrian prisoners died in a short time; and with that of the steamer Londonderry, in which 70 of 150 passengers died during a stormy night, in the tightly closed, cabin all from the same cause.

When breathing such poisonous exhalations in large quantities gives rise to consequences so fatal, it cannot be doubted that breathing them in even minute quantities is a cause of much mischief, and must interfere more or less with health and perfect nutrition; even though it may not be possible to estimate the amount of the mischief, or to trace the effects direct to the cause. It is very generally admitted that breathing an atmosphere vitiated by exhalations from the lungs and skin, produces a 'kind of putrescence in the blood in proportion to the amount inhaled and the period of exposure to it.

When an atmosphere but moderately viatiated by respiration is breathed almost continuously for a lengthened period, its effects are usually complicated with those of other conditions. Persons who are compelled to breathe such an atmosphere are usually at the same time of sedentary habits, and perhaps remain in a constrained position for many hours, and are not unfrequently badly fed or intemperate. Nevertheless, allowing to the fullest extent for the injurious effects of all other agencies, there is no doubt that breathing air vitiated by respiration, has a most injurious effect upon the health. The æration and nutrition of the blood is necessarily interfered with, and the general tone of the system soon falls below par. The subjects soon lose their appetite, become pale, and fail in muscular strength and spirits.

OF SPECIAL DISEASES caused by rebreathing breathed air, it appears clear that SCROFULA—consumption being one of its most common forms, and even TYPHUS FEVER, are common. In the sixteenth, seventeenth, and eighteenth centuries, according to Dr. Murchison, jail or typhus fever was frequently generated *de novo*, solely in consequence of over-crowding and deficient ventilation in the prisons; and the disease thus generated, often spread from the court house—the 'Black Assize'—where the prisoners were tried, to the surrounding population. So late as 1815, Harty showed that this disease was being constantly generated in the Dublin Prisons, or whenever these became overcrowded, as they usually did just before the periodical transportations to penal settlements. Regarding an extensive epidemic in Merthyr-Tydfil in 1870, Dr. Buchanan reported to the medical officer of the Privy Council, that it was true typhus fever, and he believed it due to overcrowding and want of ventilation in the habitations of the poor.

Baudelocque, a celebrated French physician, asserted long ago, that the repeated breathing of the same atmosphere is a primary and efficient cause of scrofula, and that hereditary predisposition, uncleanliness, want of proper food and clothing, cold and humid air, are by themselves non-effective. He says that invariably it will be found on examination, that a truly scrofulous disease is caused by breathing air vitiated by respiration, and that it is not always necessary that there should be a prolonged stay in such an atmosphere. Often, a few hours each day is sufficient, as sitting in a close school room, or sleeping in a confined bed room. Many of the pupils at a school in Norwood, England, some years ago, fell victims to scrofula, and on investigation it was concluded that insufficient ventilation, and the consequent atmospheric impurity, was the cause.

That most frequent cause of death, PULMONARY CONSUMPTION, is, without doubt, developed by respired air. A large amount of evidence has been collected from various sources, which goes to prove this. Twenty years ago, consumption was very prevalent among the British soldiers. A Sanitary Commission, consisting of men of the highest standing, after investigation, declared it was caused by overcrowding and want of ventilation. When more space in barracks and better ventilation were provided, on the recommendation of the Commission, the number of cases of this disease materially diminished.—(*Report of Army Sanitary Commission, 1858*).

Previous to that investigation, the cubic space per soldier, in barracks, of the Foot Guards, amounted to only 331 cubic feet, and the mortality from consumption was as high as 13.8 per 1000; while in the Horse Guards, the cubic space per head was 572 cubic feet, and the mortality from consumption was not greater than 7.3 per 1000. The disease had prevailed at all the stations, in climates the most varied, and the foul air of the barracks was the only condition common to all of them.

Evidence showing this same mode of origin of consumption is afforded by the statistics of two Austrian prisons, referred to by Dr. Parkes: In the prison of Leopoldstaldt, at Vienna, which was very badly ventilated, there died in the fourteen years, 1834–1847, 378 prisoners out of 4280, or 86 per 1000; of these 220, or 51.4 per 1000, died from consumption. In the well ventilated House of Correction, in the same city, there were in the five years, 1850–1854, 3037 prisoners, of whom 43 died, or 14 per 1000; of these 24, or 7.9 per 1000, died of consumption. In both prisons, it appears, the diet and mode of life were essentially the same.

The Royal Navy and the civil population have afforded abundant statistical evidence similar in character to the above. Like evidence is also afforded by animals, as the monkeys in the Zoological Gardens, and cows and horses in close, unventilated stables.

Other lung affections, such as bronchitis and pneumonia (inflammation of the lungs), may reasonably be believed to have their origin in the breathing of respired air. There is evidence, indeed, which seems to fully establish this.

There is a MORE RAPID SPREAD OF SOME SPECIFIC DISEASES, such as small-pox, scarlet fever, and measles, and the plague, typhus, etc., in an atmosphere vitiated by the organic vapors and particles given off from the lungs and skin. This may, it appears, be owing to either one or the other, or all, of three causes: to diminished bodily vigor and powers of resistance to disease, from the defective nutrition following exposure to such an atmosphere; to the impurities in the blood and fluids of the body, consequent upon such exposure, which impurities form the soil in which the contagium particles of disease live and flourish, or the food on which they thrive and multiply; or, lastly, to the growth and multiplication of the contagium particles in the vitiated atmosphere.

That SOME CONTAGIOUS DISEASES may be caused, or communicated from the sick to the well, by inhaling the exhalations from the lungs and skin of those suffering from such diseases, has been already intimated. Small-pox, scarlet fever, measles, diphtheria, whooping-cough, and perhaps some other diseases, are spread in this way. From numerous recent experiments, it appears that pulmonary consumption may be regarded as contagious; and it is probable that a healthy person may contract this fatal disease directly by breathing the seeds of it—minute particles of tubercle, exhaled from the lungs of another suffering from it.

THE INFLUENCE OF SINGING ON THE HEALTH.—The investigations of Dr. S. M. Wassiljew, of St. Petersburgh, made upon two hundred and twenty-two singers ranging in age from nine to thirty-five years, making full allowance for heighth, circumference of chest, &c., gave the following results: The growth of singers up to their twenty-fifth year is not proportioned as age advances, but is more rapid either before or after the period of puberty. The relative size of chest in singers is larger than in non-singers. In persons who have tuberculous deposits in the lungs, the relative size of the chest is diminished; intemperance also checks the development of the chest. The movements of the chest are greater in singers than in non-singers. The vital capacity of the lungs is greater in singers than in non-singers. Laryngeal catarrh is common in singers, but bronchial catarrh is rare. The mortality of singers is small; statistics embracing a period of twenty-five years do not show a single death from phthisis. A frequent affection of singers is Bright's disease of the kidneys, occurring even in those singers who are of temperate habits. Singing is undoubtedly a prophylactic of consumption, and is the best means of developing and strengthening the chest, and for this reason should be preferred to gymnastics.—*Allgem. Med. Central Zeitung.*

MILK AND WATER.

A LECTURE (ABRIDGED) DELIVERED BEFORE THE NATIONAL HEALTH SOCIETY, BY EARNEST HART, *(From the Sanitary Record.)*

Milk and water constitute a much greater part of our physical constitution—not to say our mental constitution—than it enters into the philosophy of everyone to suppose. How largely our structure is made up of milk we may leave it to our nursery knowledge to say; how largely we are made up of water the chemists can tell us. Of course there are some men who are more watery than others, and some too who are more milk and watery. Going through the whole animal scale, one passes from the man, whose body of 154 lbs. weight contains 111 lbs. of water, down to the jelly fish which Owen took and dried in the sun, reducing its weight by mere dessication from 2 lbs. to 16 grains. How much would be left of some of us if all the milk and water were dried out, it is difficult to say.

Whether we are water drinkers or not, water constitutes the basis of all the beverages we take from day to day. Whether we drink beer, tea, coffee, or alcohol in any form, we are in spite of ourselves water drinkers. According to a calculation of the late Dr. Lankester, the human body weighing 154 lbs. contains 111 lbs. of water, so that a man is made of water much more largely than he imagines. Some people say they are great drinkers, and others boast of drinking but little. The actual amount of water given, however, varies considerably and unconsciously to the individual according to the character of his food. A man who eats largely of potatoes, for instance, *eats* largely of water, and therefore needs to drink less. A hundred pounds weight of potatoes contain 74 lbs. of water, whilst 100 lbs. of barley contain only 12½ lbs. of water.

The value of water as an article of diet can hardly be estimated, and it may best be brought to mind by considering its marvellous digestive power, its power of dissolving food. As a matter of fact, everything which we eat, whether solid or fluid, must be dissolved by water and in water before it can be taken into the blood. Of course if you put starch into water it will not dissolve it in that form, but if you put starch into the mouth, and eat it, the starch is changed by the action of the salivary secretion into sugar, and is then dissolved easily by the water. And so with other fluids—their dissolution must be aided by the saliva and the gastric juice, and they must ultimately come to be soluble in water before they can pass into the blood. If you choose to drink your water in the form of beer you interfere with the dissolving power of the water. A pint of beer will not dissolve so much starch or digested meat as water, and the man who drinks pure water with his dinner does much more to aid his digestion than if he drinks beer or any kind of combination of water with other dissolved alimentary substances. Hence it becomes of immense importance to consider the quality of water, and I propose in what follows especially to deal with the question of the evil consequences arising from the imbibition of drinking water where it is not, as it should be, pure. In my remarks on milk, I purpose also to follow the same course, with a view to showing the crucial importance of both of these essential alimentary substances being delivered and drunk in a pure condition.

I. MILK.—(*a.*) *Effects of Bad Milk.*—There has been much discussion whether the milk from cows suffering from foot-and-mouth disease can cause affections of the mouth, or give rise in human beings to any disease similar to that of cattle. The evidence on the subject is conflicting, and to a great extent negative. An inquiry was made into the matter in 1869, under the directions of the Lords of the Council, by Dr. Thorne Thorne, who, while he reported some cases where decidedly the milk of diseased animals seemed to have produced human disease, had also to state that 'in a very large number of cases the milk of cows undoubtedly affected had been used without producing any noticeable morbid effects.' Still there are some striking cases, which seem sufficient to prove that diseases of the mouth may occur from this cause.

The most remarkable evidence, however, on the evil effects of milk itself has lately been afforded in the report presented to the Local Government Board by Mr. W. H. Power on the outbreak of diphtheria last year in North London. Mr. Power found that by far the greatest number of the 264 persons who were attacked by diphtheria received their milk-supply through the hands of several retailers from two farms belonging to the same individual. He could not, after the most patient investigation, discover any possible way in which the milk could have been infected with the specific contagium of diphtheria, and he was therefore driven to the conjecture that what he called 'actual cow conditions' might have been concerned in the epidemic. His meaning was subsequently explained at a meeting of the Pathological Society to be that a certain disease called garget, which affects the udder of the cow, was able so to change the character of the milk secreted that the drinking of it induced diphtheria in the human subject. This, it is hardly necessary to observe, is a matter of the most crucial importance, the more so because garget is stated to be a disease which the cowmen regard so lightly that they do not even tell their own masters of its occurrence. The whole question is, however, now being investigated by a committee of distinguished physicians appointed by the Pathological Society, and there is reason to hope that their labors will be of great value in the elucidation of an obscure and difficult subject.

(*b.*) *Milk infected with the Specific Contagium of an Infectious Disease.*—The idea that milk might be the vehicle of the transmission of disease germs seems first to have occurred to Dr. M. W. Taylor, of Penrith, from a series of cases of typhoid fever which happened in 1857 in the town in which he lived. A similar series of cases, this time of scarlatina, occurring in 1867 under similar conditions, confirmed him in his belief. It is, however, to Dr. Ballard, then medical officer of health of Islington, but now of the Local Government Board, that we owe the first convincing proof of milk being a carrier of infectious disease. In 1870 a localized outbreak of typhoid fever occurred in his district within a semi-circle of a quarter of a mile radius. He found it impossible to explain the outbreak on the ground of local miasma, bad drainage, or water-supply, and was at length driven to adopt as the true explanation that the outbreak was caused by the milk supplied from one particular dairy. The evidence adduced by him in support of this theory was most convincing. It is impossible here to detail the facts, and it will suffice to say that Dr. Ballard's explanation met at once with universal acceptance. He showed that water from an underground tank liable to sewage pollution existed on the premises of the dairy which disseminated the disease; and although it was stated that the water was never added to the milk, yet the probability was great that the mixture of this water with the milk was the source of its contamination. The next large epidemic of typhoid fever that was satisfactorily connected with milk was at Armley, near Leeds, which was inquired into by Dr. Ballard, in August 1872. Another at Balsall Heath, near Birmingham, in January 1873, by the same inspector, led to the same result; and about the same time Dr. Russell, the accomplished medical officer of health for Glasgow, published an account of a similar epidemic at Parkhead.

I need hardly do more than refer to the great Marylebone epidemic which occurred in 1873, and which created so much excitement and consternation at the time. A special interest in this case was that a great outbreak of enteric fever occurred at a distance of forty or fifty miles from the sanitary jurisdiction in which its true cause was contained; and the case is of the more value because the outbreak, as it happened to be in London, and happened also to have struck its first blow in the houses of more than a dozen physicians and surgeons, had from the first its circumstances very attentively noticed by an unusual number of skilled observers deeply interested in a right knowledge of them. It was proved to demonstration by Mr. Netten Radcliffe that at the dairy which supplied a large milk company in London the only water used for all dairy purposes was a water liable to be contaminated, and which was, at a particular period, in all probability actually contaminated with the specific contagium of typhoid fever. It is not necessary to discuss whether the water became mingled with the milk from the residue left after the cleansing of the pans, or was actually added to the milk. Somehow or other the infection got into the milk from the water, and attacked in nine weeks 191 persons.

Subsequently other epidemics of milk-typhoid were investigated by Dr. Thorne, at Bierley Lane, in 1874; by Mr. Power, at Eagley, in 1876; and by Dr. Thorne, at Great Coggeshall, in 1876, in all of which the source of the epidemic was traced to the polluted well on the dairy premises. Similar outbreaks have been recorded by unofficial observers at Brighouse (1873), Wolverhampton (1873), Dundee (1874), Crosshill and Eaglesham (1875), Glasgow (1875), Jarrow (1875), Edinburgh (1876), Barrowford (1877), Glasgow (1878), Bristol (1878), Croydon (1878), Perth (1878), Dublin (1879), besides numerous smaller outbreaks. In all these cases the cause was the same—polluted water at the dairy, and in all the outbreak was sharp and sudden, and died away as quickly as it came. The only other outbreak that I need now refer to is one by Dr. Ballard, made in 1877, in view of an unusual prevalence of enteric fever at Ascot during the long period of four years and a half. It is of interest in two ways—first, because the second case of a series of sixty-nine in the village was that of a boy who had, when in London, used the milk which caused the Marylebone outbreak, and who fell ill at Ascot; and secondly, because although the polluted well at the dairy farm was undoubtedly the cause of the greater part of the epidemic, its pollution with the specific germs of typhoid fever seems from the nature of the soil to have been intermittent. It is impossible to give a summary of the very ingenious argument of Dr. Ballard, which must be studied in the original; but the fact remains that fifty-eight out of the sixty-nine persons attacked used the milk from the dairy which undoubtedly caused the mischief.

I have up to the present referred only to milk as a carrier of typhoid fever. It has been proved also to be a carrier of scarlatina, though the evidence is not so full as that concerning typhoid fever. Besides the case at Penrith in 1867, cited by Dr. Taylor, before alluded to, Dr. George Buchanan made a very careful inquiry in 1875 into the circumstances attending the outbreak of scarlatina amongst the guests at a party held in the West End, on June 9 of that year. The result of that inquiry was not decisive, but the distribution of the disease was wholly unaccounted for, unless the infection of a particular cream supply accounted for it. There has been no subsequent authenticated case of any large outbreak of scarlatina due to milk, though in a recent report by Dr. Russell, of Glasgow, it is stated that scarlet fever was prevalent on a dairy farm which supplied milk to Glasgow, where an outbreak of that disease had occurred. On inspection the arrangements were found to be obviously such as to afford abundant risk of contamination, and the supply of milk was therefore stopped.

A somewhat similar case of suspicion as to the relation between scarlatina and milk is recorded in the annual report of Dr. Pirie on the public health of Dundee during 1878. In this town scarlatina was somewhat prevalent last year, and in more than one locality the cases were so numerous as to merit a special inquiry. In one instance, a child ill of scarlet fever was found lying in the back shop of a store from which milk and other articles of food were being sold; and in a second instance milk was freely distributed in town from a dairy where sickness, apparently scarlatina, had recently been; and in both cases there was an area which appeared to be influenced by the milk supplies in question.

The evils which arise from the want of proper and systematic sanitary supervision of dairy farms, as evidenced by the epidemics before referred to, have been long pressed upon the Government. Representations to this effect were made to the Select Committee of the House of Commons, which sat on the Contagious Diseases (Animals) Act of last Session; and by some mysterious process, a clause (No.

34) was inserted in that Act providing that the Privy Council might make orders for the registration with (veterinary) local authorities of cowkeepers and dairymen, and for securing proper sanitary surroundings to the cows and the milk. The Act was followed in February last by an Order of Council directing the 'local' authorities specified in the Act to keep a register of all cowkeepers and dairymen; providing for the proper lighting, ventilation, cleansing, drainage, and water-supply of the dairies and cowsheds, to the 'reasonable satisfaction' of the local authority; empowering the authority to make regulations for prescribing and regulating the cleansing of dairies, milkshops, and milk vessels; and directing precautions against the contamination of the milk with the contagium of infectious disease.

On the principle that 'half a loaf is better than no bread,' this provision may be accepted as an addition to our safeguards against the spread of disease; but it needs to be pointed out that the local authorities who are responsible for the execution of the Order are not the *sanitary* authorities of the country, but bodies who are charged with stamping out the diseases of cattle. To enact that a building must be lighted, ventilated, drained, and supplied with water to the 'reasonable satisfaction' of an authority which knows nothing about these matters itself, and has no skilled advice to guide it, is one of those grim official jokes to which we ought by this time to be accustomed. There is grave reason to fear that the 'local authorities' will allow this solitary shred of sanitary functions which they possess to become a dead letter, and they will probably need constant jogging on the part of the sanitary authorities of the district for any good to come of the clause. However, the best must be made out of what is undoubtedly an administrative mistake, and it is to be hoped that an early opportunity will be found for so amending the Act of last Session that the responsibility for the cleanliness and wholesomeness of dairies and cowsheds shall be imposed upon the proper persons.

II. WATER.—A sufficient supply of wholesome water is a fundamental hygienic necessity. Without it injury to health must inevitably arise, either simply from deficiency of quantity or more frequently from the presence of impurities. In all sanitary investigations the question of the water-supply is one of the first points of inquiry, and of late years very large additions have been made to our knowledge of facts bearing upon the vital importance of pure water to the population both in town and country. Although to some this knowledge is trite, yet it is necessary to remember that very few are acquainted with the mass of evidence bearing upon the subject, that still fewer act as if it were a part of their daily knowledge which ought to influence their own acts and the acts of their neighbors, and that a great mass of the population are entirely ignorant, or at least entirely apathetic, in the matter.

The composition of water is of importance for several economic purposes, but this is too technical for discussion here. I can only very briefly refer to the subject of chemical quality of water, or what are called its saline ingredients, because that is a matter of considerably less importance, and as to which there is less new knowledge than the subject of the animal or organic impurities of water. The only domestic matter of importance connected with the quality of water, apart from drinking and cooking, is the relative amount of soap used by hard and soft water in washing. The distinction between hard and soft waters is always worth bearing in mind. Hard waters are waters which are collected after passing through chalk districts, and contain an excess either of carbonate of lime or of sulphate of lime. The main objection to their hardness is that they are apt to produce considerable gastric irritation where the water is hard to excess, and that they are wasteful in respect to all the ordinary domestic operations of washing and cooking. A very excellent remedy for this defect is to be found in the well-known process of the late Dr. Clark, by which insoluble carbonate of lime is precipitated. An improvement on this process has been made recently by Mr. Porter, the civil engineer; and the Porter-Clark process for softening hard water may be recommended as possessing the additional advantages of not only softening the water, but of very effectually filtering it.

(*a.*) *Bad Water.*—'The doctrine that a vast influence is exercised over the health of communities by the quality of water which they consume is one,' says Mr. Simon, 'which, as far back in literature as any reference to such questions could be expected to exist, may be seen to have universal medical consent in its favor. During long ages of history, the common instincts of mankind were even surer and stronger than undeveloped science could be, in revolting against the use of unwholesome waters. For instance, among the lessons which survive in modern times from the wonderful intellect and vigor of ancient Rome, the frequent far-reaching aqueducts, which record an unbounded care for the provisions of proper urban water-supplies, are monuments kindred in spirit, and only second in dignity, to the consummate system of jurisprudence of the same singularly organising people.' Of the many invaluable additions and improvements which medical knowledge has received during the last thirty or forty years, scarcely any can be compared for present practical importance to the discoveries which have given scientific exactitude to parts of the doctrine so ably referred to by Mr. Simon. The connection between impure water and disease, although amply proved, does not, however, rest on so exact an experimental basis as could be desired, probably on account of the imperfections of our present modes of analysis of water. Moreover, the evidences of this connection differ very much with regard to different diseases, both as to the amount and value of evidence. There are some people who deny that even considerable organic or mineral impurity can be proved to produce any bad effect; whilst others have believed that some mineral ingredients, such as calcium carbonate, are useful. On these points I cannot now dwell, and I must therefore pass over any examination of the diseases, such as diarrhœa, goitre, malarious fevers, and dyspepsia, which may be induced by water impure at its source, or highly charged with mineral or other impurities. I proceed at once to consider the dangers (and they are immense) of—

(*b.*) *Water Polluted with the Specific Infection of some Particular Disease.*—Two diseases, closely correlated, stand out in very bold relief in this connection. I refer of course to cholera and typhoid fever. It is to be hoped that the system of medical inspection now in force at all our ports will suffice for the future to nip in the bud any stray cases of the former disease that may reach our shores. In the epidemics which occurred from cholera in this country in 1849, 1854, and 1866, its spread by means of water polluted with its specific infection was painfully and convincingly proved by a greater mass of evidence than had ever been previously collected with regard to any other disease. I do not propose on this occasion to attempt to give any illustrations of the spread of cholera by water. The Broad Street pump outbreak, investigated by Dr. Snow, to whom we owe the first proofs of the spread of cholera by water, is historical. There are many other instances recorded on pages 153 to 163 of the sixth report of the Rivers Pollution Commission; but as the time is short, and cholera is an exotic disease which we have only occasionally to fear, I hurry on to an examination of the spread of typhoid fever by water. Here there is of evidence an overwhelming *embarras de* *richesses.* Epidemics by the score, nay by the hundred, might be cited in which the first cause has been the pollution of the water drunk by the persons affected. In fact, it has been one of our most familiar experiences, one which will be found exemplified in every volume of every medical journal, that excremental fouling of wells is, in this respect, among the worst dangers which can threaten the health of a community; and other common water supplies, as distributed by companies and local boards, are equally capable of spreading the infection. In the admirable Fifth Report of Mr. Simon, an abstract is given of the history of no less than 146 epidemics of typhoid fever, investigated by the officers of his department during the four years 1870-73. In all these cases great excremental pollution of air or water—generally of both—was found. Since then several remarkable outbreaks of the same kind have been investigated by the Local Government Board with the same result.

These reports may be broadly divided into three sections, these showing the impurity to be imported (1) at the source, (2) in transit from the source to the reservoirs, (3) when stored in tanks or cisterns. It will be obvious that the two last dangers concern town water only, *i. e.* that delivered in pipes to the several houses. The first-mentioned source of impurity is, therefore, the one which we most commonly find as concerned in rural districts with the spread of typhoid fever. In country places wells are not uncommonly found in close juxtaposition with privies, and soakage from the latter to the former inevitably ensues. The water may perhaps be drunk for a long time without any grave danger to health, but as soon as the infection of typhoid fever gets into the well most serious results follow. Thus at Hawkesbury Upton, which is situated upon fissured oolite, the sewage is discharged into the fissures. Into the same fissured rock are sunk the wells, and when a case of enteric fever occurred at the top of the village, the disease spread through the whole village through the medium of the privies and wells. The use of brook water, again, when infected with the contagium of enteric fever, has been proved in innumerable instances to have been the cause of epidemics of the disease. Perhaps one of the most convincing cases of this sort occurred at the orphan asylum founded at Bristol by the philanthropic Mr. Muller. An extensive outbreak (something like 500 cases occurred) was shown by Mr. Davies, the medical officer of health for the city, to have been caused by the drinking by the children, whilst out for a walk, of water from a stream in a picturesque dingle, but polluted by sewage from a neighboring village at which enteric fever was prevalent.

A very remarkable outbreak of a totally different kind has only just occurred near London in the Caterham Valley. The water supplied by the local water company is above suspicion as regards contamination from cesspools; but some time in January a man who was suffering from a mild attack of typhoid fever was employed in some work beneath the surface in connection with one of the company's wells sunk in the chalk. There is no doubt whatever that he imported the specific contamination of typhoid to the water in the well, for, after the usual period of the incubation of the disease, more than 300 cases broke out amongst persons using the company's water. Unhappily several deaths have resulted from this distressing occurrence; but the company have taken every precaution to prevent a similar accident occurring in future.

Of the second sort of contamination—that received in the transit of the water from the source of the reservoir, no better example could be given than the epidemic at Over Darwen in 1874. This outbreak, which was minutely investigated by Dr. Stevens, of the Local Government Board, and which attacked 1,500 persons, killing 85, was shown to have been occasioned in the following way. In September a young lady died of enteric fever at a house situated close by the 'sough,' by which the water supplying Over Darwen is conveyed into the service reservoir. Examination showed that a drain carrying away the sewage from the house passed near this 'sough,' and had gained access to its interior through faults in its imperfectly secured joints. There was no sort of doubt that this was the true explanation of the epidemic.

Town water, though it is usually absolved from gross impurities at its source as rural water is, has many dangers of its own. In fact, the chance of substances getting into the water of tanks and cisterns is very great. Leakages from pipes, passage of foul air through pipes, or direct absorption of air by an uncovered surface of water, introduce impurities into cisterns. A danger which seems capable of wide operation has been seen to arise when water-closets receive their flushing service from the mains of a so-called 'constant' supply. This danger is that during times of intermission, if there are not service-boxes or cisterns between the closet-taps and the mains, effluvia, and even in some cases fluid filth, will be (so to speak) sucked into water-pipes. It is to Dr. Blaxall that we owe the discovery of the connection of this condition with outbreaks of enteric fever. Subsequent investigations by Dr. Buchannan, at Caius College, Cambridge, and on a much larger scale at Croydon in the year 1875, fully confirm this theory. Dr. Thorne has also reported on outbreaks at Lewes and Tideswell, which led to the same conclusion.

The connection between polluted water and the spread of scarlatina has not, so far as I know, been considered at all. It would appear, however, to be possible; and there is an authenticated case on record which seems to point very strongly to this connection. Dr. Ballard, of the Local Government Board, whose etiological skill and caution are beyond dispute, made an inquiry some time ago into the sanitary state of the Lower Sedgley Local Board district. In reporting on the mortality statistics, he stated that of 14 deaths from scarlatina which occurred in the district during the year 1871, 12 were in one street, and 10 of the latter occurred in houses on the side of the street next a brook, while the remaining 2 occurred in houses nearly equal in number and alike in construction and habitation, on the opposite side of the street, the inhabitants of which only occasionally used the brook water. Not a single death from scarlatina occurred in the main street (parallel to the other) the inhabitants of which never use brook water. Again, of the five deaths from scarlatina which occurred in 1872, all happened in the street in question, and three of them in houses on the side next the brook, whilst at the other houses water from the brook was occasionally used. These facts are strongly suggestive of a connection between the scarlatinal mortality in this street and the use of the brook water, and there can be no reasonable doubt that on both the occasions referred to (though other methods of spread were doubtless in operation), the contagium of the disease was carried from house to house through the medium of infected slops and sewage passing from infected families into the brook, and taken from the brook in the water used for drinking, for washing persons and clothing, and for all other domestic purposes.

The proofs which we have of the connection of diphtheria with polluted water have not been numerous. As regards this I have only succeeded in finding one case in which the connection seemed to be distinctly proved, though I have no doubt in my own mind that polluted water can induce it. The case to which I refer occurred at Kirk Ella, in Yorkshire. Three of the first four cases of an epidemic, which subsequently became widely extended, occurred in children attending a school so distant from their home that they had to bring their dinners with them. They would consequently drink systematically of the water supplied to the school, which was found on inquiry to come from an underground tank about nine feet from a catchpit, and otherwise exposed to pollution. The children had complained to their parents of the water being bad, and on analysis it was found to be highly contaminated. Dr. Blaxall, who made an inquiry into the epidemic for the Local Government Board, could not find out how the water became specifically contaminated, though he felt himself unable to ignore the influence which it might have had in the propagation of the epidemic.

No authenticated case of the spread of diarrhœa in England by means of polluted water has come to my knowledge, but I have recently perused the account of a remarkable outbreak of that disease at Hartford, in Connecticut, which was undoubtedly caused by the substitution, on an emergency, of the river water for that from the reservoirs. On examination, it was found that a large sewer opened but fifty feet below the main inlet water-pipe. By the tide and an eddy the sewage was set back directly over the inlet-pipe, and was so pumped up into the water. The onset of the epidemic was sudden, severe, and extensive, and limited to the region supplied by river water. Nearly every family in the affected district had one or more cases, and in many none escaped. Analysis showed the water to be very impure.

DISSEMINATION OF DIPHTHERIA BY MILK.

(From the London Lancet).

The discovery by Mr. W. H. Power, one of the medical inspectors of the Local Government Board, of the dissemination of diphtheria by milk, is of equal importance, to the physician and the hygienist, with that made, a few years ago, by Mr. W. Taylor and Dr. Ballard, independently of each other, of the dissemination of enteric fever by water. The occasion of the discovery was the serious localised outbreak of diphtheria, which. in the earlier months of 1878, happened in Kilburn, and caused so much alarm to the inhabitants of north-western London. In consequence of representations made to the Local Government Board by medical practitioners of the affected locality, Mr. Power was instructed to make inquiry as to the origin of the out-break and his elaborate report of the results of this inquiry has now (after a fashion) been made public. His report is a model of etiological investigation, to which no abstract can do justice, or, what is of greater importance, show the true nature of the evidence upon which the main conclusion of the report is founded, and the complexity of the conditions under which the investigation had to be pursued.

Briefly, it may be stated that the enquiry extended to 264 cases of diphtheria, occurring in 118 households, 38 of which cases were fatal. These cases occurred within a limited area, partly lying in the parish of Hampstead and partly in the parish of Marylebone. A careful inquiry into the several cases, and their relationship established conclusively to Mr. Power's mind that contagion had played but an insignificant part in determining the local prevalence; that there had been no antecedent existence of throat disease in the locality, of which the diphtheria might have been deemed a further development; and that there could be no question of water-contamination as concerned in the out-break, supposing that agency to be conceived. On the other hand, it was ascertained that the area of the out-break very nearly coincided with an area in which, shortly previous to the out-break, certain sewerage disturbances must have given rise to an unwholesome state of many of the houses within it.

There were not wanting several apparent connexions between particular sewerage disturbances and particular incidence of diphtheria in households; but the more closely the study of this relationship was pursued, the clearer it became that unwholesome conditions arising out of deranged and defective sewarage would not account for the outbreak as a whole, although probably having some subsidiary part in it.

Now, early in the outbreak, Dr. Thomas Morton, of Kilburn, who had numerous patients suffering from diphtheria in the infected area, noticed that a great proportion of these patients consumed milk coming from one or other of two retailers, both having their milk from the same wholesale dealer; and it presently was impressed upon his mind, as he pushed his inquiries on this subject, that this community of milk consumption among his patients had some direct relationship with the prevalence of the disease. He brought his surmise under Mr. Power's consideration, and that gentleman frankly states that, at the first aspect, he regarded it as improbable, although he felt bound to subject it to examination. The result of that examination proved that Dr. Morton's evidence was well founded. Mr. Power discovered that the incidence of diphtheria within the area of the outbreak upon the consumers of milk derived from a particular source was such as to forbid the assumption of its being accidental; and, moreover, that wherever this milk had gone, elsewhere than within the area of the outbreak under inquiry, there, within certain limits of time, diphtheria had occurred. In what manner the milk became infected with the diphtheria infection had not yet been determined, but Mr. Power submitted an important suggestion to the Pathological Society on the subject, which is reported as follows:

Dr. Buchanan read a paper communicated by Mr. W. H. Power upon certain observed Relations between Diphtheria and Milk, remarking that when it was remembered how much the etiologists owe to the pathologists in the elucidation of disease, he could not but think that the pathologists would value in their turn any suggestions for further research furnished by the etiologist. The present note was the outcome of Mr. Power's research into the recent epidemic of diphtheria in North London, where it was proved beyond a doubt that the disease had a distribution corresponding to the distribution of a particular milk, and, so far as it is possible, it has been demonstrated that in this instance the milk was the cause of the diphtheria. But how did the milk become capable of distributing the infection of the diphtheria? Here an interesting fact came out in the course of the inquiry, for it was found that the milk-supply came from two sources, one from cows kept at Muswell-hill, and the other from some at Kilburn, both sets belonging to the same owner; and whereas at one period of the epidemic the potency to do harm seemed to come from the Muswell-hill source, and not from the Kilburn, yet later on there was, as it were, a transference of such morbific agency, so that afterwards it was the Kilburn milk alone that appeared to have relations with the infection. No external conditions could be found to account for this, and the conclusion appeared to be forced on the mind that in some condition of the cow as cow, and of her milk as milk, is to be found the possible source of the morbific agent. The history of other milk-epidemics was considered in this connexion. First, as to enteric fever. In many instances in which a relation has been traced between milk distribution and enteric fever there is no doubt of the disease being due to the dissemination of milk contaminated by impure water or air. There are other examples where such introduction of water or air has been but obscurely made out, whilst there remains a third class where the intervention of infected air or water has seemed unlikely, and where the readiest explanation of the outbreak would be afforded, if milk, apart from air or water contamination, could be regarded as the source of the disease. In other words, supposing that milk *per se* were able to produce enteric fever, the observed facts of such epidemics would tally better with the hypothesis of direct infectiveness of milk rather than with the intervention of water or air. In scarlatina there are instances of milk epidemics, in which the facts are such as to suggest that some condition of the milk alone is capable of producing the disease. In diphtheria, in the epidemic just mentioned, no support is given to the hypothesis that any antecedent cases are necessary for the origin or propagation of the disease. As to the probability of such contagious diseases being communicable from animal to man, Mr. Power points out that already we know of several diseases in the cow capable of infecting the human subject. There is vaccinia, *ejusdem generis* with human small-pox, which can be produced in the cow by inoculation with small-pox matter, but which in the cow is a comparatively harmless disease, and not having the properties of human small-pox; for vaccinia in the cow does not tend to spread in the air from cow to cow; it affects the udder and does not appear to influence the milk secretion. There is the "foot and mouth" disease, which affects the milk secretion to a certain extent, and gives rise to apthous affections and disturbances of the stomach and bowels among consumers of the milk Then there is miliary tubercle of the cow. Animals consuming the milk of tubercular cows have been known to get tubercle; and possibly this may be true of man also. The anthrax fever is known to communicate an analogous disease in persons eating the flesh of cattle which have died from its effects, and a throat disease among pigs that have been fed on it and on the milk. Lastly if an instance of a parasitic disease may be taken which comparatively harmless in the quadruped, is of serious import in man, the case of trichinasis may be cited. With such instances in mind there appears to be *prima facie* ground for considering whether diphtheria may not be produced in man by the ingestion of milk contaminated and altered by some condition of the animal itself; and the question naturally arose whether, for instance, in the North London epidemic any particular disease prevailed among the cows furnishing the milk, and if so, whether such disease were specific or not? Whatever it is, it must be an affection which disturbs but little the general health of the animal, whilst affecting the quality of the milk. "Garget" is the trivial name given by cow-keepers to a disease which at times affects milch cows. It is an affection of the udder, and it attacks usually one or two, seldom all four, quarters of the udder, being accompanied by swelling of the part and by the discharge of blood-stained milk from the teat or teats, with subsequent discharge of ropy fluid and blood. But the quantity and quality of the milk yielded by the sound quarters of the same udder are not altered. It was said to lead to no obvious effects in the animals, but Mr. Power was only able to glean information from non-medical witnesses. He also learnt that there was another affection of the cow, characterized by the admixture of blood with milk, without decided affection of the udder. The period of the inquiry into the North London epidemic, when he had learnt the above facts, was too late to test their application in that instance, and his inquiries of the owner of the dairy in question served only to show to him that the cows might suffer from garget without the owner hearing of it, the affection being regarded as so trivial a one. Mr. Power's note concluded by pointing out that in garget we have a disease which can pass unobserved in the cow, and yet possibly it may have relations with human diphtheria, and it was therefore worthy of further study. The President, after alluding to the importance of encouraging the study of diseases of the lower animals, said that he could thoroughly endorse Dr. Buchanan's statement as to the connexion between milk and the epidemic of diphtheria in North London, having been fully made out by Mr. Power in his report. The subject of the communication of diseases in animals to man had always been to him of deep interest; and he would cite hydrophobia of man as being another instance in which the human disease differed in its clinical course from the same affection—rabies—in the dog. On the occasion of the Marylebone epidemic of enteric fever from milk contamination five years ago, some people started the notion that possibly it was not due to the admixture of contaminated water, but was dependent on some disease of the cow. For his own part, he was firmly convinced that then it was due to the water, and it was quite new to him to learn that enteric fever might originate in the cow.

Mr. A. H. Smee then read a paper upon Garget, having been led to inquire into the subject from Mr. Power's conclusion after his investigation into the North London epidemic of diphtheria, that the outbreak was connected with the milk supply, but that there was no evidence to show that the milk was contaminated after it left the cow; and he wished to know whether there existed any form of disease among cattle which, although capable of fouling milk, produced so little constitutional disturbance in the animal, that the disease might escape the notice of dairymen. Mr. Smee found, on inquiry, that a condition of ropy milk connected with a state of the udder, in some districts called "garget," was of such a nature. So lightly is it regarded among dairymen that Mr. Smee found, when making experiments for his work on milk, that his own bailiff, who was engaged in collecting specimens of milk of diseased animals in the district, did not think it worth while to call Mr. Smee's attention to cases of it which were occurring among his own cows. Nor was it much known to veterinary surgeons, as the cowmen treat the disease themselves, and frequently do not inform their own masters, believing that their own ill-treatment or carelessness in milking may be the cause of the disease. The quality of the milk is, however, greatly altered, so as to spoil for 'setting' a large quantity with which it may be mixed; but when used for immediate consumption it is very probable that dairymen would not detect any change in it. Mr. Smee then read the answers forwarded to him from different parts of England and Wales to the series of questions he had framed bearing on the affection, which it is impossible here to give in detail; and then proceeded to state that it was obvious from these replies that under the generic name of the garget there are more than one form of disease. First, a garget referred to traumatic origin, from blows on the udder, or pressure on it, or rupture of a vein in stock-making—*i.e.*, leaving milk in udder for twenty-four to forty-eight hours, in order to enhance the value of a cow for sale. Probably the larger number of cases of ropy milk arise from this cause. Calves fed upon the milk of this kind of garget do not appear to be affected in general health. Secondly, a form of garget produced by cold, which runs an acute course. It does not appear to affect the general health of the animal, or the health of pigs or calves which may be fed with the milk. Thirdly, a form which occurs less frequently, and is possibly of a specific nature. This form not only appears to affect the general health of the animal (as in one case, where a cow had loss of power on the side of the affected quarter), but it also seems to affect the health of calves. An analysis of milk from the affected quarter of a cow stated to have ruptured a vein in stock-making yielded—total solids, 11·97; fats, 2·95; non-fatty solids, 9·02; ash, 0·62. And, although distinctly colored, as from blood, no blood-corpuscles could be found under the microscope, but only particles of bone-coloring matter of indeterminate nature. Another specimen, supplied by Dr. Jacob from a cow suffering from some form or other of garget, yielded—total solids, 11·7 per cent.; fat, 2.5; non-fatty solids, 9·2; ash, 0·76; and the microscope revealed nothing abnormal. Such milk would have been passed as good milk by a public analyst, but at the same time the cow from which this specimen was taken had passed through the acute stage, when probably the milk was more altered. It is a coincidence of great importance, upon which Dr. Jacob would write, that when diphtheria broke out at the Princess Mary's Home at Working this garget existed in the farm which supplied the Home with milk. The chain of evidence connecting garget with diphtheria is at present altogether incomplete. Mr. Smee concluded: "Considering the universal employment of milk as an article of food by all classes of society, I have thought it desirable at once to bring under the notice of this Society my researches on garget, because a thorough investigation of milk in disease would, I venture to believe, reveal many facts of importance to the health of the human subject. It is, however, an investigation that would be surrounded with great difficulties. It would require many observations to be made in different localities under varied circumstances, besides requiring the expenditure of much scientific skill and money. A thorough investigation would be far beyond the means of any private individuals, and perhaps beyond the resources even of our scientific societies; and the subject promises, I think, to be one of sufficient importance to deserve inquiry by Government.'

OUTBREAK OF MILK TYPHOID.

The following is a brief history of an investigation in the cause of an outbreak of typhoid fever in England—from the *Medical Times and Gazette*:

Information having been received by the Local Government of the existence of a very serious outbreak of enteric fever in Chichester, Dr. Airy, one of the Medical Inspectors of the Board, was sent down to inquire into the matter, and we have his report now before us. His inquiry seems to have been very minute and very complete; and besides examining fully into the circumstances of the outbreak of fever, he deals with the general sanitary conditions of Chichester, which, though decidedly better than when reported on by Dr. Seaton, in 1865, appear still to be far from satisfactory. But the only outcome of Dr. Airy's inquiry that we propose to notice is the fact that it appears to be fairly clear that the Chichester outbreak of enteric fever was due to milk-contamination. Without going fully into details, it may be stated the inquiry made regarded cases that occurred in the western and south-western parts of the city. In these parts, in Westgate, Orchard-street, and Canon-lane, during a period commencing from about February, and extending through March into April, there were some fifty persons attacked, six of them fatally, in thirty houses. The first person attacked was a theological student, residing in a good house in Westgate, supplied with water by the Chichester Water-works Company. He was said to have been of a delicate constitution and abstemious habits, "drinking chiefly milk." Four days later, on February 13, another student, in the same house, was taken ill under similar conditions. On the same day a child was attended for typhoid fever in Orchard-street; and here the water was obtained from a private well used by two families in common. On February 15 two children were attacked in each of two families living in Westgate, and supplied by the waterworks. In one of these families there were four children; and the two who were attacked were the two who drank milk. On February 18, a family of the upper class in Canon-lane, in the south-western part of the city, were attacked by typhoid; and subsequently another family in the same lane; and it was found that not only these two families, but all those above mentioned, were supplied with milk from a particular dairy in Orchard-street. Inquiry showed that of the thirty houses infected, seventeen had wells, and thirteen were supplied by the Chichester Waterworks Company; and, it may be added, the water supplied by the Company has been analysed and been found of irreproachable quality. Any suspicion of infection by water-supply was therefore dismissed. As to the drainage, it was bad enough in some of the localities concerned, but not in Canon-lane. But as regards the milk-supply the case was very different. A list was obtained of all the families which at the time of the outbreak were directly supplied with milk from the Orchard-street diary. They were fifty-three in number; and six more obtained milk indirectly or in very small quantities from the same source, making fifty-nine in all. Of these about twenty-six, or 43 per cent., had during the epidemic more or less distinct cases of typhoid fever. In the locality supplied by the Orchard-street dairy were about forty families supplied from other dairies, and nine of the forty obtained also partial supplies from Orchard-street. Among these families no case of typhoid occurred, except in five of the nine partly supplied from Orchard-street. A very strong case seems thus to be made out against the Orchard-street dairy milk as the vehicle of infection. And it is hardly, if at all, weakened by the fact that the dairy served seven families in Tower-street, in the north-western part of the city, and none of these families suffered; for the last street served by the milkman in his daily round was Tower-street, and it happened more often than not that by the time he arrived at that street his own supply was exhausted, and he had to purchase milk from another dairyman to make up the quantity required. The next thing was to make out how the milk came to be infected; and this is the weak part of the case. The dairy was visited and inspected. The well-water used was clear and bright, and was considered by the neighbours to be preferable to most of the well-water in the street. It was analysed by Dr. A. Dupré, and his conclusion was that, if there were no sources of contamination *near* the well, he should consider the water a fairly pure chalk water. But if sources of contamination were near, he thought it highly probable that the water was "slightly contaminated by sewage or urine which had not passed through any great thickness of earth." A few yards from the well in one direction was a privy-pit, and a few yards in another a slop-cesspool. But there was no history of typhoid in the house or near it previous to the outbreak in February, therefore there had been no chance of specific infection. The general management of the dairy was good; there was no suspicion of any wilful dilution of the milk, and the customers generally gave testimony as to its goodness and richness. Dr. Airy then visited the meadows where the cows pastured, and the milking-shed, and he learned that the meadows were bordered on two sides by the "Lavant," a stream which passes along the outskirts of the city on three sides; that the milkman before milking the cows washed their udders and his hands, roughly wiped them upon his apron, and then proceeded with his milking; that when there was water in the Lavant he took from it the water for this washing purpose; and that there was distinct evidence that at the end of January and the beginning of February the Lavant stream was carrying typhoid excreta, for where the stream first approaches the city it runs close at the backs of some cottages, in which there had been a good deal of typhoid fever in the fourth quarter of 1878, extending into January, 1879. The quantity of infected water that could have been introduced into the milk in this way must have been *very* small; but no other source of infection of the milk was discovered. Dr. Airy admits, of course, that the evidence he brings against the milk on this point is very questionable, but he submits that the facts relating to special incidence of the fever on customers of a particular dairy are such as could not be explained on the hypothesis that the outbreak, as a whole, was due to sewer-gas or any other cause than infected milk.

PREVENTIVE OR STATE MEDICINE.

The following are extracts from an address delivered at the forty-seventh annual meeting of the British Medical Association, held in Cork, August 5, 6, 7 and 8, 1879, by Andrew Fergus, M.D., Crown Member for Scotland in General Medical Council; President of the Philosophical and Medico-Chirurgical Societies of Glasgow; late President of the Faculty of Physicians and Surgeons of Glasgow.

Without wasting your time in apology or preface, allow me to introduce State Medicine, past, present, and future, dwelling specially on the two first as a subject of my remarks at this time. No doubt science has made great progress since the time of the Mosaic dispensation; but if we are ever to get quit of zymotic diseases, it will be by adopting the laws of Moses in regard to them—rigorously separating the sick from the healthy. Let us hope the time is not far distant when every medical officer shall be endowed with the same stringent powers as were possessed in the time of Moses, who, we must not forget, in what he did for Israel, acted directly under the Divine authority and guidance, as well as being learned in all the learning of the Egyptians, at that time the most cultivated race in the world.

It was not among the Jews merely that lepers were treated by seclusion or exclusion. In the middle ages, in other countries, they were obliged to live apart from the general community, and if they went abroad they had to intimate their presence in various ways—sometimes by rent clothes, and a cry of "Unclean, unclean"; sometimes by using clappers to signify their approach; or, as in some countries, by wearing two bands of *white* wool (no doubt thus symbolising the nature of their disease), one on the head and the other on the breast. So anxious were communities to carry out preventative medicine in the most complete manner, and avoid all possibility of contagion, that the lepers were interred in separate burying-places. Strange to say, sufferers from this disease became dead, in the eye of the law, as soon as the disease was fully developed ; they could not hold property, nor inherit it, nor dispose of it, in short, they lost all rights of citizenship. Not content with this, in the middle ages, the Church went through the ceremonial of a leper's funeral by a special service, which was retained in the French ritual till a comparatively recent date. The priest, wearing his stole, and holding up the crucifix, sprinkled the leper with holy water, and conducted him to church, singing the usual burial verses as they went along. In the church his clothes were removed, a funeral pall thrown over him, and the mass was celebrated, with the full service for the burial of the dead. He was again sprinkled with holy water, clothed in a leper's dress, and conveyed to a leper hospital, where the priest, to typify his burial, sprinkled him with earth, and warned him never to appear otherwise than barefooted and wearing his black garment, never to enter a church or any place where corn was ground or bread baked, never even to approach a well or fountain.

It has been supposed that leprosy in Europe was spread by the return of the Crusaders ; but there is not sufficient evidence of this, though no doubt it overran Europe about that time, and invaded even the most northern countries ; and we can form some idea of its prevalence when we are told that in the thirteenth century there were upwards of two thousand leper hospitals in France. When the first hospital was founded in Scotland I cannot tell ; but at Prestwich there was one, which, if not founded by King Robert the Bruce, was at least amply endowed by him. It is still a matter of dispute whether or not the king himself was a leper. In the year 1350 we learn that the Lady of Lochow built a leper-house at the Gorbals of Glasgow ; but some hospitals were founded much earlier, even more than two hundred years before the Glasgow institution. Of course these hospitals were not like modern hospitals, numbering their inmates by hundreds ; but still, so general was this disease in the kingdom, and so much was the necessity of isolation considered a duty and a safeguard to the community, that there were about one hundred leper hospitals in England and Scotland, which were under strict regulations, while the most stringent rules were also enacted to prevent the sick from mixing with the well. In some, under certain precautions, the inmates, on particular days, were allowed to leave to buy provisions, while in others they were punishable by death if they left the hospital; and, to emphasise this regulation, a gallows was erected in front of the leper-house.

Occasionally the lepers were allowed to beg in person (with this protection to the public, that they were obliged to use a clapper to warn people to keep from contact with their person). Another curious source of support was from confiscated food. The Scotch Parliament in 1366 enacted :—" Gif ony man brings to the markit corrupt swine or salmond to be sauld, they sall be taken by the bailies, and incontinent without any question, sall be sent to the leper folke, and gif there be no leper folke, they sall be destroyed all uterlie." This shows also that there were inspectors of food in those days.

The regulations for the separation of the plague-stricken were quite as complete and stringent. The sick and their families were obliged to remove out of town. Their friends, under the charge of an officer, could visit them after eleven o'clock, and anyone going before that hour was liable to death. The houses were cleaned, and the clothing of the infected was boiled in the open air. The parties who discharged those duties, and those who were employed as bearers of the dead, were obliged to wear a grey gown, with a white St. Andrew's cross before and behind; the bier was covered with a black cloth with a white St. Andrew's cross. A bell was also attached to it, so that it might ring as is passed along, to warn any person to get out of its way. In September, 1584, the authorities of Aberdeen built ports to prevent the entrance of people who might bring the infection. This does not appear to have been successful, for we find that in May next year the magistrates erected gibbets, "ane at the nearest cross, ane other at the brig of Dee, and the third at the Haven mouth, that in case any infectit person arrive or repair by sea or land to this burgh, or in case ony indweller of this burgh receive, house, or harbor, or give meat or drink to the infectit person or persons, the man to be hangit, and the woman to be drownit." As recently as 1645, two lads who had received change at a public house which was shut up on account of the plague, were next day separated from the family and shut up for a fortnight, their food, etc., being handed in to them. The pocket with the change was cast into the fire. There are many other curious regulations to be found both in Imperial and Burgh laws. I have merely cited the foregoing to show the antiquity of preventative medicine.

Having seen how strict and severe, we might almost say how brutal, were the laws of early times, it becomes an interesting question how all regulations as to preventative measures were allowed to lapse, and not applied to other diseases, such as small-pox, the most obvious as well as the most repelling of our zymotics. It has been imagined that the Reformation might have had some influence on this, but there is no evidence of its being so, and we have already seen that in Scotland the kirk sessions took charge of the leper hospitals. In the minutes of the Kirk Session of Walls, in Shetland, there is a record, under date March 17, 1742, of a resolution to hold a day of thanksgiving for the extinction of leprosy; and the last mention of leprosy in the same session books is in 1776, where there is an order to separate a leper, and to provide food, which was to be brought daily. It may possibly have been the growth of civil liberty which rendered people impatient of any interference with their domestic concerns, while another reason may be that some zymotics have no outward visible eruption, while in others it is so slight as not to be recognised by the public at large.

This brings us to the consideration of the results that have been achieved by the labors of the sanitarian. . . . I shall not trouble you with observations on each year, but shall rather dwell on some leading features. And I would note that there is not a single death from *diphtheria* registered till 1851, when we find two deaths per million of the population. It did not spread rapidly, for in 1857 there are only sixteen deaths in the same. It then rises very suddenly, and reaches its maximum in 1859, when there were as many as 487 deaths per million of the population. Since then it has fluctuated greatly, but has only once been under 100 deaths per annum for every million of the population. I have no doubt it will occur to many of you, possibly to most of our younger members, that although there were no cases of diphtheria registered before 1851, still deaths from it did occur previously to that, but were registered by some other name.

The disease most likely to be confounded with diphtheria is, of course, *croup*. If, before the appearance of diphtheria as a cause of death in the returns, it had helped to swell the number of the deaths from croup, then, as soon as it became a considerable figure in the Registrar's returns, there should have been a fall in the croup column. To ascertain whether this was the case, I procured a table of the deaths from that disease, and now show you in a diagram all the deaths both from croup and diphtheria. We generally find that when the death-rate from diphtheria is high, the death-rate from croup is high also; and I think it is not unfair to conclude that many of these last were in reality deaths from diphtheria.

I now crave your attention to the *diarrhœal* group, the table in regard to which brings out singular results. Beginning with the small nnmber of 225 deaths per million in 1838, we find that they amount to 472 in the last year (viz., 1842) of the first quinquennium. It would be tedious to go over the table year by year; you will see the progress of these diseases in the diagram, and you must bear in mind that the years 1849, 1854, and 1866 are exceptional, each of them having been marked by an outbreak of cholera. I ask you to compare the first five years with the two last completed periods of like duration. You will find that the average for the first five years (viz., 1838-1842) was 298; for the five years 1867-1871 it was 1161; and for the last completed five years, 1872-1876, 998. In none of these periods was there the disturbing element of epidemic cholera. It is not a little surprising to find that in the second last period there were nearly four times as many deaths from this group as in the first period, and that even in the last quinquennium there were more than three times as many deaths from the diarrhœal group as in the first period of five years.

If we consider the other zymotics mentioned in the table, we shall in some of them be able to trace the benefits resulting from the labors of the sanitarian. First comes small-pox, the deaths from which vary from a maximum of 1064 per million of the population in the first year (viz., 1838) to a minimum of 40 in 1875. If we look to the quinquennium, we find that the fourth is the lowest (1857-61, with 187), and the first is the highest (viz., 577), while in the last quinquennium the deaths are 232. It is to be hoped that, as vaccination and revaccination are more stringently carried out, there will be a great diminution in the deaths from this disease. It is most desirable that the prejudices against vaccination should be removed, and possibly this might be greatly helped by the use of animal instead of human vaccine.

Scarlet Fever.—The deaths from this disease vary considerably in the individual years, but not to such an extent if we look to the averages for five years. It is very satisfactory to observe that the last quinquennium has the lowest mortality, viz., 738 in the million of population.

Measles.—The highest mortality from this disease occurs in the first quinquennium, and is 440; the lowest (viz., 370) is in the third; and in the last the number is very little higher, being 375.

Whooping-cough varies less than any of the other zymotics, the maximum death-rate being 542 in the fifth quinquennium, and the minimum 472 in the second.

Fevers vary greatly; the first and second quinquenniums are the highest, viz., 1053 and 1197 respectively, while the last is by far the lowest, viz., 555; and there can be no doubt that this great improvement is owing to what sanitarians have effected.

Better house accommodation and the supervision of medical officers of health have tended in a most marked manner to diminish typhus, which prevailed during the first two periods. This is made plain when we look to the relative prevalence of fevers, since in 1869 they were divided into three groups. We find that typhus falls from a death-rate of 193 that year to 49 in the last year, viz., 1876.

Typhoid does not show so well, but the maximum is still in the first year, and the minimum in the last; the numbers for each individual year being 1869, 390; 1870, 387; 1871, 371; 1872, 379; 1873, 376; 1874, 375; 1875, 372; and 1876, 311.

Simple continued fever gives almost as favorable results as typhus, the maximum in 1869 being 245, and the minimum in 1876 being 83. Allow me to direct your attention to the totals of the zymotics mentioned in the table, which you will find lowest in the first and last quinquenniums. If, again, you look to the total deaths per million of the population you will observe that the last quinquennium is the lowest, viz., 21.729; the fourth is next, viz., 22.030; and next to it the first, viz., 22.078.

We now turn our attention to the future of State Medicine, and would observe that the standard to be aimed at should be both practical and attainable. I have been in the habit of saying that we should never rest contented till our towns are as healthy as rural districts. The healthiest district over a series of years is Glendale, in the north of Northumberland, in which the death-rate is but 15; and if we had this death-rate all over the kingdom the result would be a diminution of nearly one-third of all the deaths. In the pursuit of this aim, let us inquire whether we can draw any lessons from the Registrar-General's returns.

The first facts that strike us are the increase in the diarrhœal group, the addition of a new zymotic, viz., diphtheria, which does not appear till 1851, and the small diminution of typhoid in the fever group.

If we bear in mind that these are excremental-pollution diseases, I believe we shall find the reason of this increase in the fact that we have been careless in the disposal of our excreta, and have been drinking water and breathing air contaminated by it in a state of decomposition.

When I first turned my attention to public health, I had the most perfect faith in water carriage for the removal of the refuse of communities, but investigation, experiment, and experience have obliged me to change my opinion.

My first investigations referred to decayed soil-pipes, and from observation and analysis I was led to conclude that the decay was produced by gas. I shall not enter into detail on this subject, but merely mention one point of practical importance, that pipes open at the top to the external air last longer than those which are closed.

It was many years after my conviction that the pipes were destroyed by gas before I could satisfactorily explain how it got into them. I knew that there is always decomposition going on in most traps, but the quantity of gas generated there did not appear to me sufficient to account for this action on all lead pipes that had been long enough in use. Tension in sewers occasionally overcoming the traps, being only an accident, could not be an important factor in a constant result. After much consideration, I was helped to a solution of my difficulty by Graham's experiments on the diffusion of gases. I argued that if these diffuse so readily through gases, they might probably do the same through water; and thus, after first being absorbed on the sewer side of the trap, they might be discharged on the house side of the same. I experimented on the subject.

Mr. M'Tear, F.C.S., repeated these experiments with larger tubes, with similar results. He found that the gases passed in a peculiar mode through the water; he says: "A curious fact, and yet one quite to be expected, is here shown, viz., that light gases pass through by the top of the bends, and heavy gases at the bottom; also, that the gas does not saturate the water in the trap by any means, but that it first saturates the surface next the vapor, then the gas seems to sink down in a fine stream, and gradually travels through the liquid to the other side, when it again spreads out and begins to diffuse both into the atmosphere above it, and downwards through the water in the trap; in fact, the most apt illustration of the general appearance is the gradual dispersion of a so-called smoke ring from the funnel of a locomotive."

Another point I had to consider was the behaviour, if we may so term it, of water and excretal matter. If the kidney and bowel secretions are kept separate, decomposition goes on very slowly; if they are mixed it is more rapid, and if water be added it is much accelerated. It is a popular opinion that water is a purifier, but in regard to these matters it is a mere shunter. It merely removes the nuisance from my door to deposit it somewhere else; it conveys organic refuse, but does not destroy it; it merely carries the nuisance from the city to make it a source of pollution in the river. Chemical science tells us that water of itself and by itself has no purifying powers; if you could shut up pure water and pure filth (if we may use such a term), they would remain the same for all time, the only purifying element in the water being the small modicum of air dissolved in it. In a shallow brawling stream, this exercises a considerable power, as the water is constantly being re-aërated; but very slight in a deep, sluggish stream, and hence the ready pollution of our rivers by organic refuse. I hope I shall not be misunderstood and considered as in any way defending the abounding abominations of the old privy system, when I say that the change to water-carriage was adopted without sufficient investigation, and with no adequate conception of the results which would follow. The system was hailed as a great boon both to comfort and decency, and it was at that time supposed that if these offensive matters were once out of sight there was an end of them, and no evil consequences were dreaded.

But another most cogent reason against passing these offensive matters into our rivers or the sea, is the consideration that such a course is directly opposed to the laws of nature, in the economy of which there is no such thing as waste. Earth is the original mother of all organised matter, and her law of rotation seems to be first plants, from which animals draw their support. What is given off from animals should be restored to the earth again. We know that the carbonic acid so freely given off by animals is at once utilised for the growth of plants; but I believe if it had been left to our own disposal, the whole world would have been asphyxiated long ago. The other excretions of animals are equally necessary for the growth of the vegetable world. After years of further study and investigation, I can only adhere to my opinion expressed many years ago, that "if it is true that organic poisons producing disease may pass from sewage; if it is true that cholera, diphtheria, typhoid fever, and diarrhœa are traceable to taking into our systems by air or water the results of decomposition of human excreta; if it is true that these diseases, and others from the same causes, swell our death-rate and carry off some of the most valuable of our population, then, gentlemen, I affirm that the only true sanitary solution of our difficulties so that all excreta shall either be returned to the earth or subjected to its chemical action, rendering decomposition impossible; and I am furthermore sure that if a tithe of the time, skill, and ingenuity, and one-thousandth part of the money, that have been devoted to water-carriage had been spent in investigations in this direction, the problem of the sewage question would have been solved long ago."

ARSENICAL POISONING FROM WALL PAPER.

Jabez Hogg (*Sanitary Reeord*) in *Detroit Lancet* calls attention to the masked forms of arsenical poisoning arising from the use of wall papers that are impregnated with arsenic in some of its forms. Of six cases cited the headings are 'Acute Arsenical Conjunctivitis,' 'Ciliary Blepharitis and Nebula,' 'Ciliary Blepharitis,' 'Acute Conjunctivitis and Dimness of Sight,' 'Conjunctivitis and Skin Eruptions,' 'Fainting, Dimness of Sight and Paralysis.' In all these cases the symptoms were masked at first, and only became fully understood when an analysis of the wall paper of the rooms in which the patients lived, or in some causes an analysis of portions of fabrics on which the afflicted people had worked had been made.

Mr. Hogg says that the general symptoms observed in cases of wall paper poisoning are considerably modified by constitutional susceptibilities of idiosyncracies. The earliest indication of the absorption of the poison, and that most frequently noticed, is an excessive irritation of the mucous tract, and which is nearly always attributed to a catarrhal attack. Usually, as the nasal irritation subsides, a feeling of faintness, sickness, constant headache and great prostration occurs. In other persons the first symptoms of poison are dyspepsia, stomach sickness or bilious attack. If sleeping in a room newly papered, the sufferer will awake in the morning unrefreshed, complaining of sick-headache and sore throat and smarting of the eyes.

In many instances it has been noticed that after breathing the arsenical dust a peculiarly aggravated form of hay fever, or spasmodic asthma, or even bronchitis, is experienced, whilst in others fainting fits, vomitting, irritative fever, dysentery, nervous prostration, paralysis, skin eruptions, psoriasis, conjunctivitis, dimness of sight, etc., succeed each other in regular sequence. The following symptoms may be enumerated as having been from time to time observed in connection with wall-paper poisoning. Violent fits of sneezing, lachrymation, sore throat, difficulty of breathing, spasmodic asthma, bronchitis, faintings, constant headache, nausea, sickness, great thirst, eruptions and ulcerations over the skin, conjunctivitis, dimness of sight, nervous depression, general debility or great prostration, cramps, colic, palsy, paralysis, and coma, followed by death. Some of the earlier symptoms are either modified or delayed by the manner of breathing, that is whether a person breathe through his nose wholly and with the mouth quite closed, or through the open mouth. Also the quantity of dust moving through a given space, as for instance, in a chromo-lithographic printing-office. The men employed at the work, when using green pigments, complain of symptoms of poisoning in fifteen or twenty minutes after beginning that particular work.

From the above it will be seen that the symptoms of conjunctivitis are only a small portion of those helonging to the symptoms of general arsenical poisoning, but because the source of the irritation is so obscure, the cases need careful attention to arrive at a full diagnosis. The more constantly recurring kind of cases of arsenical poisoning are 'relapsing bronchitis,' 'chronic bronchitis,' 'general debility and fainting fits,' 'cramps and depression.'

Two points are of interest in the clinical history of these cases. 1. The symptoms, although of an alarming character, are always accompanied with a fairly good pulse. 2. The attacks are usually of a spasmodic character, that is they are not persistent in their duration, and thus they help the diagnosis, which is sometimes surrounded with all manner of perplexities.

It is commonly believed that green papers only are colored with arsenical pigments. But this is an error. A variety of other papers besides greens are quite as dangerous—blues, mauves, reds, browns, and even white papers. Of the pigments employed may be mentioned the teroxide of arsenic (arsenious acid), which is the most common ingredient as well as the most dangerous. This is an ingredient in Scheele's green, which is composed of one part of arsenic teroxide, and cupric oxide two parts. Schweinfurt green, Vienna, Brunswick, or emerald green is an aceto-arseniate of copper. Another pigment is composed of chromic and ferric arseniate, whilst arsenious acid is used in the preparation of aniline dyes, and of red anilines in particular. The magentas are no better. Sodium arsenite is almost exclusively employed in calico printing, white alumina arseniate is used for fixing the colors.

Another important fact is that arsenical pigments are volatile. Although the color and odor may not always attract attention, it is nevertheless a fact that an appreciable quantity of gaseous and solid particles of arsenic will be separated by the heated air of an ordinary sitting-room in summer time. The more immediate special dangers to be apprehended from arsenical wall-papers are two-fold: 1st. The danger that arises from the very minute crystals of arsenious acid that separate from the papers and fabrics and float in the air. 2d. The danger from the gaseous products—arseniuretted hydrogen—evolved by the decomposition of the organic matter mixed with the arsenic, and which is absorbed into the system both through the absorbtive surface of the air passages of the lungs and through the skin. It is highly probable that a considerable quantity of gas is evolved from arsenical wall papers.

Arseniuretted hydrogen contains one grain of arsenic in each cubic foot of gas. Several cases of poisoning have been traced to the inhalation of this gas. The late Dr. Elliotson attended several members of a family all of whom were poisoned by breathing the gas evolved from decomposing organic matter and arsenite of copper. The principal symptoms observed during the illness of the family were nausea, vomitting, great thirst, watering of the eyes and nose, foul tongue, rapid pulse, varying from 120 to 100 per minute, and, after apparent recovery, long continued pains of the limbs. The poison was eliminated by the kidneys, in which organs it gave rise to great irritation.

These two facts seem to be clear: 1st. The dust separated from wall paper that is colored with arsenical pigments give rise to a peculiar train of symptoms, and, 2d, under certain conditions arseniuretted hydrogen is evolved from the same papers and adds materially to the virulence of the arsenical dust.

PROGRESS IN THE MANAGEMENT OF CONTAGIOUS DISEASES BY THE BROOKLYN, U. S., BOARD OF HEALTH.

BY J. H. RAYMOND, M.D., SANITARY SUPERINTENDENT, MED. SOC. KING'S CO.

(Extracts from the Proceedings.)

Until very recently the certificate of any physician was sufficient authority for the re-admission of children who had been suffering from scarlet fever or other contagious disease to the schools of the city, and was also adequate for the return of children from a family or house in which these diseases had existed. The experience of the Health Department demonstrated to its officers that such certificates were given long before the danger of contagion had passed, at the solicitation of parents ambitious that the standing of their children in their classes should not be impaired.

In order to diminish as much as possible the spread of contagious disease, the Sanitary Ordinances were amended by the Board of Health in February, 1879, and having been approved by the Common Council and Mayor, and duly advertised, are now in force. They are as follows:

SECTION 142. That no principal or superintendent of any school, and no parent, master or custodian of any child or minor (having the power and authority to prevent) shall permit any child or minor having scarlet fever, diphtheria, small-pox, or any dangerous infectious or contagious disease, or any child residing in any house in which any such disease exists, or has recently existed, to attend any public or private school until the Board of Health shall have given its permission therefor; nor in any manner to be unnecessarily exposed, or to needlessly expose any other person to the taking or to the infection of any contagious disease.

SEC. 166. . . And all rooms or apartments occupied by any person sick of any contagious disease, shall immediately upon the death or recovery of such person, be, by the person having charge or custody of such rooms or apartments, thoroughly fumigated by the burning of sulphur, or otherwise, in such manner as may be required by the Board of Health; and all clothing, beds, bedding or infected articles used by or in caring for such sick person, shall be likewise fumigated or disinfected, or, in extreme cases, destroyed, as the Board of Health may direct.

Since this has been in force nearly 1,000 children have returned to schools on these permits. It will also be noticed that rooms or apartments occupied by any person sick of any contagious disease must be fumigated with sulphur after recovery or death, and that this duty devolves upon the person having charge of such rooms or apartments, and not upon the Board of Health. This department has, however, since this ordinance was passed, fumigated 300 premises at the request of citizens, furnishing the material when the people were unable to pay for it. The method recommended is as follows:

For the purpose of fumigation, the windows and doors of the room and the fire-place should be tightly closed. Everything that was in the room during the sickness should be left in it. If the carpet was not removed when the sickness commenced, it should be taken up and raised as far as possible from the floor on chairs, or in any other manner; one board of the floor should be taken up.

An iron kettle should then be raised from the floor on bricks, and five pounds of sulphur placed therein, or one pound of sulphur for each thousand cubic feet to be fumigated; upon this two ounces of alcohol are to be poured and set on fire. Every one must withdraw from the room immediately, as the fumes are poisonous.

The precautions taken with the carpet and the removal of the board from the floor allow the fumes of the burning sulphur to pass beneath the floor and between the walls, and to destroy any germs of disease which may be there. At the expiration of ten hours, not before, the room may be opened. All the windows, doors and the fire-place should remain open for twenty-four hours, that everything may be well aired.

Section 123 of the Sanitary Ordinances is as follows:

That every physician shall report to the Sanitary Bureau, in writing, every person having a contagious disease (and the state of his or her disease, and his or her place of dwelling and name, if known) which such physician has prescribed for or attended for the first time since having a contagious disease, during any part of the preceding twenty-four hours; but not more than two reports shall be required in one week concerning the same person; but every attending or practising physician thereat must, at his peril, see that such report is or has been made by some attending physician.

Section 5 says that the phrase 'contagious disease' shall be held to include all persons sick, affected or attacked by a disease of an infectious, contagious or pestilential nature (more especially, however, referring to the cholera, yellow fever, small-pox, diphtheria, ship or typhus, typhoid, spotted, relapsing and scarlet fevers), and also including any new disease of an infectious, contagious or pestilential nature; and also any other disease publicly declared by this Board dangerous to the public health.

Every twenty-four hours a report is sent to eighty schools in the city, including all the public schools, and many of the parochial and private ones, of all the cases reported that day. These are written with Edison's electric pen, and printed on one of his presses; to do it with pen and ink would require so many clerks as to make it impossible. Through the kind co-operation of Col. James McLeer, postmaster, these notices, received by him at four o'clock in the afternoon, are delivered by the carriers on their half-past four o'clock trip. In this manner, the principals are notified of any contagious sickness before the school assembles in the morning, and can send any children home who come from the infected house. When a house is no longer infected, the premises having been fumigated, the principals are notified of that fact also.

It sometimes happens that children desire to return to school as soon as the house is fumigated, but a period of seven days from the last exposure, in cases of scarlet fever, must relapse, lest the child re-admitted might at the very time be incubating the disease. In brief, as long as there is danger of carrying the disease to school, so long is the child excluded.

CONDITIONS OF IDIOCY.—In the annual report *(Scien. Am.)* of the Pennsylvania Training School for feeble-minded children, for 1878, two interesting facts are noted. The statistics of the institution show that a larger proportion of males than females are admitted, the ratio being greater than can be explained except on the presumption that idiocy, like other infirmities, strikes with most severity the male; also that in the order of birth nearly half the idiots are first-born children, a fact strongly suggestive of a special line of ills to which the first-born are peculiarly liable, and to which they so often succumb either in death or in chronic disease. These disadvantages, the superintendent remarks, are often a sad recountal of the young mother's unfitness either for the genesis, nourishment, or intelligent care of her offspring. It is also noted of the whole number (288) present in the institution at this date 150 are half orphans and 74 whole orphans. This startling fact would seem to prove the assumption of some writers, that idiocy is one of the results of a degeneracy of race, by which, after a long exposure to debilitating influences and excesses, it ends in premature death, in scrofula, idiocy, or sterility.

Editorial.

WATER SUPPLY.—ARTESIAN WELLS.—THE TORONTO SUPPLY.

Pure water for drinking, and indeed for all domestic purposes, is absolutely indispensable, not only to good health but to perfect purity of body and that degree of elegant comfort for which everybody aims.

In all ages, from the very earliest until recent ones, it is evident that men have felt the great importance of a pure water supply, and have often incurred immense expense in order to secure it—in order to bring to their cities from far distant places, or from where the most pure water could be obtained, or to purify it or preserve it in a state of purity. It is only, it appears, within the last few centuries, that men have fallen into indifference in regard to the purity of the water supply. Quite recently, within comparatively few years, there has been apparently a general awakening from this indifference, to a sense of the close connection between pure water and good health. People are now anxiously seeking information in reference to the best means of obtaining pure water.

Rain water, as it falls from the clouds, is the purest of all known natural waters. As it falls through the air it absorbs oxygen, nitrogen, carbonic acid gas, and ammonia, which give it its agreeable taste. As it approaches the earth, however, especially in cities and towns, rain water washes the air and receives from it organic matter and all sorts of impurities which the atmosphere may happen to contain, and thus becomes more or less foul. Water, especially rain water, is a most powerful solvent, and dissolves and takes into itself portions of almost every substance with which it comes in contact. On reaching the surface of the earth and in percolating through the upper strata of soil, rain water meets everywhere with decaying, soluble organic matter, animal and vegetable, even, sometimes the contagiums of diseases, and invariably takes up some portions of these impurities ; and whether it finds its way into shallow surface wells, or into streams, rivers and lakes, it is not suitable for drinking or other domestic purposes until it is again purified, either by nature's great process of distillation—evaporation from the earth by the heat of the sun, into the air, forming rain clouds, to be poured down to wash the surface of the earth again—or by artificial filtration through some suitable media. That portion of rain water, however, which trickles and filters down very deeply through the deeper strata of soil, free from organic matters, will eventually become entirely free from organic impurities, and if it does not in its course meet with and dissolve and take up too much mineral matter, it may be obtained from deep wells as a pure and wholesome water.

The water which is exposed to the sun and air and currents, in rivers and lakes, gradually becomes somewhat purified by the oxidation or decomposition of the organic impurities, and by subsidence; but probably as fast as the water can be purified in this way, other impurities find their way into it from the same sources—from the smaller streams and brooklets, collected to a greater or less extent from surface washings, and which supply the rivers and lakes with water.

Not much reliance can be placed upon purification by oxidation, through exposure in streams, &c. Dr. Parkes says in reference to this: 'Much influence has been ascribed to oxidation, and doubtless in part correctly; but Dr. Frankland has shown its effects to be limited. The Irwell river, after passing Manchester, runs 11 miles to its junction with the Mersey without further material pollution, and falls over 6 weirs; yet the purification by oxidation is trifling. By syphoning water from one vessel to another so as to represent a run of 96 miles, the organic carbon was only reduced 6.4 per cent., and the organic nitrogen 28.4 per cent.'—(*Practical Hygiene, Foot Note.*) Hence the waters of rivers and lakes are never pure or free from organic contamination, though reagents may not show the presence of much more than a trace of organic matter.

It does not therefore seem possible for the water of any river or lake, even in this not very densely populated Canada, however large the body of water, to be sufficiently pure for drinking purposes, without filtration. Such waters are never safe for use, and it is false economy for any community to use them. Much more than will be saved by not filtering them, will be spent through sickness resulting from using them unfiltered.

As the obtaining of a pure water supply for a town or city by collecting or storing rain water, though possible, is not very practicable, and as it is well known it is never safe to use the water of ordinary shallow wells in towns and cities, the only two sources of supply worthy of notice are that of filtering on a large scale river or lake water, or that of obtaining water from very deep or artesian wells, which is usually very pure, and is, especially, free from organic matters, by far the most important impurities in ordinary waters.

Many substances are used as filtering material, but all, of whatever sort, must necessarily be reapeatedly changed, or washed and exposed to the sun and air. The filtering of large quantities of water, therefore, becomes somewhat expensive. The more impure the water is, of couse, the more frequently the filtering media must be renewed, and the more expensive the process of filtering becomes. Comparatively, however, the cost is not great, and it is always much better to incur the cost than to use impure water. The entire water supply of London, England, derived from the Thames, is filtered before it is used. The London Water Companies usually employ sand and gravel for filtering purposes. At certain intervals the sand has to be cleaned.

The London Water Companies have the filters so constructed as to permit usually from 70 to 75 gallons of water to flow or percolate through each square foot of filtering surface every 24 hours. A purer water than the Thames might pass through a like filter at a more rapid rate, by means of a greater pressure of water.

A city the size of Toronto, at the rate of filtering usually adopted by the London companies, would require a filtering surface of about 200 feet square (40,000 square feet), in order to supply from 35 to 40 gallons per head per day. A city of 10,000 inhabitants could be supplied at the same rate by a filtering surface 50 feet by 100 feet. The water of most of our Canadian streams and lakes might be filtered at perhaps double that rate.

Other filtering materials are more costly than sand or gravel. The sand should not be too fine, and the 'sharper' it is the better. Animal charcoal well prepared and washed and pressed, is perhaps the best filtering material, though it is rather too expensive for ordinary use. Dr. Frankland has, however, recommended that the water supply of towns should be filtered through this substance. He has passed over 90,000 gallons through each square foot of charcoal 34 inches thick, in 24 hours.

ARTESIAN WELLS.

The subject of Artesian wells for water supply has quite recently commenced to attract considerable attention. It is said that an artesian fever is spreading on this continent, and that it started with San Francisco making an effort to reduce the cost of water supply.

Undoubtedly most abundant, pure and good water may be obtained from artesian wells, and often at less cost than in any other way. The water has usually trickled through such a great depth of earth, sand, stone, rock, &c., that it is quite free from organic contamination, and very often contains no objectionable mineral ingredients whatever. The supply is not unfrequently so very abundant that one well will supply many thousands of people. Not the least strange thing connected with artesian wells is that, while one well may supply a salt water unfit for use, another less than 100 feet distant may supply excellent water. Sometimes an artesian supply is obtained after only boring 300 feet or even 200 feet, and occasionally even much less than this. The supply is usually permanent, especially from the deep wells.

There is a well at Aire, in Artais (from which name the word 'artesian' is derived), France, which has flowed steadily for about a century, the water rising above the surface at the rate of 200 gallons a minute. At Lillers, in the same country, one well has given a constant yield since the year 1126.

There is an artesian well at Grenelle, a suburb of Paris, in which seven years and two months of constant labour were devoted to the boring, the rock being extremely difficult to pierce. The water-bearing stratum was reached at a depth of 1,802 feet, when the water was discharged at the rate of upwards of 880,000 gallons in 24 hours. The force is such that the water ascends to a height of 120 feet above the surface. The present yield of the well is about 500,000 gallons in 24 hours. The water is at a uniform temperature of 82° Fah., and is used to warm some large hospitals in the vicinity.

The supply of water for Potsdam, a city of 50,000 inhabitants, near Berlin, Prussia, is obtained from 14 artesian wells, about 30 feet apart.

The city of Pesth, Hungary, has almost accomplished the task of obtaining an unlimited supply of nearly boiling water, which will be available for public and private use. The ready heated fluid is obtained from a deep artesian well, from which, when completed, the water will issue in a mighty fountain, to the height of nearly 50 feet. The Pesth well has already attained a depth of 3,120 feet. The water now issuing from the bowels of the earth, three-fifths of a mile below the surface, has a temperature of 161° Fah., and the work will be prosecuted until a warmth of 178° Fah. is obtained. The meaning of these figures will be better understood when it is remembered that the temperature of a hot bath is 98°, while that of boiling water is 212°. The daily supply is already 175,000 gallons, a quantity which will be greatly increased at the enhanced depth.

In the desert of Sahara some seventy-five shafts have been sunk, which yield an aggregate of 600,000 gallons per hour. The effect of this supply is said to be plainly apparent upon the once barren soil of the desert. Two new villages have been built, and 150,000 palm trees have been planted in more than 1,000 new gardens.

At Her Majesty's dockyard, Chatham, England, a new artesian well lately reached a depth of 903 feet, and the water then overflowed the top of the well.

The deepest bore in the world is one, begun as a rock salt mine and yet uncompleted, at the village of Sperenburg, some twenty miles from Berlin. Its present depth is 4,194 feet.

In the United States the deepest artesian well is that bored for the insane asylum in St. Louis, Mo. This has reached the enormous depth of 3,843 feet, or, in that locality, 3,000 feet below the sea level. This would give water pressure at the bottom of 1,293 lbs. to the square inch.

Numerous artesian wells have been sunk along the line of the Union Pacific railroad, in order to obtain water for the locomotives and for the workmen laboring in the coal mines along the route. One well is at Separation, 724 miles from Omaha, and another one is at Rock Spring, 83(2) miles.

At Prairie du Chien, Wisconsin, an artesian well, 960 feet deep, was started in 1876, to discharge 869,616 gallons of water daily, with a force equal to a head of 900 feet.

The artesian fever has spread throughout California. Numerous wells have been sunk in San Francisco. Some of them have been affected by the tides. Some wells close to each other have affected each other's supply. Others, grouped even more nearly together, have seemed to be entirely independent as to water resource. Brackish water has been found in some wells; in some very hard water; in others good soft water.

There are four flowing wells in Tulare county: one near Tipton, of which so much has lately been published, and three others. This well struck water at 280 feet below 7 feet of sandstone. It went 30 feet deeper through clay and four gravel beds, each of which gave water. It yields 86,000 gallons of water, containing only six grains of solid matter to the gallon.

At Battle Mountain, Lander county, Nevada, on the line of the Central Pacific railroad, there are several artesian wells. The water is cool and quite free from deleterious chemical substances. The borings are about 150 feet in depth, and the geological strata are mainly volcanic detritus : clay strata, gravel and sub-alluvium.

Some citizens of Winnemucca, Nev., have clubbed together to pay expenses of a trial well. Arizona has caught the fever. Montana is just getting it, and her press is beginning exhortation to artesian efforts.

In considering the origin of artesian supplies and the place for boring, three general points are to be noticed : The configuration of the country, character of the material occurring in the neighborhood, and the climate. For the following on these points we are indebted to the *Scientific American Supplement*; as we are likewise for most of the above in reference to artesian wells.

In attempting to form some judgment as to whether or not artesian well boring will prove successful in a given locality, the general principal on which artesian wells depend must be borne in mind. Water falling on the earth as rain or snow, or whatever, is disposed off in one of three ways: Part flows rapidly over the inclined surfaces, collecting in rills, and rivulets, and rivers ; part sinks into the earth ; part is evaporated. That which disappears into the earth continues its course through permeable material until it meets with some impermeable obstacle. If this obstacle be a rocky cavity the water trickles into it, filling it up until some crevice is found through which the water can continue its always downward course.

If the obstacle met with be the rocky sides of some old water-course long covered by material washed down its sides or carried into it by other means, the water follows the rocky incline to the bottom of the old channel, and runs down this to appear at the foot of the old ravine in springs, or to meet other impassable obstacles, and collect in the reservoir furnished by the old river bed until it again finds outlet.

If the obstacle be an extended and somewhat regular stratum of impermeable material the water will run along upon it, seeking the lowest portion, and filling up the space or the porous material above the stratum until again some outlet is found. If the impermeable stratum has beneath it more porous material and below that again a similar impermeable stratum, and if the two are bent in such a way as to present their edges upwards so that the percolating water has access to the porous 'filling,' then the two together form a kind of U tube, which may become filled with water, the water at the bottom being subject to pressure corresponding to the height to which it has risen in filling the tube. The water so caught in porous matter between impermeable strata continues in its 'tube' until some break is found, and if no extensive break is met with there is a constant tendency for the water to force its way, under the influence of the above-mentioned pressure, through the upper stratum of the tubes and to appear in springs, such as are found often in the centre of valleys at considerable distances from hills. This is likely to be the case only when the water-bearing strata do not reach to a great depth. When the strata are deep they may become swollen with water, having perhaps no outlet, or an outlet at great distance from the outcrop, as, for instance, under the ocean. In the latter case the strange phenomenon of fresh-water springs in mid-ocean occurs.

David Dale Owen, in the report of a geological reconnoissance of Arkansas, made in '59 and '60, gives three conditions, which are necessary to the successful boring of artesian wells: First, the fountain-head must be higher than the boring: second, there must be a general dip of the surface from the fountain-head toward the well: third, there must be alternation of porous and impervious strata. These are all self-evident. The first two illustrate well the popular idea of the best place for boring wells. A valley is *par excellence* the ideal location for a well. But 'valley' need not imply the neighborhood of hills. On the contrary, the vaster the tracts of low land, and the more widely separated the hills which form the 'valley,' so long as the necessary conditions are fulfilled, the better chance for a deep well to obtain a large and lasting supply. No hills need be in sight, and their absence should not discourage the water prospector. The larger the circumference of the rim surrounding any valley, the greater, other things being equal, the surface exposed for the catchment of water.

The most favorable condition of strata, as to inclination, is found where they dip on all sides from the rim to the center, forming a basin. They may dip towards an axis, forming a trough. Again, they may dip in but one direction, forming a nearly plane incline, in which case there can be little choice as to location of the borings.

Not only the dip of the strata demands attention, but the condition of their outcrop is also of great importance. English engineers distinguish three or four different kinds of outcrop of water-bearing strata. The porous strata that absorb the water may appear on the surface at the top of a hill, the most unfavorable occurrence. They may outcrop on the slope of the hill, and become so worn to conform to the general inclination of the hill, that the water running over their edges may have so great a velocity that only a small percentage can be absorbed. This will vary with the slope. At the foot of a hill, and in a depression, is the most favorable occurrence of the outcrop The outcrop may be naked, so that the water may be directly absorbed, or it may be covered by drift material; in this case the character of the drift determines the amount of water that may reach the porous strata.

Besides the inclination of the water-bearing strata, and the condition of their outcrop, their regularity and continuity must be looked after. Often a bed of clay beneath a porous stratum is found to thicken to such an extent, that it is impossible for water to find a passage. An upthrust of any impervious material through the water-bearing strata may blast all hopes for artesian water in an otherwise favorable locality. In such cases the land lying between the fountain head and the barrier is the more likely to yield artesian water, as in some instances may be indicated by the appearance of springs, which indeed may be the only evidence of the existence of the barriers.

All these details of the configuration of the country may be studied with advantage before attempting to bore wells in an untried region, especially when it is intended to make that outlay which is necessary in sinking to great depths.

Spon says, in his ' Practice of Sinking and Boring Wells ": ' Every permeable stratum may yield water, and its ability to do this, and the quantity it can yield, depend upon its position and extent.' The type of permeable material is sand; of impermeable, compact clay. As rock is full of irregular fissures which do not exist in it in regular strata, there is small chance of obtaining water in it, and for this reason, as well as on account of the difficulty of boring in it, rock is avoided as much as possible. Between sand and clay there are innumerable grades of permeability according as the one or the other predominates or as other material, for instance gravel, is mixed with these. Experiments by Prestwich, quoted by Spon, have shown that ordinary silicious sand will hold about one third of its bulk of water, or from two to two and one-half gallons per cubic foot. When clay and gravel are introduced the amount absorbed is less. When the material is compacted as in sandstone or limestone water is still absorbed, but in very diminished quantity. Drift material, consisting largely of sand and gravel brought down comparatively recently by rivers or floods, may yield water, but not in large supply. Alluvion, consisting of sand, gravel, rolled pebbles, clays, as found in the valleys of great rivers, is distributed more regularly than drift and over more surface, and hence may yield a larger supply of water. But, as has been already many times hinted, it is in more regular, more widely extended, and, generally speaking, deeper strata of sandstones, limestones, and clays, that reliable supplies are to be sought. The striking of rock is, of course, no sign of failure. The rock may be drilled through, or if it is merely a bowlder, it may be avoided by another boring.

The amount of rainfall on the outcrop of water-bearing strata determines the quantity of water that may probably be obtained from them at a distance by artesian borings. An entirely rainless district may be supplied with artesian water. In fact the gentle tilting of alternating pervious and impermeable strata seems to be a special arrangement of nature, by which low, dry, unwatered plains may receive their share of irrigation. All that is needed is rain on the surrounding highland where the edges of the water-bearing strata are turned up and exposed. An examination into the condition of this outcrop (explained above), of its extent and of the rainfall upon it, may furnish data for roughly calculating the amount of water that the plains may expect to be able to obtain. For instance, on a steep outcrop less water can be absorbed than on a more level one; again, less water can be appropriated by the outcrop from a deluge immediately followed by burning sunshine, than from a long continued drizzle followed by dull cold days. It is unnecessary to enter further into this. The entire subject, in fact, is very simple, and even suggestions are hardly necessary to an intelligent and observant mind.

Mr. Delafield, C.E., of New York, gives the following as the approximate ordinary cost of boring artesian wells through the rock formations of New Jersey and Pennsylvania, with the diamond drills, the diameter of the well being six inches:

For the first 100 ft.,	$6	per foot	....	$600
" " second "	7	" "	....	700
" " third "	8	" "	....	800
For a well 300 ft. deep			....	$2,100

The cost may be estimated to increase $1 per ft. per each additional 100 ft. Thus the cost of a well 1,000 ft. deep, would be $7,000; add for contingencies, 3,000, and we have $10,000 as the total cost.

THE TORONTO WATER SUPPLY.

In reference to the water supply of Toronto, it being clear that all river and lake waters should be filtered before use, it may be asked: Will the filtering basin on the Island ever receive from the lake a sufficiently abundant supply for the use of the city? If it does, will the water in it have been sufficiently purified by the sand? Is the sand there sufficiently pure for filtering purposes? Or does it not contain in itself organic matter which it might give up to the water passing through it. If it proves to be pure enough for filtering the water, how long will it remain pure without being cleaned or renewed in any way? If the water of the lake is filtered and purified at the Island, what security is there that it will not at any time or almost constantly receive such additions from the water of the bay, through leakages into the main stretching across the bay, as to make it unfit or unsafe to use? Finally, might it not be better to pump the water from the lake to the high ground north of the city, near the reservoir, and filter it all there before supplying the houses?

The water supply should be a matter of deep concern in all communities, and the people of Toronto and of other cities and towns in Canada should not rest contented until plans are devised and carried out for the purpose of supplying pure water. A 'tolerably' pure water is not all that is needed. The supply should be perfectly pure, or as pure as careful filtering can make it.

It might be well worth while to spend some money in trying what success would follow the boring of artesian wells. For this, in order to be satisfactory, several wells should be bored and the boring continued to great depth, if necessary.

DOMESTIC WINES AT THE RECENT LARGE EXHIBITIONS.—The splendid displays of domestic wines at the Industrial Exhibition Toronto, Dominion Exhibition, Ottawa, and the Western and Southern Fairs held this year, must convince the most skeptical that Canada is destined to become a great wine producing country. By far the finest displays at these shows was made by "The Pelee Island Wine Co." for which Messrs. Hamilton, Dunlop & Co., of Brantford, are the sole agents for Canada. Their wines are of a very high class, and were highly appreciated as evidenced by the fact that this year Messrs. H. D. & Co. were awarded 4 medals, 3 diplomas, and 12 prizes. Having seen these wines put to severe tests, we can confidently commend them to the medical faculty.

VENTILATION AND HEALTH.

The time is about past, for this year, in Canada, when windows and doors can be left freely open, day and night, to let in abundance of fresh air and afford free ventilation. Thousands will soon be shut in close rooms, with double windows, to breathe over and over, again and again, the same air; drawing oxygen from it at every breath, and at every breath exhaling into it poisonous gases and vapors—waste excremental matters from their own bodies, and frequently from the bodies of others occupying the same rooms. Is it surprising that so many die during the latter part of winter, and in the early spring, with lung diseases—consumption, inflammation and congestion of the lungs, bronchitis, &c. But the weather is blamed for this increase in the death-rate from these diseases. This is largely misplaced unjust censure. It is most difficult to get people to understand or comprehend how large a quantity of air around us, we, at every breath, render unfit to be drawn into our lungs. Herein lies the chief benefit of out-door life: the breath, as it escapes from the mouth in the open air, is usually at once dissipated and carried away, so that no portion of it gets back into our lungs again: in close rooms this is not the case. The expired air floats about an unventilated room, and some of it soon finds its way back into our lungs again, and hence into our blood, where it is incompatible with good health and vigor. Very much better, and more economical in the end, will it be, for those who can, to burn extra fuel during cold weather, and let into their rooms, night and day, abundance of fresh out-door air. Those must suffer more or less who cannot or do not do this.

THE WORST CRIMINALS in the prisons of Canada, and elsewhere, are surrounded, at the public expense, usually, by the best or most approved sanitary conditions—provided so far as possible with pure air, water and food, and comfortable quarters. The poor laboring man and mechanic are permitted to live on in want of healthy surroundings, frequently without the knowledge or means necessary to obtain the essentials of health and of life. Too frequently their landlord is permitted to surround them with the causes of disease and death. Who is to help them? Philanthropists *might*. Those who control state and municipal affairs *should*. Is there no temptation to intemperance and crime among the poorer classes arising from the insanitary conditions in which they are permitted to live?

VITAL STATISTICS AND THE PUBLIC HEALTH.

The quarterly returns of births and deaths, from eighteen of the largest cities and towns in Ontario, for the three months ending 30th September, 1879, are given on another page. The total number of deaths from the 18 places show a death-rate, per annum, per 1000 living, of estimated population, of only about 11.5. Either these localities, or most of them, must be highly favorable to longevity, or the returns must be very incomplete. The latter would probably be the most correct inference. The actual death-rate in these places is probably not much less than 20 per 1000; or say 18 per 1000, which is about as low as any country can show. It would appear then that only about, or less than, two-thirds of the deaths are registered. But when we look at the returns of deaths from one or two of these places we find them less than one-third, and from many of them, only a little over half of the estimated number. For example, Lindsay returns about 5 deaths per 1000 of population (per annum), Ottawa 6 per 1000. There is no possible reason why the death-rate in these two places should be lower than in Toronto, which returns over 21 per 1000.

It is really too bad that the returns from most municipalities are so very incomplete as they evidently are. Some people think, or appear to think, it is very hard to be fined for neglecting their duty in this work, but what else can they look for. Complete returns of deaths are indispensable, and must be obtained. If those whose duty it is to see that all deaths are registered, do not do their duty, they must be made to do it, or be so punished that they will not fail in it again.

Much, doubtless, depends on the division registrars being active and looking after deaths which occur, as well as after those who neglect to register them. Many of these, it appears, think their pay is altogether inadequate for the work they are expected to do. Reeves and Councillors should see to this. The small sum required to pay well for having this work well done, which will be of great future benefit to the Province, will not be felt by the municipality. Councilmen should be able to explain the importance of the work to their constituents.

It is probable that some improvements or amendments may be required in the Registration Act; and we trust this will receive consideration from the Government. Possibly something more strin-

Quarterly returns of deaths and births, for the three months ending September 30th, 1879, for 18 Cities and Towns in Ontario.

City or Town.	Total No. of Deaths.	Total No. of Births.	Diphtheria.	Typhoid Fever.	Scarlet Fever.	Measles.	Diarrhœa.	Dysentery.	Constipation.	Deaths under one year.	Cholera Infantum.	Inflammation of Lungs.	Debility.	Rate per 100 living.
Brantford	28	57	......	1	......	......	4	......	4	13	3	......	......	10.
Stratford	19	......	......	1	......	......	3	......	1	7	......	......	......	9.
Woodstock	12	24	......	......	......	......	1	1	2	2	......	......	......	9.5
Goderich	14	26	......	......	......	......	6	......	1	7	......	......	......	12.
St. Thomas	17	38	......	1	......	......	2	......	4	5	......	......	......	10.2
Guelph	35	80	......	......	......	......	6	......	1	8	......	......	......	14.
Belleville	50	62	6	4	6	......	8	5	6	8	......	......	......	20.
Lindsay	6	19	......	1	......	......	1	1	1	2	......	......	......	5.
Port Hope	7	23	......	......	......	......	......	......	......	3	4	......	......	......
Kingston	41	50	......	2	......	......	4	1	4	7	......	......	......	12.
Peterboro	16	......	......	......	......	......	......	3	8	4	......	......	......	9.5
Ottawa	36	50	3	......	......	......	7	......	3	12	......	......	......	6.
London	92	101	1	......	7	......	6	3	10	41	5	5	......	18.5
Hamilton	156	181	2	7	......	1	13	1	20	59	......	......	......	18.4
Cobourg	13	37	......	......	......	......	1	......	3	1	......	......	......	10.
Toronto	377	651	5	12	......	5	55	27	41	169	......	......	......	21.3
St. Catharines	65	30	1	1	......	......	4	1	3	26	3	2	2	......
Chatham	22	29	......	......	1	......	2	2	2	10	......	......	......	......
Total	1006	1458	18	30	14	6	123	45	114	383	15	7		11.5

gent or definite is required in reference to burials being permitted without a certificate of registration, as well as of death. We have before suggested the advisability of dividing the township municipalities into smaller registration sections ; and that it might be well to consider that of enlisting in some way the services of school teachers or trustees in the work, as these have supervision over but small sections of country.

The table, it may be observed, shows that the returns from Toronto and Belleville, and even London and Hamilton, may be regarded as tolerably correct. Much is probably due to the registrars in these cities. St. Catharines returns 32 as non-residents.

Of the total number of deaths returned from the 18 cities and towns, viz. : 1006, nearly 38 per cent., or 383, were of those under one year. The death-rate among young children during the summer quarter in towns and cities is invariably high. This is entirely owing to insanitary environments, and not to warm weather, *per se.* The young need warmth. The totals for the full year of 1877, in Ontario, show a death-rate under one year of 24.1 per cent. But if 38 per cent. is high, what of some of the larger cities : While Hamilton is about the average of the whole—28 per cent.—Toronto returns about 45 per cent., and London 50 per cent. of the deaths as of those under one year. On the other hand, Belleville, from which the returns are full, shows a death-rate, at this age, of only 16 per cent.

The summer death-rate among young children may be regarded as a good index of the sanitary condition of a town or city.

The total death-rate from consumption is below the yearly average, as would be expected, in this quarter ; though Hamilton shows above the yearly average. The returns show a death-rate from diarrhœa of 11.6 per cent. of the totals ; more than double that of the 20 largest cities and towns in Ontario for the full year of 1877.

SPECIAL NOTICE.

NO ONE has now any authority to collect money for the "Sanitary Journal." We find it next to impossible to get it from collectors, and it is bad enough to have to collect it once. Please remit to "Sanitary Journal" direct.