Outbreaks of sore throat caused by slight escapes of coal-gas / by W.H. Corfield.

Contributors

Corfield, W. H. 1843-1903.
Royal College of Surgeons of England

Publication/Creation

London : Harrison & Sons, printers, [1887]

Persistent URL

https://wellcomecollection.org/works/ca63nf5u

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BY

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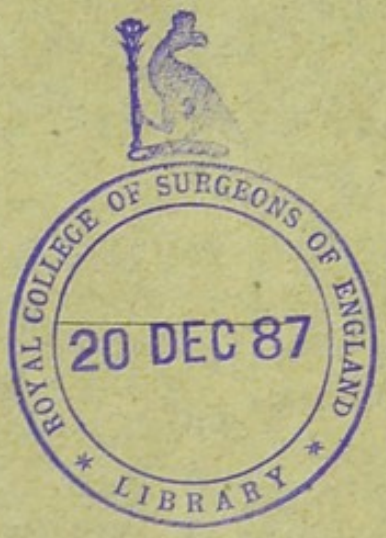

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Harrison & Sons, Printers in Ordinary to Her Majesty,
St. Martin's Lane, London, W.C.

Reprinted from the Transactions of the Society of Medical Officers of Health, 1886–87.

OUTBREAKS OF SORE THROAT CAUSED BY SLIGHT ESCAPES OF COAL-GAS.

BY PROFESSOR W. H. CORFIELD, M.A., M.D. (Oxon.), F.R.C.P., Medical Officer of Health for St. George's, Hanover Square.

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(*Read: April 15th*, 1887.)

In considering the deleterious effects of escapes of coal-gas into dwelling rooms, attention has hitherto been almost entirely directed to cases of poisoning by asphyxia produced by such escapes, asphyxia which has been shown to be due to the carbonic oxide contained in the coal-gas. The most recent investigation into the poisonous characters of coal-gas is that of Professors W. T. Sedgwick and W. Ripley Nichols, of the Massachusetts Institute of Technology, and the results of it are stated in a paper by them, entitled "A Study of the relative poisonous effects of Coal- and Water-Gas," the latter being largely used in the United States, and being derived "from the decomposition of steam by the action of incandescent coal, and enriched with the vapour of naphtha." They come to the conclusion "that the only really poisonous substance which is present in any considerable portion in either case is carbonic oxide," and this "is conspicuous for poisonous properties which are peculiarly its own;" and again they say "without denying the other constituents their proper physiological effects when breathed with air in a mixture of which they form a large proportion, it is probably true that carbonic oxide is the only component of illuminating gas whose poisonous qualities are at present of practical importance to the public health."

I agree with these statements if they are limited to cases of fatal poisoning produced by coal-gas, but believe that I shall be able to show you that where people habitually live, and especially sleep, in atmospheres continually contaminated by even slight escapes of coal-gas serious effects are produced, which are most probably due to other constituents of coal-gas and not to carbonic oxide.

The most important results arrived at by the authors just quoted are the following :—

"1. With ordinary gas fixtures it is difficult to get more than 3 per cent. of illuminating gas into an ordinary room. By using one burner alone it is difficult to exceed 1 per cent."

"2. With coal-gas it is a matter of some difficulty to get into an ordinary apartment through the ordinary burners gas enough to produce upon healthy animals distinctly poisonous effects. With water-gas, on the contrary, it is comparatively easy to get into an ordinary apartment, through the ordinary burners, gas enough to produce poisonous and even fatal effects."

This is because water-gas contains about five times as much carbonic oxide as coal-gas.

"3. It does not follow that because one illuminating gas contains three, four, or five times as much carbonic oxide as another, it is therefore only three, four, or five times as dangerous to life."

In effect there is a certain percentage in each instance which may be called the "danger line," above which the danger rapidly increases, and below which it rapidly diminishes. "In terms of carbonic oxide it is probably never very far from 0·5 for the human species."

"4. Our experiments confirm the work of Gruber and others, who claim that carbonic oxide is not a cumulative poison ; thus, the breathing of a small quantity for a long time is not equivalent to the breathing of a large quantity for a short time. A similar conclusion may be drawn for all the constituents of illuminating gas."

They then mention five particular ways in which injuries are likely to occur from escapes of gas, one of these ways being "by the slow and obscure poisoning (especially of feeble or anæmic persons) owing to leaks in or about pipes or burners in ordinary dwelling rooms," and they give an example of a lady in fair health, who "began somewhat suddenly to suffer from intolerable headaches," which "were worst on awakening from sleep." A faint smell of gas was noticed in the sleeping room, and it was found that a pipe leaked under the floor. The leak was stopped, and the lady quickly recovered. The gas in this case was water-gas, and it is probable that, as the authors believe, the carbonic oxide in that gas was the chief cause of the effects complained of, and possibly "if it had been coal-gas it would have proved less

harmful," but I think it is too much to say that in that case "it might possibly have done no injury at all."

It will thus be seen that those authors limited their attention entirely to the carbonic oxide, and attributed any ill effects produced by coal-gas to the presence of this substance in it.

Michel Lévy, in his "Treatise of Hygiene," notes that persons who live in shops lighted by gas and badly ventilated suffer from headaches, malaise, giddiness, &c.; and that "persons who are obliged to live in places abundantly lighted with gas complain of dyspnœa, a sense of suffocation, acrid heat at the throat, and a tickling of the larynx, which provokes a dry and fatiguing cough, and that such an atmosphere is especially hurtful to subjects of tuberculosis;" and he goes on to add that "these effects are due to substances which escape combustion; to wit: sulphurous acid, so irritating to the mucous surfaces; sulphide of carbon, which is very acrid; sulphuretted hydrogen, the baneful influence of which is well known; and lastly, the vapour of carbon (? carbonic oxide), which, continually inspired, is a source of irritation to the bronchial mucous membrane."

Here we have a distinct suggestion that other substances in coal-gas besides the carbonic oxide are dangerous to health. With regard to these, in considering escapes of unconsumed coal-gas, the most deleterious substances apart from the carbonic oxide are the bisulphide of carbon and other organic sulphur-compounds; for the sulphurous acid mentioned by Michel Lévy is one of the *products of combustion* of coal-gas, and the sulphuretted hydrogen exists in properly purified gas in too small a proportion to be worth considering. But I can find no account of definite illnesses produced by continuous slight escapes of coal-gas from defective burners or joints in pipes.

During the past few years my attention has been gradually arrested by cases of illness, and more especially of relaxed and even of ulcerated sore throats occurring in persons sleeping in rooms in which there were defective gas burners, but living in houses of which the sanitary condition was otherwise as perfect as the application of modern sanitary knowledge could make it.

In 1883 I was asked to inspect the sanitary arrangements of a Public Institution, the superintendent of which had been taken ill with what was described as blood-poisoning; this was attributed by the medical attendant to some defect in the sanitary arrange-

ments of the building, and more especially of the superintendent's office itself. A peculiar smell, which was believed to proceed from some defective drain or pipe connected with the drains, was observed in the room. A great deal of trouble had already been taken to find out the cause of the evil, and among other things the floor had been taken up, the earth under it removed to a depth of several feet to search for drains or cesspools and replaced by concrete, but all was of no avail; as soon as the superintendent occupied the office again the illness recurred, and the person was advised to give up the situation. On inspecting the building no defect in the sanitary arrangements could be found which would account for the illness; but after having the superintendent's office shut up from Saturday till Monday morning, on entering it a distinct smell of coal-gas was perceived, and on further examination a defect was found in the connection of the gas-pendant with the pipe near the ceiling; this was remedied with the result that nothing further was heard of the superintendent's illness.

In 1884 I was suddenly summoned to a large country house, where the sanitary arrangements had been put into perfect order under my own direction shortly before, the internal soil pipes having been removed, and new soil pipes fixed and soil drains laid externally to the house with proper disconnecting arrangements and ventilating pipes, by a telegram stating that there "were several severe cases of diphtheritic sore throats" in the house. On inspection the sanitary arrangements were found in perfect order, and there was no escape whatever of foul air from the drains or soil pipes into the house. The first case that had occurred was one of ulcerated sore throat in the person of a footman, who slept with two others in a particular room on the ground floor, with no basement under it; on entering this room I noticed an escape of gas from a tap of one of the brackets, but did not think much of it at the time. As one of the sink-water drains (disconnected from the soil drains) passed directly under this room, I had it exposed, but found that there was no defect in it. On being informed that a serious nuisance had been created in the neighbourhood of that room by an earth closet, which the men-servants had brought in from outside and had used, without properly supplying it with earth, I thought that it was possible that this might have been the cause of the mischief, and came back to town. A few days afterwards I received another telegram

stating that another case of "diphtheritic sore throat" had appeared in the same room as the first case, and went down at once to make a further investigation. I was then informed by the lady of the house that among the thirteen or fourteen cases which had occurred, four were those of visitors who had slept successively in a particular room, and who were taken ill with sore throats after leaving the house, one of them so severely that he was unwell for a month. I slept in that room myself, and on examining it my attention was arrested by a very evident escape of coal-gas from one of the brackets, the gas having, moreover, a very foul smell from being insufficiently purified, as is often the case with gas made at country houses. I then remembered having noticed the escape in the footmen's room on the previous occasion, and on inspecting other rooms in the house, where cases had occurred, found other escapes. The brackets were repaired, new ones being fixed where necessary, and no more cases of sore throat have since occurred there.

The next instance which came under my notice was that of a large house in London, where the sanitary arrangements had recently been put into perfect order, but where an outbreak of sore throats occurred on the return of the family from the country. It was thought by the medical attendant to be due to some defect in the drainage arrangements, but this was soon shown to be out of the question, and on examining the gas brackets many of them were found to be defective, and especially those in that part of the house in which most of the inmates had suffered. The leaky brackets were repaired, and no more sore throats occurred in the house.

At another house I found an escape of gas, in such quantity that it could be lighted, from a defective bend in a gas-pipe under the floor of the sitting room, the inmates of which had suffered from severe headaches and sore throats.*

At a country house, in which the sanitary arrangements had been put into perfect order, and where there was no drain under the house, and no soil pipe inside it, an outbreak of sore throats occurred in a family who took the house; they were ordered to the sea-side, and the doctor who saw them there was convinced that there must be some defective drainage arrangements in the

* This house shortly afterwards passed into other hands. The new tenant had 22 superfluous gas-brackets removed, and neither he nor any of his household have suffered from sore throats.

house question. On examination no such defect could be found, but escapes of coal-gas were found from the brackets in the hall, and in the passages upstairs, and a slight smell due to these escapes was perceptible all over the house and especially on the bedroom floor. I recommended that the brackets should be repaired, and have not heard that any more cases have occurred.

The next case, which I investigated quite recently, was that of a house in the west end of London, but in this instance there was a complication caused by a defect in the sanitary arrangements upstairs. A slop-sink had been recently fixed in the housemaids' closet, and its waste-pipe connected with that of the housemaids' sink which was there previously, the waste-pipe having been properly trapped and disconnected. I found that when water was thrown down the slop-sink, the trap of the housemaids' sink and also that of the slop-sink itself were both siphoned out. The trap of a wash-hand basin, the waste-pipe of which discharged into an open head outside the house on the course of the pipe into which the waste-pipe of the other sinks discharged, was also siphoned out when the basin was emptied, and a bad smell had been noticed in the room in which the wash-hand basin was, and which opened into one of the nurseries, and also in the housemaids' closet; this was probably the cause of the sore throats occurring in the upper part of the house; but severe cases of sore throat also occurred among some of the men-servants who slept in the basement. One case was that of the butler, in whose bedroom a serious escape of coal-gas was found to take place from the tap supplying the gas fire in his room; another was that of a footman who slept in the pantry, where there was also a very marked escape of coal-gas. These defects were remedied, and no more cases have occurred.

At about the same time an outbreak of sore throats took place in another house in London. On testing the drains, soil pipes, &c., which were properly disconnected and ventilated, no escape of foul air was found into the house. The first case in this house was that of a boy who slept in the bedroom on the top floor; in this room there was no gas bracket, but I found a gas plug in the wall with a very evident escape of gas from it. Other escapes were found in the rooms in which the other cases occurred. They were all remedied, those who were attacked speedily got well, and there have been no further cases.

Not long ago both my wife and I suffered from troublesome relaxed (and in her case ulcerated) sore throats, which I found were due to an escape of coal-gas from a leaky pipe in the wall of our bedroom. I had this cut off and stopped under the floor, and since that time we have had nothing the matter with our throats.

Coal-gas may get into houses in various other ways, which would take me too long to enumerate, but I wish to point out that it may come directly from defective mains in the streets. In a house in which I formerly lived, on more than one occasion the front rooms were filled with gas to an alarming extent, on account of the main in the street having been crushed by a steam roller; the gas found its way through the wall of the house and up behind the panelling of the rooms.

I must not omit to mention that the smell caused by a slight escape of coal-gas into a room is somewhat peculiar, and is usually described when noticed as "stuffiness" or "closeness." It does not suggest to an ordinary observer the idea of coal-gas at all, and the notion that it is caused by coal-gas is frequently regarded as too absurd to be entertained. When mixed with other odours, such as that of new carpets, leather trunks, furniture polish, the smell of cooking, or that of a housemaid's sink, it is often difficult even for an experienced observer to detect the smell produced in the air of a room by a slight escape of coal-gas.

From the cases I have observed I have been forced to come to the conclusion that sore throats are frequently caused by the breathing, especially at night, of air contaminated by a small proportion of coal-gas, and I think it most probable that the effective agents in producing the irritation in the throat are the bisulphide of carbon and other sulphur-compounds known to be contained in coal-gas.

To our hospital throats and sewer-air throats we must add coal-gas throats, and I am convinced that these ulcerated throats are frequently thought to be due to foul air from drains, when they are really due to escapes from gas-pipes and fittings.

Discussion.

Mr. Wynter Blyth said that Dr. Corfield had not referred to one channel by which coal-gas could enter houses, *i.e.*, through water mains, two instances of which had come under his own

observation, and the details of which were published some time ago in his monthly report; in the one case, each time that the water was turned on from the main a dangerous volume of coal-gas rushed into the house; the whole family, with the exception of the master who was much away from home, suffered from slight sore throat and general malaise, they always recovered their usual health when removed even for a few days from the home influences, but were again attacked on their return. The gas leakage stopped, the malady subsided.

In the second case, the escape of gas was also very great, and the drinking water itself was contaminated by it, but no illness resulted. If coal-gas can be sucked into vacuous water mains, it is certain that sewer-gas and sewage may in the same manner find entrance, this the more likely as the London soil must in many places be much polluted.

Dr. Corfield's cases, he thought, appeared to be due to coal-gas poisoning, but if to the sulphur-compounds, in what form was the sulphur present? Certainly not sulphuretted hydrogen, for gas was almost free from this impurity. There was always some sulphide of carbon present, but so little would escape into the house that in twenty-four hours there would not be enough to affect health. In one manufacture where bisulphide of carbon was much used, he noted that the ailment from which the operatives suffered was headache, and not sore throat; it was, however, possible that persons usually susceptible to the latter malady would be more liable to it at times when their health was depressed, and therefore coal-gas may produce indirectly sore throat, by inducing a general want of tone.

Mr. Rogers Field, after expressing his opinion of the great value of the paper, said he himself had had so many cases where offensive smells which were attributed to defective drainage were found to be due to escapes of gas, that he now made it a practice always to have the gas-pipes tested and made thoroughly sound after the drainage of a house had been reconstructed. He found the only effectual method of testing the gas-pipes and fittings was to attach a pressure gauge, and then pump air into the pipes. If the gauge stood, the pipes were sound; if it fell, there was a leakage, which had to be found out and remedied, and the work was not left as complete until the pressure gauge would stand. He proceeded to refer to the case of an outbreak of sore throats

in a school of young boys where earth-closets were used. The drainage was found to be defective, and was entirely reconstructed under his directions, and he recommended that the gas-pipes should be tested and made sound, but this was not done. After the boys returned the throat attack broke out again, and he was sent for to examine the drainage. The drainage was found perfect, but he noticed an escape of gas in the dormitory, and again pressed for the gas-pipes to be made sound. This was partially done, and the work then stopped, as the defects left unremedied were so slight that his client thought they could do no harm. The unsatisfactory state of the boys' health eventually induced his client to have all the defects in the gas-pipes made sound, and after that the health of the school was good. In a house occupied by friends of his own, illness appeared again to be associated with leakage from gas-pipes. In his own house at Hampstead, to which the gas was not laid on, a very strong escape of gas took place, which was eventually found to have its origin in a broken gas main more than 100 yards distant. The gas came up an old disused road-drain, and then penetrated through the wall of the house.

The speaker further referred to a paper by Professor Pettenkofer, on "Poisoning by Lighting Gas" (published in a German monthly magazine, *Nord und Sud*, January, 1884), which gives a number of very interesting cases. One case was very striking, and showed the great effect of increase of temperature in drawing foul gases into a house. An ecclesiastic, now in a high position at Munich, but formerly a priest at Augsburg, suffered at the latter place from a disease which was inexplicable to him, as it increased when the weather was cold and moderated when it was warmer. The doctor pronounced the disease to be "typhus." One night, when the patient was so ill that the worst was feared, the landlady of an hotel came to see the priest, who was her father confessor, and at once said there was an escape of gas and that he must leave the house immediately. This idea was discredited, as no gas was laid laid on to the church-house where the priest was; moreover, the doctor declared that the patient could not be removed in his then state. The landlady, however, persisted, and eventually the patient was removed to the cathedral residence, where he recovered so rapidly that even during the short drive to the residence he gained sufficient strength to step out of the carriage himself and

walk into the house. In the meantime there was a development of the trouble. In a room adjoining that which had been occupied by the patient there was another priest, and on the night after the patient was removed this other priest was taken ill with the same symptoms. The explanation of this was that the first patient always kept his room very warm, so that it drew the gas in, whereas on his removal the fire was let out and the windows opened, and then the gas was drawn into the adjacent room. This also explained the cause of the fluctuation of the disease with the alteration of temperature. Eventually a fracture of the gas-main in the street was discovered, and the cause of all the trouble was removed.

Dr. SYKES related a recent experience in his own family, two of whom suffered from malaise, headaches, and a feeling of giddiness on rising in the morning. On leaving home for a while, the symptoms disappeared, but reappeared on returning to London. On entering the bath-room adjoining their bedroom, he discovered an escape of gas.

Mr. BUTTERFIELD said he was specially interested in Dr. Corfield's paper, because a fortnight ago he had been called to a large house in Tunbridge, where were 29 boys, 28 of whom had been taken ill in one way or another; the first boy suffered from conjunctivitis, then several had congested lungs. He had expected to find some faulty condition of drainage, but careful examination negatived this possibility; the house was provided with earth-closets, which were in good order, and the water supply was satisfactory; finally it was discovered that the gas main in the street was broken, and a slight smell of gas was perceptible in the house.

Mr. SHIRLEY MURPHY thought that, although Dr. Corfield's cases were very suggestive of coal-gas as a cause, it could not yet be said that they afforded an absolute proof. No doubt the difficulty of obtaining positive evidence was very great, because it was impossible to eliminate every other condition that might have given rise to the symptoms described. The evidence would have been more conclusive if the health of two groups of individuals could have been compared, both of which were exposed to exactly similar conditions, with the exception of the one breathing air thus contaminated; but Dr. Corfield's paper would have the good effect of making investigators direct their attention to this subject

Professor CORFIELD in reply, said that as to the cause of the sore throats, he thought it probable that the organic sulphur-compounds in coal-gas, which were very irritating to the respiratory passages, were the active agents in producing the disease. He was much obliged to Mr. Rogers Field for the facts he had mentioned from his own experience in confirmation of the view advocated in the paper. With regard to the proof that the sore throats were really caused by breathing air contaminated with coal-gas, he considered that, as in a number of instances he had found that persons who slept in rooms in which there were slight escapes of coal-gas, suffered from sore throats, and in every instance got quite well when the gas leakages were cured, he was justified in the conclusion he had drawn.

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