

III. 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.

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, or be discarded from the *Materia Medica*. In the aërial kingdom, we have actually the two extremes of Stimulant and Sedative Power, in the examples of nitrous oxide and carburetted hydrogen.

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 poisoning the jar in water, or, more completely, by breathing from the gazometer. 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 procured 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, founded on some experiments made by Lavoisier, and repeated by Davy, which appear to prove, that when animals are supplied with pure oxygen, or with oxygen mixed with a portion of atmospheric air, less of it is actually 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 more lately, Messrs Allen and Pepys have 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; they also observed a diminution in the volume of air, or the disappearance of a portion of it; whence they inferred, that, when oxygen is breathed pure, a quantity of it is absorbed by the blood. 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, and 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 azote, 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 am-

monia by heat. When this salt is exposed to a temperature about 400° of Fahrenheit's scale, its principles react 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 azote, 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 thrilling 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 are 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 Mr Davy appear 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 medicinally employed :

GAS HYDROGENIUM. Hydrogen Gas.

GAS NITROGENIUM. Nitrogen gas.

GAS ACIDUM CARBONICUM. Carbonic Acid Gas.

GAS HYDROGENIUM CARBURETUM. Carburetted Hydrogen 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.

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 Mr 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.

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 of 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 Pharmacopœia.

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 pint 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.

AN application of the aërial fluids connected with medicine, is 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. 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. These are Oxy-muriatic Acid Gas and Nitric Oxide Gas. The power of the former in producing these effects appears, from the evidence brought forward by Guyton, to be unquestionable: considerable benefit appears, likewise, from the reports of Dr Carmichael Smyth, to be derived from the latter. It is however probably inferior to the oxy-muriatic acid gas in activity; but it has the advantage, that fumigation with it in the wards of an hospital, or in similar instances, may be had recourse to without the removal of the sick. The one is disengaged from a mixture of muriate of soda, black oxide of manganese, and sulphuric acid; the other from nitre and sulphuric acid, the mixture being put in small earthen cups, and a moderate heat applied to favour the disengagement of the gas.
