SEWER-GAS POISONING.

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IN the houses of the present day containing all the modern improvements there is constant danger that the air from the soil pipes or drains will enter the house in consequence of defective plumbing; and that this danger is a very real one is shown by the frequency with which oil of peppermint, introduced into the drain of such a house, betrays itself by its odor in one or more of the rooms. Even a small leak in the soil-pipe, in consequence of the steady escape of sewer-gas, will suffice to contaminate a large air space, especially when the air is not rapidly changed —as, for instance, when the house is tightly shut up on a winter night.

Although it is a difficult thing to determine the exact cause of individual cases of disease, yet it is certainly a very widespread, if not a universal, belief in the medical profession that the escape of sewer-gas into a house may give rise to sickness. The mere fact that in a house with defective plumbing a certain form of disease occurs is, of course, no proof that the former is the cause of the latter. It may either be a mere coincidence, or the sewer-gas may predispose the system to, or even aggravate[1] the disease, without actually causing it. In order to make it probable that the defective plumbing, and the consequent escape of sewer-gas, is the cause of the disease, the two things must occur together many times, and the oftener that this concurrence

[1] Rigby: Parke's Hygiene, vol. I, p. 148.

takes place the stronger becomes the probability that there is a causal connection between them, and this probability becomes still stronger if, after the plumbing has been repaired, the disease more or less quickly disappears.[1]

The character of the sickness resulting from sewer-gas poisoning varies greatly, depending in part upon the different susceptibility to different diseases of the inmates of the house, and in greater part on the varying composition of the sewer-gas itself. An analysis of sewer-gas taken from well-ventilated sewers shows it to contain oxygen, nitrogen, carbonic acid, and ammonia in proportions not varying essentially from those of the atmosphere; and an analysis of sewer-gas taken from badly ventilated sewers (which is much more poisonous than that from well-ventilated ones) shows a diminution of oxygen, an increase of nitrogen, ammonia, and carbonic acid, and the presence of hydrogen sulphide, marsh-gas, and organic vapors of a carbo-ammoniacal composition. Large quantities of bacteria have also been found in sewer-gas.

Sewer-gas (which is merely a convenient name for the atmosphere of sewers) is, therefore, of a very complex and variable composition, and its toxic elements are not certainly known. In cases of acute

[1] It is true that there is often an escape of sewer-gas into a house without any sickness resulting from it, but it is to be remembered that not every one exposed to a contagion, or other cause of disease, contracts the disease. In this connection the investigations of Lissauer (Vierteljsch. f. öff. Gesundht. Pflege, 1881, 13, p. 341) are of interest, who found that in six out of ten houses in which there was an escape of sewer-gas there occurred one or more cases of disease which could be attributed to the sewer gas, while in the other four houses there was no such disease; and that such diseases occurred in only sixteen per cent. of a considerable number of houses in regard to whose sanitary condition he was gnorant, as against the sixty per cent. in the houses in which here was known to be an escape of sewer-gas.

asphyxia from very foul sewer-gas the symptoms so strongly resemble those of poisoning by hydrogen sulphide that this gas is probably the cause of such attacks; but it is very doubtful whether hydrogen sulphide is often present in a house in sufficient quantities to produce any poisonous effects. On the other hand, in cases of typhoid fever from sewer-gas poisoning the toxic element is doubtless the bacillus of typhoid fever, for which the sewer-gas acts merely as a vehicle, and it is probable that most of the cases of sewer-gas poisoning are due to pathogenic bacteria, which happen to be present in the sewer-gas, and are carried by it into the air of the house. It is probable that in all cases of sewer-gas poisoning the toxic element belongs in one or the other of the following classes:

1st. Pathogenic bacteria, which have already been isolated and studied, and may, therefore, be said to be "known."

2d. Pathogenic bacteria, which have not yet been isolated and studied, and are, therefore, "unknown."

3d. Poisonous gases, such as hydrogen sulphide.

The first two classes are by far the most important as a cause of disease, and in them the sewer-gas merely conveys the specific germs, which have got into it more or less accidentally, and which are not necessarily present in sewer-gas.

In the case of those diseases which are known to be caused by bacteria it is not difficult to understand that the bacteria entering the drain, and finding there food, moisture, warmth, and other requisites for growth, should propagate rapidly, and subsequently getting into the air of a house through a leak in the drain, might enter the body of some person, and might cause the diseases of which they are the etiological agents. Many cases have been

reported which tend to prove more or less conclusively that typhoid fever, pneumonia, diphtheria, cholera, dysentery, cerebro-spinal meningitis, erysipelas, and scarlet fever, can be caused by sewer-gas infection.[1]

But in addition to these diseases which are caused by a well-known specific germ, there are many other

[1] The proof that typhoid fever may be caused by sewer-gas is very strong. Numerous and convincing cases have been reported by Murchison (Continued Fevers, 2d ed., p. 472, et seq.), Hutchinson (Pepper's System of Medicine, vol. 1, p. 253), Cosgrave (Trans. Acad. Med. Ireland, 1885, 3, p. 365), Nourse (Sanitary Record, 1880, p. 127), C. F. F. (Boston Med. and Surgical Journ, 1875, 93, p. 599), and others. A striking proof that pneumonia may result from sewer-gas poisoning is given in the Medical Times and Gazette of April 4 and June 30, 1874, and cases of pneumonia apparently caused by sewer-gas have been reported by Eaton (Sanitary Record, 1885–86, p. 525), Ward (Sanitary Record, 1880–81, N. S. 2, p. 4), and Nourse (loc. cit.). Although diphtheria is more commonly propagated by contagion directly from one patient to another, yet so many cases have been reported which seem to be due to sewer-gas poisoning that this must be considered as one of its causes. Such cases have been reported by Bayley, and also by Thursfield (Sanitary Record, 1877), Tripe (Sanitary Record, June 14, 1878), Eaton (loc. cit.), Nourse (loc. cit.), Cosgrave (loc. cit.), C. F. F. (loc. cit.), Meredith (Sanitary Record, April, 1884, p. 498), and Noel (Am. Pub. Health Assoc. Reports, 1876, p. 362). That cholera may in some cases spread by means of sewers and privies appears from the epidemics described by Radcliffe (Ninth Report of the Medical Officer of the Privy Council), and Routh (Brit. Ass. Med. Journ., 1856, p. 827). Cases of dysentery due to sewer-gas have been reported by Routh (loc. cit), and Clouston (Med. Times and Gazette, June, 1865). That cerebro spinal meningitis may spread by means of sewer-gas seems probable from the report of Morris (Rep. New York City Board of Health, 1871, p. 348), and cases apparently due to sewer-gas poisoning have been reported by Ward, (loc. cit.), and Trask (Med. Record of October 16, 1875). Cases of erysipelas due to sewer-gas poisoning have been described by Nourse (loc. cit.), and others have been reported in the Sanitary Record for December, 1879, p. 221. Although scarlet fever spreads in most cases by direct contagion from patient to patient, yet that it may sometimes spread by sewer-gas seems not improbable from the cases reported by Carpenter (Sanitary Record, March 15, 1882), C. F. F. (loc. cit.), Meredith (loc. cit.), and Noel (loc. cit.).

forms of disease (most of which are probably also of bacterial origin) which are generally regarded as being due to sewer-gas poisoning, and which, unfortunately, are sometimes classed under that much abused term "malaria," taken in its etymological and broadest sense, "bad air." Although in a general way numerous allusions have been made to this class of diseases, both in medical and in general literature, yet when one comes to study the subject, it is surprising how little the nature of the individual diseases of this class have been studied, and how impossible it is to say just what diseases can and cannot result from sewer-gas poisoning, and what group of symptoms in any case would lead one to suspect sewer-gas poisoning. During the past few years I have seen a number of cases of this class, which I would like to present to this Association. The time allowed for the reading of papers prevents my giving more than a brief summary of each case, and indeed the cases are so few in number, and some of them are so imperfectly studied that I cannot hope to offer any well-grounded conclusions, but only to bring up points for discussion, and to suggest the importance of an exhaustive study of the subject to those members who are better able than I to investigate it. It is certainly important to know to just what disease inmates of a house in which there is an escape of sewer-gas are exposed, and this study is undertaken not with the idea of discovering the essential cause of any disease, but only to replace the general statements found in medical literature in regard to the diseases which may be caused by that very complex body, sewer-gas, by statements a little more definite, and to lay a foundation for future work on this subject. For convenience of study I have grouped the cases not according to the houses in which they occurred, but according to the symptoms which they presented.

The most generally recognized effect of sewer-gas poisoning is a disturbance in the functions of the alimentary canal, and, as illustrative cases of this group, I would report the following:

Case I.—Mr. E., æt. fifty-five, slept in a small room, with untrapped stationary wash-stand, and for ventilation opened a window on a small well in the centre of the house, in which well an untrapped gutter-pipe connecting directly with the sewer opened not three feet from the window. On pouring oil of peppermint into a distant part of the house-drain, the odor of peppermint filled this bedroom immediately. For five or six years, almost as long as he had lived in this house, Mr. E. vomited every morning as soon as he got out of bed, and presented no other symptom. The pipes were trapped, and the plumbing put in proper order, and the vomiting of Mr. E. stopped immediately; so that, in this case, the vomiting, and the vomiting only, seemed to be directly caused by the sewer-gas. The wife of Mr. E., who slept in this same room, died of sewer-gas poisoning (Case XVI.), and his son-in-law, who did not sleep in this same room, but whose room was ventilated by the same window in the little well, also presented symptoms of sewer-gas poisoning (Case XIX.),

Case II.—Mr. G., æt. forty-three, had been working very assiduously during two weeks in January, in a building in which the plumbing was full of defects; among other defects, sewer-gas had free access to the hot air which warmed the building. During the last week of his work in this building, and for a week afterward, Mr. G. had a severe diarrhœa, or rather purging, which came on every morning, and consisted of half a dozen or more copious watery discharges which exhausted him greatly, and then ceased, not to return till the same hour next morning. The diarrhœa finally yielded to quinia.

In these two cases the purging and vomiting occurred separately, and were not combined as they are usually, and as they were in the following cases:

CASE III.—Mr. T., æt. twenty-eight. In the spring the drain under the kitchen was broken, and the contaminated earth was upturned in order to repair the break. Mr. T. went down to look at the work, and was attacked with vomiting, purging, loss of appetite, and great prostration, which lasted about a week, and ran its course without fever. The prostration lasted about two weeks.

CASE IV.—Mr. H., æt. thirty-two. In the spring the drain under the basement was broken, and the contaminated earth was upturned in order to repair the break. Mr. H. examined the work several times, and before it was completed he was attacked by vomiting, loss of appetite, and violent purging, the stools being copious, watery, and of dark color. The purging continued about a week, and ran its course without fever. The prostration lasted about two weeks.

A Mr. P., who had charge of the repairs of this same drain, was attacked by a severe sore throat.[1]

Eulenberg, in his book *Die Lehre von den Giftigen Gasen*, states that the symptoms of chronic poisoning by sewer-gas are nausea, vomiting, colic, weakness, and diarrhœa, or constipation.

Workmen engaged in cleaning out sewers which have become choked are often overcome by the very foul gases occurring in such sewers, and present a very acute and severe form of sewer-gas poisoning.

Such cases have been reported by Harbordt (*Berl. klin. Wochenschr.*, 1871, p. 289), Seifert and Macintosh (*Phil. Med. Bull.*, 1883, v. p. 148), and many others. These patients are usually in a condi-

[1] Cases somewhat similar to these first four, in which nausea, vomiting, purging, and prostration, were prominent symptoms, have been described by Foss (Medical Examiner, 1876, 1, p. 47), Noel (Amer. Pub. Health Ass. Rep., 1876, p. 362), Eaton (Sanitary Record, 1865–66, p. 525), C. Handfield Jones (Med. Times and Gazette, July, 1871, p. 9, 2d case), Finklenburg (Viertljsch. f. gerichtl. Med., 1874, N. F., 20, p. 301), Trend (Brit. Med. Journ., November, 1878, p. 719), and Morrill (Bost. Med. and Surg. Journ., December, 1884, p. 531).

tion of collapse, comatose, and have general convulsions; if recovery takes place, there usually remains for a considerable length of time a condition of physical and mental weakness. Eulenberg (loc. cit.) divides these cases into three classes: *First*, a mild form, of which the symptoms are nausea, vomiting, colic, weight in epigastrium, pressure on vertex, dyspnœa, rapid, and small pulse, great weakness, and, in some cases, delirium. *Second*, a condition of clonic and tonic spasm, together with faintness and unconsciousness. *Third*, a severe form, in which the patients become slowly or rapidly asphyxiated. Face is pale, lips cyanotic, breathing and pulse faint. As this condition of asphyxia passes off, convulsions appear. The unconsciousness may continue three or four days, and when it passes off the patient vomits and complains of pain in his head and limbs. There is a disgusting stink emitted from the body of such patients. Dr. Herbert Barker (*Malaria and Miasmata*, 1863) has approached this subject from an experimental standpoint. He found that dogs kept in a box which was supplied with air from a cesspool vomited and purged, and would not eat. They recovered rapidly when removed from the sewer-gas. After a short exposure to the gas there was only slight exhaustion, but after a long exposure there was fever, and a condition of feebleness lasting six weeks. Dogs exposed in the same way to hydrogen sulphide fell insensible, had rapid respiration and pulse, and violent heart-action, tremors, and convulsions. Unless the percentage of hydrogen sulphide in the air was very small, the dogs died; and, in any case, they only recovered slowly from the effects of their exposure to it.

In these four cases the sewer-gas poisoning caused only a temporary gastro-intestinal disturbance which was accompanied and followed by a prostration of

short duration, but in the following case the subsequent prostration continued a long time.

CASE V.—Mr. P., æt. eighteen, was present when a very foul privy vault, which had been unused and covered up for many years, was opened. He was immediately seized with faintness, and with severe vomiting and purging. Afterward he was extremely prostrated, and for five or six years he was an invalid, unfit for any physical or mental effort. He was very weak, and appeared to be in a condition of general debility without presenting any evidence of organic disease.

The following case is interesting in many respects.

CASE VI.—Miss S., æt. forty. An iron ventilating pipe of light weight ran up in the wall of her bedroom from the drain to the roof. The joints of this pipe were found, on examination, to be open, and the peppermint test gave a strong odor of peppermint in the room. Miss S. had occupied this room less than a year when she had an attack of acute Bright's disease, œdema of lungs, and general œdema, vomiting, diarrhœa, etc., abundance of casts, and a large amount of albumen in the urine. She was taken to the hospital, and made a good recovery. After a few months she returned to this same room, and during the next ten years had no return of the Bright's disease, but suffered from frequent attacks of complete loss of appetite, great prostration and wretchedness, vomiting, diarrhœa, coated tongue, and headache. On several of these occasions the urine was examined, and was found to be free from albumen and casts. Each attack lasted from one to three weeks, and she had eight or nine such attacks each year. A year ago she had three severe attacks of facial erysipelas; she was scarcely over one attack a fortnight before she had another, and it was these attacks of erysipelas which led to an examination of the plumbing. The defective pipe was replaced by a thicker one properly leaded, and Miss S. has enjoyed good health ever since.

In this case the escaping sewer-gas caused a succession of attacks of gastro-intestinal catarrh during

ten years, at the end of which time the specific micrococcus of erysipelas probably got into this particular drain, and escaping into the room caused the succession of attacks of erysipelas, and both these kinds of attacks promptly ceased when the leak in the pipe was stopped. The question naturally arises, whether the attack of acute Bright's disease with which this series of diseases commenced, was not also the result of sewer-gas poisoning. The following cases, it seems to me, make it extremely probable that this is so.

Cases VII. and VIII.—Dr. P., æt. sixty-five. Connected with the bedroom in which he and his wife sleep, is a little room in which there is a water-closet, which they never use in the winter time and only rarely in the summer; so that the closet is rarely flushed, and it is certain that the trap often dries out. The soil pipe of the water-closet runs to an hermetically sealed cesspool. At times a bad odor is noticed about this closet. In the early part of the winter his wife was attacked by a low form of fever, which was followed by an attack of acute Bright's disease (general œdema, albumen and casts in the urine) from which she completely recovered. During his wife's illness Dr. P. began to complain of general weakness, numbness of extremities, dyspnœa, palpitation, insomnia, pain in the occiput, failing eyesight, and confusion of mind. These symptoms have continued up to the present time. Micturition is frequent. Urine is abundant and contains a small amount of albumen and many finely granular casts of small calibre. Otherwise physical examination is negative except for a high arterial tension.

The occurrence of Bright's disease almost simultaneously in the wife and husband, makes it probable that there is some local cause for the disease, and taken in connection with the case of Miss S., renders it very probable that this local cause is sewer-gas, and this probability is strengthened by the seven cases which follow.

CASES IX. and X.—Mr. K., æt. sixty-eight. Connected with his bedroom was a bath-room, the plumbing of which was in very bad condition, allowing a free escape of sewer-gas; and under the basement floor the house-drain was broken and a large pool of sewage had gradually formed, into which a workman, who unsuspectingly walked over it, sank to his knees. Mr. K. came to the office on May 8th, complaining of great weakness, dyspnœa on exertion, and looked haggard and miserable. At that time his urine contained no albumen. He grew rapidly worse, and the next night his dyspnœa became orthopnœa, he had complete anorexia, he developed general œdema and œdema of the lungs, and his urine became scanty and contained a large quantity of albumen together with hyaline and granular casts. On May 17th he became delirious, then comatose, and died on May 20th, twelve days after he first came to the office for medical advice. His wife soon afterward began to present the same symptoms: dyspnœa, prostration, haggard face, etc. It was then suspected that the plumbing was in bad order, and an examination revealed the condition of things described above. Mrs. K. was removed to a room entirely unconnected with the plumbing, and made a rapid and complete recovery.

CASE XI.—Mrs. G., æt. fifty-six. In March she had an attack of indigestion, at which time her urine was examined and found to contain no albumen. On the following May she moved into another house, and after that time she did not feel well, and about the middle of July an attack of acute Bright's disease was ushered in by a chill, vomiting, and diarrhœa. The urine contained one-eighth per cent. of albumen and numerous hyaline and finely granular casts of small calibre. During the first few days of her sickness she had numerous chills and a low form of fever, the temperature not rising above 101°; and during the whole sickness she was extremely prostrated, so that she could not raise herself up in bed; she also had absolute anorexia and a profuse diarrhœa. An examination of the house revealed numerous leaks in the soil pipes, one hole being two inches square, through which there was a

free escape of sewer-gas. The plumbing was repaired, and as soon as it was possible, Mrs. G. was removed to another house. The albumen had disappeared from the urine by the end of July, and on August 20th she was able to walk out on the street, although she did not recover her strength for several months.

CASE XII.—Mr. C., æt. sixty, as a contractor worked for a long time at a very foul sewer. Before he had finished working at it he was seized with weakness, dyspnœa, and œdema, and an examination of his urine showed one-sixth per cent. of albumen, and numerous hyaline and granular casts. He continued to present the symptoms of chronic Bright's disease, and died after a sickness of less than a year, from uræmic poisoning.

CASE XIII.—Mr. H., æt. seventy-five. About a year and a half ago he moved his office, where he worked more than ten hours a day, to a room which was heated by hot air, which was contaminated by sewer-gas, so that when the room was shut up for a few days the air became extremely offensive. At the time of moving into this office Mr. H. was an unusually vigorous man for his age. A month or two later he began to be troubled by diarrhœa and frequent micturition. To these symptoms were added dyspnœa, palpitation, sweating, frontal headache, and failing eyesight. The dyspnœa then became orthopnœa and œdema of the legs appeared. The pulse was quick, irregular, and intermittent. The heart's action was violent and irregular; the area of cardiac dulness was increased, but no murmurs could be heard. The urine contained one-eighth per cent. of albumen, and a few hyaline casts. Mr. H. is still living. He has ascites and much œdema, and a very irregular and labored action of the heart.

CASE XIV.—Mr. X., æt. fifty-five, went to work in an office in which there was a stationary washstand, the soil-pipe of which was untrapped and allowed a free escape of sewer-gas. The previous occupant of this office died, and his death certificate reads fatty degeneration of the heart, although he was said to have had Bright's disease also. Mr. X. soon after commencing work in this office began to be troubled by dyspnœa on exertion, headache, and general weakness. The

dyspnœa and weakness became extreme, and about a year after commencing work in this office he was suddenly seized with a right-sided hemiplegia, followed in a few hours by coma of short duration. At that time the urine was examined and found to contain one-sixth per cent. of albumen, and hyaline and finely granular casts. The pulse was irregular and intermittent; the heart's action violent and labored; area of cardiac dulness was increased; no murmurs; arterial tension high. He left his office and travelled about and improved slowly and steadily. His urine was last examined six months ago, at which time it still contained albumen and casts. His heart's action continued labored and he was feeble. Since that time he has continued to improve in strength.

CASE XV.—Mr. S., æt. fifty. In the cellar of his store, in which he spent most of his time, there was a large opening into the drain. In the middle of the winter he began to be troubled by dyspnœa and general weakness. Pulse was rapid and feeble; heart's action extremely labored; urine contained a large amount of albumen (¾ per cent.) and hyaline and finely granular casts. He developed ascites and general œdema, and a secondary pleuritis and pericarditis, and finally died from exhaustion.

The last ten cases make it very probable that one of the effects of chronic sewer-gas poisoning is some form of nephritis. In the absence of autopsies, the nature of the renal lesion cannot be determined. In all the cases there were diarrhœa and extreme prostration. In almost all of the cases the quantity of albumen in the urine was rather small, and in the case of Mr. K. (Case IX.), when he first presented the symptoms of dyspnœa and prostration, albumen was absent from the urine and did not appear till several days later;[1] so that it seems in these cases as though the symptoms can hardly be altogether ex-

[1] In this connection compare the first case reported by C. Handfield Jones (Medical Times and Gazette, July, 1871, p. 9).

plained by the nephritis, but rather that the change in the kidneys is only one manifestation of a general infection of the body by the poison of the sewer-gas.

In the last three cases there wa a very labored action of the heart; a greater degree of cardiac disturbance even than is usually met with in Bright's disease; so that it is a question whether the poison of sewer-gas does not cause a degeneration of the heart's substance as well as of that of the kidney.[1] That this is not improbable, appears from the following case, in which, in addition to the general prostration, the heart seems to have been especially involved, although there is no evidence of any renal lesion.

Case XVI.—Mrs. E., æt. forty-eight. The very unsanitary condition of her bed-room (which was not discovered till just before her death) was described in reporting the case of her husband (Case I.) who for years vomited every morning. Mrs. E., who had previously been a strong, healthy woman, occupied this room for seven years, during the whole of which time she felt weak, miserable, and nervous. Her principal symptoms during these years were great weakness and nervousness, loss of appetite, dyspnœa, palpitation, and vomiting, (occasionally there was bloody vomitus at the time of menstruation, but only when menstruation was imperfect). She grew steadily weaker, so that during the last month of her life she could scarcely walk across the room, and her stomach was so irritable that she vomited almost all her food. She was anæmic and fleshy, but her flesh was soft and flabby. Pulse was

[1] I have seen a number of cases, each one of which is too imperfect to report, but which taken collectively, lead me to believe that there is a form of disease, rather difficult of exact diagnosis, which presents the symptoms of prostration, emaciation, anæmia, anorexia, œdema, dyspnœa, and diarrhœa, and the physical signs of a weak heart, often, but not always, associated with a small amount of albumen and sometimes with casts in the urine, and occasionally with œdema of the lungs, and which is due to sewer-gas poisoning. Recovery usually takes place in these cases when the patient is removed from the sewer-gas infection.

small, 110. Heart's action irregular and labored. Great enlargement of the liver and of the spleen, apparently the result of passive congestion. Her urine was examined several times, and was found to contain neither albumen nor casts. Her pulse became more and more rapid; being 120 a fortnight before she died, and during the last week of her life was too rapid and irregular to be counted. Toward the end of her illness she had several attacks of precordial pain, and on the last day of her life she had two severe attacks of angina pectoris, which were relieved by hot applications and inhalations of nitrite of amyl. Soon after the last attack she became comatose and died in a few hours. No autopsy was allowed.

A common effect of sewer-gas poisoning is a condition of general weakness, and I am inclined to think that some cases of nervous prostration are due to this cause.[1] Indeed, weakness, irritability, loss of appetite, dull headache, and drowsiness are a group of symptoms which play a principal part in almost every form of disease due to sewer-gas poisoning; but there are some cases, such as the following, in which these symptoms are alone present and constitute the entire disease.[2]

CASE XVII.—Mrs. K., æt. fifty-five. The cold air box of the furnace in her house was connected indirectly with the drain. For several years she has suffered in the winter time from loss of appetite, diarrhœa, vertigo, drowsiness, and great prostration. She was tired out on slight exertion, was greatly depressed, and every duty seemed a mountain in her path. She continued to grow weaker until she could scarcely walk. Her temperature was normal. Pulse 110. The urine was free from albumen. Although scarcely able to be out of bed she was sent south and improved rapidly.

[1] Compare Morrill (Boston Med. and Surg. Journ., Dec. 1884, p. 531).

[2] Compare Eaton (Sanitary Record, 1885–6, p. 525) and Cosgrave (Trans. Acad. Med. Ireland, 1885, p. 365, Case 101).

In her absence the house was put in good sanitary condition, and after her return she continued to improve, and is now well.

XVIII.—Mrs. V., æt. sixty. The plumbing in her house was old, and was in very bad condition; there being a number of leaks in the soil pipes. During the winter she has frequently had attacks of chilliness. In April she began to feel very weak and miserable, had no appetite, complained of dull headache and of great drowsiness, she was much depressed and did not feel able to accomplish anything. At the same time that Mrs. V. suffered in this way her daughter became feverish and had a typical attack of typhoid fever. A servant in the house had a succession of sore throats and headaches during the whole winter. Mrs. V. went away from her house while it was being repaired and gradually regained her health and strength.

CASE XIX.—Mr. T., æt. twenty-six, lived for a short time in the house, the unsanitary condition of which was described under Case I. During the whole time that he was living in this house he felt weak and wretched, had a dull headache, no appetite, and was drowsy. He recovered very soon after leaving the house.

In all of these cases of general weakness the patients have complained of great drowsiness, and this, in my experience, is one of the first and most constant symptoms of sewer-gas poisoning. In the following case it was the only symptom.

CASE XX.—Mrs. F., æt. sixty, in consequence of anxiety and worry got into a condition of great nervous exhaustion, and was greatly troubled by insomnia. In the midst of this condition she moved into a house, the plumbing of which was found to be in a very defective condition, allowing the escape of sewer gas in all parts. As soon as this was discovered she was taken to another house, but during the five days that she remained in the house with defective plumbing, her obstinate insomnia disappeared and she slept not only during the night but also during most of the day. When she left this house, however, her insomnia returned.

Chronic sewer-gas poisoning often manifests itself in an irregular low form of fever either with or without chills, as is seen in the following cases.[1]

CASE XXI.—Mr. M., æt. sixty-seven, had locomotor ataxia for several years and had been pretty closely confined to his sitting-room and bed-room, both of which were on the same floor, and between them with doors always wide open, was an old-fashioned pan closet, which was found by the peppermint test to leak badly, and on examination the cement was found to have fallen away from the joint of the soil pipe leaving a large opening. Mr. M. was suddenly seized with a severe chill followed by fever and by a delirious semi-comatose state. During the next week he had frequent chills followed by high fever and sweating. He was frequently comatose during and after the chills, and was much of the time delirious. The chills occurred once or twice a day at no regular hour, usually in the morning, and occasionally in the afternoon also. The leak in the water closet was then discovered. It was found impossible to remove him effectually from the sewer-gas infection, but he was moved into a hall bed-room and the water closet door was kept shut, with the result, that he had one slight chill on the day that he was moved but no more, and the temperature fell to 99½° the next day and was afterward normal. He continued to have absolute anorexia, grew steadily weaker and finally died from exhaustion.

CASE XXII.—Dr. H., æt. thirty-one. On February 7th he did not feel well and had no appetite, and in the evening his temperature was 102°. He did not feel well during the next week, but his temperature continued normal till the evening of February 13th, when it was again 102°. He then began to be troubled by a severe dry cough, his appetite continued poor, but his temperature continued normal till the evening of February 19th (another interval of just six days), when it

[1] Compare Burrall (N. Y. Hosp. Gazette, 1879, p. 662), Nourse (Sanitary Record, October, 1880, p. 127), Trask (N. Y. Medical Record, October 16, 1875), and Noel (Am. Health Ass. Reports, 1876, p. 362).

was 103°. After that time the temperature continued elevated; being a little above normal in the morning and rising to 102° or 103° in the evening. On February 21st he discovered a very bad break in the drain beneath the kitchen floor; the ceiling of the kitchen was broken and above it was his bedroom with a poor floor, thus allowing the foul air an easy access to his bedroom. The break in the drain was repaired as soon as possible. On the 24th, 25th, and 26th he had slight epistaxis, bowels were rather constipated, the dry troublesome cough continued. On February 27th the temperature was A.M. 99°, P.M. 104°. On the 28th A.M. 101°, P.M. 100¾°. On March 1st, A.M. 99½°, P.M. 99½°. After this the temperature remained normal, his appetite slowly returned, and he gradually recovered the flesh which he had lost.

Such cases of fever have been frequently reported. The epistaxis and the dry troublesome cough recall typhoid fever.

CASE XXIII.—Mr. P., æt. thirty-four. In an alcove off from his bedroom is a stationary washstand, in which there was a leak, and consequent escape of sewer-gas. He was attacked by pain in his head and back, loss of appetite, and great prostration. He had a low form of fever for two weeks, the temperature being 101° every night with great regularity, and between 99½° and 100° each morning. After two weeks of this low form of fever, the temperature commenced to rise, and the spleen commenced to enlarge, although it was not so before. At the same time diarrhœa commenced, and there were tenderness and gurgling in the right iliac fossa; a couple of days later he had an epistaxis, and about a week later rose spots appeared. In other words, after a low form of fever continuing for two weeks, an attack of typhoid fever commenced with all the typical symptoms, which then appeared for the first time. The typhoid fever ran a perfectly regular course, and lasted three weeks. In this case, then, the sewer-gas poisoning produced a low form of fever, during the course of which the system became infected with the typhoid fever germ, probably also from the sewer-gas.

Under Cases IV. and XVIII. sore throats have been mentioned as occurring in houses at the same time with other forms of disease due to sewer-gas poisoning, and cases of sore throat have often been reported as being due to sewer-gas poisoning.[1] In many of these cases the sore throat has a diphtheritic character, as in the following case :

CASE XXIV.—Mrs. C., æt. sixty, lives in a house in which, within two months, there have been a case of pneumonia, a case of erysipelas, and a case of measles in the adult. Beneath the basement floor there is a bad break in the drain. One evening the stench from this drain was very offensive, and Mrs. C., who was sitting in the basement, was seized with a chill, headache, and sore throat. That night she was feverish, and the next morning there was a compact, oval patch of white membrane on each tonsil, measuring about a half by a quarter of an inch in its long and short diameters respectively. In thirty-six hours these patches fell off, leaving quite deep ulcers, which slowly healed. There was no enlargement of the cervical glands. The throat was sore, and deglutition was painful. Pulse varied from 80 to 90. Temperature was 100½° in the morning and 102° in the evening. On the fourth day of the disease the fever left her, and she felt in every way so much better that, although still very weak, she considered the disease as over, as indeed it was, although she continued greatly prostrated for several weeks.

Such cases as these may be considered either as mild forms of diphtheria, which they probably are, or they may be considered as necrotic tonsillitis, following the classification in *Strümpell's Text-book of Medicine*.

[1] Compare Carden (Brit. Med. Journ., March, 1884, p. 600), Davis (Sanitary Record, March, 1885, p. 401), Brown (Brit. Med. Journ., March, 1879, p. 346), Morrill (Boston Med. and Surg. Journ., December, 1884, p. 531), and Nourse (Sanitary Record, October, 1880, p. 127).

Not infrequently sewer-gas poisoning shows itself in disease of the nervous system. The most common of these diseases thus produced is neuralgia, as can be seen from the following cases[1]:

CASE XXV.—Mrs. L., æt. thirty, slept in a middle room opening out of a bath-room. An examination of the plumbing showed that it was very old, and leaked in almost all parts, the bath-room being particularly defective. During five or six weeks she suffered from intense neuralgic pains, which commenced in the lumbar region and extended around into the groin and down the posterior and other outer surfaces of the thighs and legs. These pains recurred daily, and were so intense as not only to require morphia hypodermatically, but they reduced the patient to a very low and precarious condition. She was also extremely weak, and had no appetite. When the trouble with the drain was discovered, she was moved to another house. After she was taken to the other house there was no return of the pain, her appetite returned, and she quickly regained her strength. There could hardly be a more striking example of neuralgia due to sewer-gas poisoning than this one.

CASE XXVI.—Mrs. T., æt. thirty-two, lives in a house in which the plumbing was found to be in an extremely defective condition. In the latter part of December she had an attack of fever, lasting three days, the evening temperature being 103.8° on one night and 103° on another. Even after the fever left her she continued to be weak, and to have no appetite. On the first of January she was attacked with severe neuralgia of the ninth right intercostal nerve, which continued till the third week of January, when she went out of town. Early in February she returned to her house, and on the second day the pain returned, and was accompanied by a slight attack of jaundice. She then moved into another house,

[1] Compare Morrill (Boston Med. and Surg. Journ., December, 1884, p. 531).

and in a couple of days her neuralgia ceased, and in a week the jaundice disappeared also.[1]

There is another form of nervous disease which I am inclined to think may also be caused by sewerage, and that is myelitis of the anterior horns, which is probably an infectious disease.

CASE XXVII.—Mr. B., æt. twenty-nine, worked in a little wooden shed built on the very edge of the Albany Basin, and just over the outlet of one of the principal city sewers. The stench at times was so bad that the clerks had to relieve each other frequently, and go up the street for a little fresh air. He worked in this place, from May till October, for three summers. During the third summer he noticed that he was very drowsy during the day, although somewhat restless at night, and that his appetite was very bad. On the first of September, 1880, at 5 P.M., his legs suddenly gave way under him, and he fell. He managed to walk home, and to creep upstairs on his hands and knees. The next day he could move his arms and legs a little, but inside of three days he lost completely all power of voluntary movement, except that he could masticate his food pretty well; for a short time he was unable to close his eyes. There was no disturbance of sensibility, but a complete loss of all the reflexes: superficial, deep, and organic. He went through a typical attack of myelitis of the anterior horns, with great muscular atrophy, and the electrical reaction of degeneration. At the end of a year he could get about on crutches, and in about two years and a half he could walk without a cane. Even at the present time, seven years after his attack, he is emaciated and weak.

CASE XXVIII.—Mr. B., æt. forty-two, was obliged to inspect for several weeks a sewer which was being repaired, and which emitted a very bad stench. In the course of this inspection he was attacked by a chill followed by fever, and during three weeks he had a low

[1] Jaundice has been noticed in cases of sewer-gas poisoning, by C. Handfield Jones (Med. Times and Gazette, July, 1879, p. 9) and by Burrall (N. Y. Hosp. Gazette, 1879, 7, p. 662).

continued fever, with frequent chills. After the fever ceased he did not regain his health, but during the next year steadily lost flesh and strength, his appetite became poor, he had neuralgic pains in various parts of the body, and his health failed in every way. His urine was free from albumen and casts. At the end of a year his legs suddenly gave way under him, and he fell several times in the street. He then developed a well-marked case of myelitis of the anterior horns, from which, after several years, he made a complete recovery, and is now in good health.

Finally, I will report a case in which the diagnosis as to the nature of the disease is doubtful, but which seems to be an undoubted case of sewer-gas poisoning.

Case XXIX.—J. L., æt. six and a half, slept in a middle bedroom, with connecting bath-room, in a house in which there was a free escape of sewer-gas, especially in this bath-room. The sanitary condition of the house was described under the case of his mother (Case XXV.), who presented a well-marked case of severe neuralgia, due to sewer-gas poisoning. His grandmother, who had lived in the same house, suffered from great prostration and an obstinate bronchitis,[1] both of which quickly disappeared when she moved to another house. I saw the boy in consultation once only. He had, for a week or more, such a severe frontal headache, probably of a neuralgic character, as to suggest the possibility of cerebral disease; but no other cerebral symptoms could then be discovered. His tongue was coated, pulse was rapid, there was decided enlargement of the spleen, and his urine contained albumen. During the first two weeks of his sickness he had a fever ranging from 99° in the morning to between 100° and 101° in the evening. He became extremely emaciated. About a week before his death there was, during several days, a partial sup-

[1] In regard to bronchitis due to sewer-gas poisoning, compare Nourse (Sanitary Record, October, 1880, p. 127), and Ward (Sanitary Record, 1880–81, N. S., 2, p. 411).

pression of urine. Cheyne-Stokes respiration appeared, he gradually sank, and, without any expression of pain on his face, he died, a little less than three weeks after the commencement of his sickness. No autopsy was allowed.

In all of these twenty-nine cases there was an escape of a large amount of sewer-gas into the air which the patient breathed, and at the time that each case was observed it seemed extremely probable that the sewer-gas was the cause of the disease. I have notes of a number of other cases of this class, but as they are not in all respects convincing, I have not reported them; and I would only say that it seems to me that phthisis, and also diabetes mellitus, may sometimes have their origin in sewer-gas poisoning.[1]

From a consideration of these twenty-nine cases, we may conclude that it is probable that the following conditions may result from sewer-gas poisoning:

1st. Vomiting and purging, either separately or combined.

2d. A form of nephritis.

3d. General debility, in some cases of which the heart is especially involved.

4th. Fever, which is frequently accompanied by chills.

[1] In addition to the numerous reported cases of disease due to sewer-gas poisoning mentioned in the notes to this paper, there are some other forms of disease which it is claimed are due to sewer-gas poisoning. Thus, Playfair (Lancet, February, 1887, p. 251), Cosgrave (Trans. Acad. Med. Ireland, 1885, 3, p. 365), Brown (Brit. Med. Journ., March, 1879, p. 346), and Trask (N. Y. Med. Record, October 16, 1875), think that puerperal fever may be due to this cause; while Brown (loc. cit.), Owen (Lancet, 1878, 2, p. 172), Cheadle (Lancet, August 17, 1878), and Noel (Am. Pub. Health Ass. Rep., 1876, p. 362), think that abscesses and enlarged and suppurating lymphatic glands may be due to sewer-gas poisoning; and Cassells (Edinburgh Med. Journ., 1878, 18, p. 910) thinks that acute aural catarrh may be due to the same cause.

5th. Sore throat, which is frequently of a diphtheritic character.

6th. Neuralgia.

7th. Perhaps, also, myelitis of the anterior horns.

These conditions may occur separately, but are frequently combined, and it is especially common for the fever to be associated with the other forms of sewer-gas poisoning.

Finally, in cases of sewer-gas poisoning there is one group of symptoms which is almost always prominent, and these symptoms are: loss of appetite, drowsiness, extreme prostration, and a dull, unpleasant feeling in the head; and whenever this group of symptoms occurs, not as the result of an attack of acute disease, but as a chronic condition, we are justified in suspecting that the patient is exposed to sewer-gas infection.

If we summarize the cases of sewer-gas poisoning which are scattered through medical literature, and which have been mentioned in the notes to this paper, we find that more or less satisfactory evidence has been adduced that the following diseases may result from sewer-gas poisoning:

8th. Zymotic diseases, such as: typhoid fever, pneumonia, diphtheria, cholera, dysentery, cerebro-spinal meningitis, erysipelas, and scarlet fever (in these cases undoubtedly the sewer-gas merely acts as a vehicle for the specific germ).

9th. A condition of asphyxia, which, in its severe form, is characterized by coma, convulsions, and collapse.

10th. Puerperal fever.

11th. Abscesses.

12th. Lymphadenitis.

13th. Acute aural catarrh (?).