
II. OF THE GASES EMPLOYED AS REMEDIES.

SUBSTANCES existing in the aërial form might *a priori* be supposed capable of producing important effects on the system, as by respiration they are brought to act directly on the mass of blood, and induce in it chemical changes. They occasion too immediate and important alterations in the functions of life, some of them producing the highest excitement, others occasioning depression and exhaustion of power. And in the classes of aërial substances, we have actually the two extremes of stimulant and sedative power, in the examples of nitrous oxide and carbureted hydrogen.

Though the expectations that were at one time formed, with regard to their medicinal efficacy, have not been realized, and the use of them has now been nearly relinquished; yet since they are capable of producing such changes in the state of the functions, and of the general system, and since the proposition must be admitted, that every substance possessed of these powers may be capable of producing medicinal effects, they ought not to be entirely lost sight of, and a few observations on their operation are necessary to complete the history of the *Materia Medica*. There are some applications too of their chemical agency applied to medicinal purposes, which require to be taken notice of.

The modes of preparing these gases are, in a great measure, peculiar to each of them. The manner of administering them is nearly the same. They may be breathed

from a jar placed in water ; but this is laborious, from the effort required to sustain the column of water within the jar. This may be partly remedied, by poising the jar in water, or, more completely, by breathing from the gazo-meter. But the easiest mode is, for the patient to breathe the gas from a silk bag, to which a tube with a stop-cock is affixed.

The gases that have been employed in medicine may be considered under the divisions of those which *excite*, and those which *depress* the functions of life. To the former order belong,

GAS OXYGENIUM. Oxygen Gas.

GAS OXIDUM NITROSUM. Nitrous Oxide Gas.

OXYGEN gas is proenred from black oxide of manganese by heat. A quantity of the oxide is put into an iron retort, connected by a tube with a gas holder, or a large jar filled with water, inverted and placed on the shelf of the pneumatic trough. The retort is exposed to a full red heat ; at this temperature the affinity of the oxygen to the manganese is so far weakened by the repulsive agency of the caloric, that a large portion of it is separated from the combination, and assumes the elastic form : the gas is transmitted through water, and is allowed to stand over it for some hours before it is breathed.

As oxygen is so immediately necessary to the support of life, it might be supposed, that when afforded in a more pure and concentrated state than that in which we breathe it in atmospheric air, it would prove a salutary agent of no inconsiderable power. To this inference, however, independent of any experience, an objection occurs, from the fact, which, on some experiments made by Lavoisier, and repeated by Davy, appeared to establish, that when ani-

imals are supplied with pure oxygen, or with oxygen mixed with a portion of atmospheric air, less of it is consumed than in ordinary respiration. This result appears, however, to have arisen from some fallacy in the experiments. Seguin, in subsequent experiments, found that the consumption of oxygen gas, when it is breathed pure, is at least equal to its consumption in ordinary respiration. And Messrs Allen and Pepys found that in breathing pure oxygen gas, more of it is consumed in a given time, and more carbonic acid formed, than in breathing atmospheric air. The positive action of oxygen, in the respiration of it, in its undiluted form, is also shewn by the effects which result from its inspiration, and still more unequivocally by the fact ascertained by Priestley, Lavoisier, and Davy, that animals confined in air, with an increased proportion of oxygen, die before it is exhausted, and even while the air which they breathe contains more oxygen than common air, so that it can enable another animal to live. It is obvious, therefore, that the animal dies not from deprivation of oxygen, but from some positive power the gas exerts, and probably, as may be inferred, from some appearances which present themselves, from its too highly stimulating power.

Oxygen, when respired, acts partly by communicating a stimulating quality to the blood, by which the left side of the heart and the arterial system are excited to action: hence, when its supply by respiration is suspended, the contractions of the heart become feeble, and at length cease, as Goodwyn demonstrated. The phenomena of asphyxia from its abstraction, prove that it likewise exerts some other operation more immediately subservient to the functions of life; for in that disease the functions of life are suspended, while the contractions of the heart still continue,

to a certain extent, as the experiments of Coleman have shewn.

The diseases in which oxygen gas has been administered, are principally those of chronic debility,—chlorosis, asthma, scrofula, dropsy, paralysis, and some cutaneous affections. It requires to be diluted with from ten to twenty or more parts of atmospheric air, increasing the proportion of oxygen according to the effects produced. From one to two quarts of oxygen are given, by breathing it in its diluted state, at intervals, in the course of the day. It generally increases the force and velocity of the pulse.

NITROUS OXIDE GAS.—This gas, a compound of oxygen and nitrogen, in the proportion of 37 of the former to 63 of the latter, is most economically obtained, and in greatest purity, from the decomposition of nitrate of ammonia by heat. When this salt is exposed to a temperature about 400° of Fahrenheit's scale, its principles re-act on each other, and enter into new combinations. The hydrogen of the ammonia attracts part of the oxygen of the nitric acid and forms water; and the remaining oxygen combining with the nitrogen, both of the acid and of the ammonia, forms this particular compound, nitrous oxide, which is disengaged in the gaseous form. After its production it requires to stand some hours, to deposite a small portion of saline matter, before it is fit to be breathed.

The effects of nitrous oxide gas on the system, when it is respired, are scarcely analogous to those of any other agent. The excitement which it produces is extended to the functions of body and mind with more rapidity and force than that arising from the action of the most powerful stimulants. It is accompanied, too, with effects as various as they are peculiar; it excites usually a peculiar thrill-

ing of the body, with feelings of pleasure not easily described : muscular vigour is increased, so that unusual exertions are made with alacrity and ease, and there is even an irresistible propensity to strong muscular exertion ; the mind is also affected : there is usually a high degree of exhilaration, yet even when this is greatest, perfect consciousness remains. What still more marks the singularity of its operation, this high excitement of the functions of life and exhilaration of mind is not followed by proportional languor or debility ; the state of the system gradually returns to the healthy standard, without any apparent waste of power. A substance capable of acting in such a manner, we might suppose, would prove one of our most valuable remedies. The transient nature of its operation must undoubtedly limit its medicinal efficacy ; but still, in diseases of extreme debility, we seem justified in expecting from its administration the most beneficial effects. It has not, however, been very extensively employed. In paralysis it has been used with advantage. In diseases of increased sensibility, it may prove hurtful ; and when breathed by delicate females, it has, in more than one case, induced hysterical affections. The dose which is requisite to produce its peculiar effects varies from four to nine quarts, which may be breathed pure or diluted with an equal part of atmospheric air. It cannot be breathed undiluted for more than four minutes and a half, insensibility being induced. And it requires to be attended to in its administration, that its effects are considerably different in different individuals. On some, its operation has even been productive of unpleasant consequences, — palpitation, fainting, and convulsions.

Nothing satisfactory can be said as to its mode of action, since we know so little of the connection which subsists between the phenomena of life and the chemical changes

which are carried on in the system. The experiments of Davy appeared to prove, that it is absorbed by the blood when respired; but, admitting this, we can discover nothing connected with its composition or chemical agency which can lead us to any explanation of its peculiar effects. We can therefore only mark the dissimilarity of its operation to that of any other physical agent.

UNDER the second subdivision of the Gases,—those which depress the functions of life, might probably be placed all the substances existing in the aërial form, oxygen and nitrous oxide excepted. The following are those which have been applied to medicinal purposes.

GAS HYDROGENIUM. Hydrogen Gas.

GAS NITROGENIUM. Nitrogen Gas.

GAS HYDROGENIUM CARBURETUM. Carburetted Hydrogen Gas.

GAS ACIDUM CARBONICUM. Carbonic Acid Gas.

GAS ACIDUM MURIATICUM. Muriatic Acid Gas.

GAS ACIDUM NITROSUM. Nitrous Acid Gas.

GAS ACIDUM OXYMURIATICUM. Oxymuriatic Acid Gas.

HYDROGEN GAS is most easily procured by the action of diluted sulphuric acid on iron or zinc; but as a little acid vapour might be diffused through it, it has been supposed preferable to obtain it, when it is designed to be breathed, by passing water in vapour over pure iron heated to the temperature of ignition. The iron attracts the oxygen of the water, and the hydrogen assumes the aërial form.

Hydrogen gas received into the lungs does not appear to exert any positive deleterious power: all its effects seem referable merely to the exclusion of oxygen. The respiration of it can accordingly be continued for some time, if it is mixed with a portion of atmospheric air, without any

deleterious effect. In a pure state, however, if the lungs have been previously emptied as much as possible of atmospheric air, it cannot be breathed but for a very short time. It quickly occasions a giddiness and sense of suffocation; the countenance becomes livid, and the pulse sinks rapidly, and a state of insensibility is soon induced. When diluted with two-thirds or an equal part of atmospheric air, it can be safely breathed; nor does it appear to produce any very important effect. It occasions some diminution of muscular power and sensibility, and a reduction of the force of the circulation. It has been respired, diluted usually with four or five parts of atmospheric air, in catarrh, hæmoptysis, and phthisis; but its powers seem merely those of a palliative, dependent on the partial exclusion of the stimulating power of oxygen.

NITROGEN.—What has been said of hydrogen applies likewise to nitrogen. It seems to exert no positive action on the system, but to produce any effects arising from its inspiration merely by excluding oxygen. As it is not so easily obtained pure as hydrogen gas, it has scarcely, if at all, been employed.

CARBURETTED HYDROGEN GAS.—The gas which has been used in medicine under this name is obtained by passing the vapour of water over charcoal at the temperature of ignition, in an iron tube. The oxygen of the water unites with one part of the charcoal, forming carbonic acid; the hydrogen combines with another part of it, and forms this species of carburetted hydrogen. The carbonic acid is abstracted by agitating the gas in lime water.

This is the most active of those gases which operate by depressing the functions of life, and is perhaps the most

powerful agent of this kind. Even when largely diluted with atmospheric air, it occasions immediate vertigo, sickness, diminution of the force and velocity of the pulse, reduction of muscular vigour, and in general every symptom of diminished power. It can scarcely be breathed in an undiluted state. Mr Davy found, that at the third inspiration, total insensibility was induced, and symptoms of extreme debility continued for a considerable time. These effects prove its positive deleterious agency.

As a medicinal agent, it is the gas of which the evidence in favour of its efficacy is greatest. In phthisis, in many cases, it unequivocally relieved the symptoms, and at least arrested the progress of the disease; and in diseases of increased action or increased power, much benefit might, from its known operation, be expected from its use. Much caution was found to be requisite in the trials that were made of it, with regard to the dose. At first, one point of the carburetted hydrogen gas, diluted with twenty parts of atmospheric air, may be respired: the quantity may be slowly increased, and with less dilution, taking care to avoid the production of great vertigo or muscular debility. Not more than from two to four quarts can be taken in the day, even when the patient has been accustomed to it for some time. It is always more powerful when recently prepared, than when it has been kept for some days, a circumstance requiring to be attended to in the regulation of its dose.

CARBONIC ACID GAS.—This gas is easily procured from the action of diluted sulphuric or muriatic acid on carbonate of lime (chalk or marble); but to obtain it in a proper state of purity for breathing, it is preferable to decompose the carbonate of lime by exposure to a strong red heat

in an iron bottle. The carbonic acid which is disengaged is collected over water, as it is not immediately largely absorbed by that fluid, and any vapour diffused through it is speedily condensed.

This acid gas, when it is inspired, proves more speedily fatal than nitrogen or hydrogen. It appears, from Davy's experiments on its respiration, to excite spasmodic contraction of the epiglottis, so as to induce suffocation; and it has this effect, even when diluted with nearly an equal part of atmospheric air. Yet the operation of it is more speedily fatal than that of any other agent that acts, by occasioning merely suffocation, which would lead to the supposition that it acts by some positive power,—a supposition confirmed too by the fact, that in animals, in whom the symptoms of life have been suspended by its respiration, the irritability of the heart is entirely destroyed.

The respiration of carbonic acid gas was employed at an earlier period than that of the other gases, and sanguine expectations were formed of it as a remedy in phthisis. In the many cases, however, in which it has been tried, though it frequently proved useful for a time, by lessening the expectoration, diminishing the hectic fever, and acting as an anodyne, there is little evidence of its having ultimately effected a cure. The difficulty, indeed, of employing this and all the other gases, is, that of obtaining their continued operation. In that state of disease existing in the lungs, in the earlier stages of phthisis, much advantage, for example, might probably be derived from the continued respiration of a reduced atmosphere, while little can be expected merely from its occasional operation. Carbonic acid gas, when employed, was respired diluted with four or six parts of atmospheric air. It has been found, in that irritable state of the lungs, in which cough and dyspnoea

are excited from the application of cold, to be attended with considerable advantage when it is breathed in a diluted state; and an easy mode of employing it with this view, is, to put a mixture of chalk or marble with diluted sulphuric acid and water into a large glass bottle, so that it shall occupy a depth only of a few inches. The carbonic acid gas is extricated, and forms an atmosphere mixed with atmospheric air in the upper part of the vessel, which may be breathed by introducing a glass tube to about the middle of the bottle, and inspiring from it.

Carbonic acid has likewise been employed as a local application to cancer and painful ulceration, and has at least been serviceable as a palliative. A stream of it is directed on the part by means of a flexible tube, taking care to transmit the gas previously through water, if it has been obtained by the action of an acid on carbonate of lime, and confining it for some time over the sore by a funnel connected with the tube. A cataplasm, formed of substances in a state of fermentation, has, in some measure, a similar effect, and is more convenient in its application. A formula for this preparation has now a place in the London and Dublin Pharmacopœias, and has been already noticed.

THE three last gases which I have enumerated, Nitrous Acid Gas, Muriatic Acid Gas, and Oxymuriatic Acid Gas, require notice under this section only as having been applied to one medicinal purpose,—that of neutralizing or destroying noxious or contagious effluvia. These effluvia are probably evolved by chemical processes, and must consist of principles in forms of combination subject to chemical agency, and capable of being subverted by its exertion. It has accordingly been found, that the air of places offensive from the presence of such effluvia is corrected, and its

freshness restored, by the diffusion of those acid gases, the operation of which, in changing the chemical constitution of compound elastic fluids, is most powerful.

GAS ACIDUM MURIATICUM. Muriatic Acid Gas.

The vapours of vinegar raised by heat, and the vapours of sulphurous acid disengaged in the burning of sulphur or the deflagration of sulphur and nitre, had long been employed as the most active means of fumigation. Dr James Johnston at an early period, 1758, had proposed muriatic acid, but little attention appears to have been given to the proposal. In 1773, Guyton Morveau employed it on a large scale, the use of it having been suggested to him by an hypothesis he had formed of the nature of those noxious effluvia which arise from the decomposition of animal matter. The atmosphere of the Cathedral Church at Dijon had become extremely offensive and noxious, from exhalations from cemeteries within the church; and the methods of fumigation at that time usually practised had been employed without any advantage. Morveau supposed, that the putrid odour of these effluvia must arise from the ammonia which is abundantly formed in the decomposition of animal matter, combined with a small portion of acrid oily matter formed in the same process. To neutralize this impregnation, a volatile acid, which should be capable of being diffused easily through the air, seemed to be most proper, and this led to the employment of the muriatic acid gas. A mixture of sea salt and sulphuric acid, supported over burning fuel, was placed in the body of the church, the doors being closed for twelve hours. When opened at the end of that time, the putrid odour was entirely gone. In some subsequent trials in prisons, and other situations, the same method proved equally successful. The vapour of the acid

might perhaps, by some operation similar to that which Guyton supposed, lessen or remove the putrid odour; but it can scarcely be supposed capable of destroying noxious effluvia, as, of all the acids, it is the one which, from being unable to impart oxygen, is least powerful in subverting the combination of compounds, consisting of elements such as those which must be supposed to enter into the composition of elastic fluids disengaged in the putrefaction of animal or vegetable matter. And other gases having since been employed, much more active in this respect, muriatic acid gas is now scarcely employed.

GAS ACIDUM OXYMURIATICUM. Oxymuriatic Acid Gas.

After the discovery of oxymuriatic acid, its energy of chemical action being obviously so much greater than that of muriatic acid, it was applied by Cruickshank, who shewed by experiment the rapidity with which it acts on compound elastic fluids, to the purpose of fumigation. When it is mixed with sulphuretted hydrogen, phosphuretted hydrogen, or any of the varieties of carburetted hydrogen gases, it decomposes them rapidly by imparting oxygen; and though these gases may not in a pure form be evolved in the spontaneous decomposition of vegetable and animal matter, the deleterious exhalations which arise from this process must in every probability consist of elastic fluids of similar constitution: there is reason therefore *a priori* to believe, that they will be neutralized and destroyed by the oxymuriatic acid gas. It has accordingly been established by Guyton's experiments, that air tainted with a putrid odour, by exposure to substances in a state of putrefaction, has this odour removed by its action; and in the subsequent applications of it to destroy deleterious and contagious effluvia, its superior power appears to have been sufficiently established.

Oxymuriatic acid gas is applied to the purpose of fumi-

gation by disengaging it by the usual process. Four parts of muriate of soda, one of black oxide of manganese, two of sulphuric acid, and one of water, may be mixed in an earthen pipkin, which is to be placed in a sand bath over a charcoal fire, and placed in the apartment designed to be fumigated, the doors and windows being closed. After a few hours the air may be admitted, and ventilation established, to remove completely the vapours of the oxymuriatic gas.

GAS ACIDUM NITROSUM. Nitrous Acid Gas.

The application of nitrous acid gas to the purpose of fumigation, was principally introduced by Dr Carmichael Smyth. In energy of chemical action, it is much inferior to oxymuriatic acid gas, and is probably, therefore, inferior to it in the power of destroying noxious or contagious effluvia. The evidence brought forward by Dr Smyth seems to prove, however, that it has considerable activity, and that fumigation with it is successful in restoring the purity of a corrupted atmosphere; and it has the very important advantage, that being free from the intolerable suffocating odour of the oxymuriatic gas, and free from its deleterious action on the lungs, fumigation with it in the wards of an hospital or ship, where the sick cannot well be removed, may be had recourse to without inconvenience. It is applied by mixing two parts of nitre in powder and one part of sulphuric acid, placing this mixture in warm sand, and renewing the heat occasionally as long as any vapours continue to be exhaled. Several small vessels containing a few ounces of this mixture are placed in the apartment.