

XXIX. *Observations on Air found in the Pleura, in a case of Pneumato-thorax; with experiments on the absorption of different kinds of air introduced into the pleura.* By JOHN DAVY, M. D. F. R. S.

Read June 6th, 1823.

I TRUST that the following case of pneumato-thorax, with the experiments made to illustrate it, will not prove undeserving of the attention of the Royal Society, which, from its commencement, has warmly encouraged physiological inquiries, and every investigation directed to the improvement of medical science.

ABRAHAM IREDILL, of the 7th regiment of Foot, aged 30, was admitted into the General Military Hospital at Fort Pitt, Chatham, on the 15th of January last, labouring under phthisis pulmonalis, and invalided on account of it.

His disease exhibited some peculiarities, the cause of which was not discovered during life, the chest not having been minutely examined by exposure and percussion, owing to the severity of cold at the time and the hopeless state of the patient, evidently on the brink of the grave. He expired on the 11th of February, and his body was inspected the day following, fourteen hours after death.

The right side of the chest exhibited a great degree of fulness, and it emitted, when struck, a hollow sound. On carefully opening the abdomen, the diaphragm was found protruding into the right hypochondrium, exhibiting a surface convex, and almost conical instead of concave; and it was

tense and tympanitic. The right lobe of the liver was pressed into the epigastrium, and rested on a portion of the stomach and duodenum and a part of the transverse colon. Owing to the pressure of the liver, the pyloric portion of the stomach was removed from its natural situation to the left iliac region, where it rested on the upper part of the sigmoid flexure of the colon ; and, owing to the same pressure, the small intestines generally were driven downwards, and more or less displaced.

The body was put into a bath, and a small opening was made, under water, with a scalpel, into that part of the right pleura, best adapted by situation to allow the escape of air. Air issued out in abundance : 212 cubic inches were collected in receivers, and about 13 cubic inches escaped, making altogether the enormous volume of 225 cubic inches. The air collected was set aside for examination, and the body being replaced on the table, a portion of the ribs was removed from the right side to admit of the examination of the chest, the water that had rushed in to supply the place of the air having been carefully taken out and preserved.

The inner surface of the right pleura was covered with a thin layer of coagulable lymph. The right lung was exceedingly compressed : it adhered closely to the upper part of the pericardium, and loosely to the posterior part of the chest (about the sixth and seventh ribs) by a few strong bands.

On inflating the lungs with a double bellows through an opening into the trachea, the right lung became much expanded, and air was found to pass freely from the lung into the pleura through an ulcerated opening in the upper part of the superior lobe.

The right lung was carefully dissected out. In the upper part of its superior lobe "a tubercular excavation," or vomica, was found, of the capacity of about four ounce measures, which communicated with the aspera arteria by a large bronchial tube, the ulcerated end of which terminated in the side of the excavation opposite to the openings by which the vomica communicated with the pleura.

On examining minutely the communication between the cavity of the chest and the lung, a kind of valvular structure was discovered, which would allow of air being pumped into the pleura in the act of inspiration, but not of its escape in expiration, owing to which, no doubt, the accumulation of air in question took place. Even at the risque of being tedious, I must attempt to convey some idea of this structure. Between the false membrane of the vomica and the pleura there was a small irregular sinus, not exceeding an inch in diameter, the sides of which though not adhering, of course were in contact, or very nearly so. This sinus was the channel of communication, and contained the valvular structure alluded to. It opened into the cavity of the chest by a hole in the pleura pulmonalis about the size of a crow-quill, and into the vomica by three smaller holes in the substance of the lung, not corresponding with the former, so that a probe could not be passed from one into the other in a straight line; and, consequently, when the surfaces of the sinus were pressed together by the compression of the air in the pleura in the act of expiration, the communication through which the air entered was closed, and its exit prevented.

I shall now proceed with the description of the remaining morbid appearances. Besides the vomica described in the right

lung, this viscus contained small tubercles, few in number in the inferior lobe, but abundant in the superior lobe. The largest of them did not exceed in size a common pea, and the smallest were not larger than mustard seed. The smallest were translucent; the larger were of different degrees of opacity; all of them were solid, and none of them had suppurated. The left lung was free from adhesion; like the right, it contained numerous small tubercles, that had made very little progress. The bronchia, and the lower part of the trachea, were redder than natural. There were three ounces of serum in the pericardium, and a larger quantity of fluid than usual in the ventricles of the brain. No air was observable in the blood vessels or in the cellular membrane of any part of the body.

I shall now return to the contents of the right pleura. The water taken from the pleura (*viz.* that which entered when the air was discharged,) was turbid, as if from the admixture of pus. After resting 24 hours in tall glass jars, a white sediment formed, which, carefully separated by decantation, was about an ounce in quantity. It had the appearance of pus, and exhibited the properties of pus when examined by the most approved tests:—thus it became viscid with a solution of muriate of ammonia; it was soluble in sulphuric acid, and precipitable by dilution with water; and it produced coloured rings when placed between two surfaces of glass and held before a candle, according to the method recommended by Dr. YOUNG. The decanted fluid, examined by solution of corrosive sublimate and by evaporation, was found to contain serum; and, judging from the extract it afforded, it was about eleven ounces in quantity; half an ounce of the decanted water having yielded, when evaporated, 2.2 grains of dry residue.

The air collected from the pleura had not the least foëtor, nor indeed any smell. It extinguished flame, and was not inflammable. Examined by means of lime-water and phosphorus (which was sublimed in it without effect,) 100 parts of it were found to consist of 8 carbonic acid gas, and 92 azotic gas.

Whence this air was derived became a question for consideration. Reflecting on the communication, discovered by dissection, between the pleura and the atmosphere through the medium of the lung, it seemed almost demonstrated, that the air was atmospheric air altered.

The next question that presented itself was, how the alteration had taken place; what had become of the oxygene that had disappeared; whence the carbonic acid gas with which the azote was mixed?

To endeavour to learn how the oxygene had disappeared, the following experiment was instituted. The right pleura of a dog was inflated with atmospheric air by means of a double bellows, and the incision through which the air was introduced was closed by a suture. At the end of 48 hours the dog was killed. An hour after death the pleura was punctured under water, and about 8 cubic inches of air were collected, which, examined by means of lime-water and phosphorus, were found to contain slight traces of carbonic acid gas, and to consist of 93 parts azotic gas, and 7 oxygene gas. The wound in the pleura was closed by coagulable lymph, and the pleura was found free from inflammation.

The result then of this experiment seems to show, that the oxygene was absorbed in a greater proportion than the azote;

and thus tends to account for the accumulation of the latter gas in the preceding case.

It may be said, that the experiment does not warrant the inference that any azote was absorbed, and, consequently, that the expression "in a greater proportion," is incorrect. The absorption of this gas is probable, however, though not demonstrated in the present instance, as Sir ASTLEY COOPER has found that common air introduced into the cellular membrane, and into the cavity of the thorax and abdomen of dogs, is, after a certain time, entirely removed by absorption.*

Relative to the source of the carbonic acid gas, it is easy to conceive that it was formed, or emitted, in the air cells of the lungs, as in ordinary respiration; and that, mixing with the air inspired, it was received into the pleura. If thus derived, and not from the surface of the pleura by secretion, it seems to follow, that it is less readily absorbable by the pleura, than oxygene. To endeavour to decide this point, the following experiment was made.

About 30 cubic inches of air, consisting of 80 parts common air and 20 carbonic acid gas, were passed from a receiver into a bladder, furnished at one extremity with a stop-cock, and at the other with a small trochar; both air tight. A small incision having been made through the integuments of the right side of the chest of a dog, the trochar was passed through the intercostal muscles into the pleura. The stillette was immediately drawn from the cannula into the bladder, and the air of the bladder instantly rushed into the pleura, and, on expiration, was in part forced back into

* Surgical and Physiological Essays by JOHN ABERNETHY, p. 55; London, 1793.

the bladder. The exact quantity of air retained was not determined ; it must have exceeded at least ten cubic inches. As speedily as possible the cannula was withdrawn, and the external wound carefully closed by suture. The health of the dog was very little impaired by this operation. Two days after, when the animal appeared to be quite well, a similar experiment was made on the left side of the chest, and a mixture, consisting of 75 parts common air and 25 carbonic acid gas, was introduced into the pleura. This operation had very little more effect than the former. At the end of 24 hours the dog was killed, and immediately examined.

About 3 cubic inches of air only were procured from the left pleura, which were found to consist of

18.3 carbonic acid gas,

78.3 azotic gas,

3.4 oxygene gas :

whilst the air admitted consisted of

20.0 carbonic acid gas,

63.2 azotic gas,

16.8 oxygene gas :—

Thus apparently showing, that during a sojourn of three days in the pleura, the oxygene had been absorbed in a greater degree than the carbonic acid gas, and the latter in a greater degree than the azote. The result of the experiment on the left pleura was very similar ; it afforded ten cubic inches of gas, consisting of 25 carbonic acid gas, 70.6 azotic gas, and 4.4 oxygene gas. The appearances on examining the wounds were satisfactory : the cavity of the chest was free from inflammation, the lungs uninjured, and the cicatrix in the pleura only just perceptible.

The results of these experiments seem to warrant the conclusion, that in the preceding case the carbonic acid gas found, was not derived from the surface of the pleura by secretion or exhalation, but from the respired air through the ulcerated opening. And with this remark I shall dismiss the case of Pneumato-thorax, the consideration of which, as a medical subject, would not be appropriate to this place.

The power exhibited by the pleura in the preceding instances of absorbing gases, and the manner in which it exercised that power, in a greater degree, on one air than on another, and that in no ratio to their solubility in water, appeared to me so interesting and novel, that I was induced to prosecute the subject a little farther. With the same apparatus, I made similar experiments on the admission of three other gases into the pleura of dogs, viz. hydrogene, nitrous oxide, and nitrous gas, the results of which I shall briefly describe.

About 20 cubic inches of a mixture, consisting of 57.5 parts carbonic acid gas, and 42.5 hydrogene were admitted into the left pleura of a dog, in the manner, and with the precaution already noticed. The health of the animal was not apparently affected. At the end of two days, about 30 cubic inches of a mixture, consisting of 44.5 azote, and 55.5 nitrous gas, were passed into the right pleura. Immediately the dog's breathing became quick and short, but not laborious. It refused to eat, and expired in the evening, at the end of five hours from the time that the air was introduced. The next morning the body was examined. About six cubic inches of air were collected from the left pleura, consisting, apparently, of 12 carbonic acid gas and 88 azote. After the

removal of the carbonic acid gas by lime water, the residual gas extinguished flame, and was not itself in the least inflammable; whence the inference that it was azote, or at least principally azote, as the presence of a small quantity of hydrogene might be concealed, and escape detection. From the right pleura, about five cubic inches of air were procured, which consisted of 6.9 nitrous gas, or air absorbable by a solution of green sulphate of iron, and of 93.1 azote. On opening the chest, the wounds in the pleura were found closed; the pleuræ were of natural appearance; the substance of the left lung was redder than usual, and that of the right was dark red, and it contained a good deal of blood and serum; the bronchia did not exhibit decided marks of inflammation; the right auricle and ventricle and the venæ cavæ were distended with grumous blood, and the left auricle and ventricle and aorta contained a good deal of liquid blood, which, as well as that of the venous system, had lost its peculiar tint, and had acquired a chocolate hue.

The obvious results of these two experiments on the same dog, are, 1st. the absorption of the greater part of the carbonic acid gas, and the whole of the hydrogene introduced into the pleura, and the appearance, *de novo*, of a considerable quantity of azote:—2dly, the death of the animal in the space of five hours from the time of admission of the nitrous gas and azote into the opposite pleura, the absorption of the greater part of the former gas without inflammation of the membrane with which it was immediately in contact, and the production of a peculiar change in the blood.

Results so singular as these required to be narrowly scrutinized. I have twice repeated the experiment on the admis-

sion of hydrogene into the pleura of dogs, and in each instance after death I found that the hydrogene had disappeared, and that its place was supplied by a small quantity of azote.

Did the azote found in these instances exist in the pleura previous to the experiment ?

A remark of Dr. LAENNEC, would seem to countenance this notion. He says, " M. RIBES assures me, that he has found in opening the serous cavities of dogs a small quantity of air constantly to escape."* On the contrary, in opposition to this, are the experiments of HALLER and other accurate observers, recorded in the controversy which HAMBERGERUS gave rise to, by reviving and maintaining the opinion of GALEN, that air is contained between the lungs and the pleura.†

In doubt between these contending authorities, with the desire of satisfying myself on the point, I have made some experiments on dogs, the results of which convince me, that in a healthy state, no air is contained in the pleura of this animal. When I opened, under water, the chests of dogs killed by drowning, not the smallest globule of air escaped ; but, when the right side of the chest was opened in the atmosphere, an appearance presented itself, at first favourable to the idea of a little air being contained in the left pleura, for the mediastinum was pressed from the left side towards the right, (the body lying on the left side) evidently by air within the transparent membrane. This appearance on examination proved to be fallacious, for the air was found to

* A Treatise on the Diseases of the Chest, &c. translated from the French of R. T. H. LAENNEC, M. D. by JOHN FORBES, M. D. p. 208.

† HALLER's Not. in Prælect. BOERH. DCVI. HALLER's Opuscula Anatomica, de resp. Gott. 1751, p. 91, and 345. MARHERR's Prælect. in BOERH. Inst. vol. iii. p. 391.

be not in the left pleura, but in a cavity of the mediastinum communicating with the right pleura, and containing a lobule of the right lung, *dextri pulmonis additamentum*, as HALLER calls it, who has noticed this structure in the mediastinum of the dog and many other animals, and pointed it out as one of the principal causes of the erroneous notion that he combated.*

Was the azote derived from the blood as an exhalation or secretion?

Facts might be advanced in favour of this idea. An exhalation, or disengagement of azote appears to have taken place in the experiment of MESSRS. ALLEN and PEPYS, when oxygene nearly pure was respired.† In the inspection of dead bodies, air has frequently been found in the vessels and closed cavities, which is probably azote.‡ It has been asserted

* HALLER's *Opuscula Anatomica*, p. 44.

† *Phil. Trans.* 1809.

‡ Vide MORGAGNI *De sed. et Causis Morb. Epist. v.* and *Transactions of a Society for the Improvement of Med. and Chir. Knowledge*, vol. i. in which an interesting "case of Emphysema not proceeding from local injury," with some important observations relative to the secretion of air, is given by Dr. BAILLIE.

Notwithstanding the experiments detailed by Sir EVERARD HOME, in his Croonian Lecture, published in the *Phil. Trans.* for 1818, I am induced to believe that the gas in question is azote, rather than carbonic acid; because the alkali in the blood is not saturated with carbonic acid; because the serum of blood is capable of absorbing carbonic acid gas, rather more even than water, as I have ascertained by experiment; because, during the coagulation of blood spontaneously, and the coagulation of serum by heat, I have never observed carbonic acid gas to be disengaged, when the experiments were properly made in vessels to which air could not have access, as in tubes completely filled with blood or serum, and inverted in blood or mercury; and lastly, because I have not been able to procure carbonic acid gas from blood just drawn from the vessels, and still warm, when placed under a receiver, and completely exhausted of air. I may here remark, that I have made two experiments on blood in vacuo, and in both with the same negative results. In one instance the arterial blood of an ox was employed, and in the other the blood of a man in health. In the former eight ounces were used, in the latter one ounce. In both instances

lately, that air thus found is, in every instance, the consequence of putrefaction. But surely the accurate MORGAGNI was not so egregiously deceived. Many times I have noticed air in the vessels of the pia mater, in bodies only a few hours dead, and very lately I detected some in the internal jugular veins of a body that had been dead only eighteen hours, and free from every mark of incipient putrefaction: and I lay the more stress on this observation, because it was very carefully made before any large vessel was divided through which air could gain admission. Farther, air seems to pass pretty readily (probably through the exhalants) from the air cells of the lungs into the pleura. Is not this proved by an experiment of HALES?*

And an experiment which I have made, and which I may briefly notice, seems to afford some proof of it. Immediately after death, before the muscles had lost their irritability, I inflated the lungs of a dog under water by means of a double bellows, through the trachea. Air in exceedingly minute bubbles escaped from the surface of the pleura covering one of the inferior lobes; and on making gentle pressure with the fingers on any part of the inflated viscus, the same appearance presented itself.

These circumstances, which I have ventured to bring forward as somewhat favourable to the idea of the secretion or exhalation of azote, are still far from conclusive. After having given the subject all the attention in my power, I do not venture to draw a positive conclusion. I have thought it

the blood remained perfectly tranquil, when the vacuum was as complete as could be made with a good air pump, and of course did not exhibit the slightest traces of the disengagement of any air.

* Vide Stat. Essays i. 252.

right to state what I have observed relative to a topic so interesting and obscure ; and to notice such facts as seemed to bear more immediately on the question, in hope of exciting farther inquiry, by which alone the true source of the azote, apparently evolved in the preceding instance, can be ascertained.

The effect of nitrous gas introduced into the pleura now requires consideration. I have made several trials farther with this gas. When admitted nearly pure into the pleura it produced very serious symptoms, but did not prove fatal, provided the lung on the opposite side was free to act. The distressing symptoms usually subsided in about twelve hours ; and then, on killing the animal, the greater part of the nitrous gas was found to be absorbed ; the pleura was free from inflammation, the substance of the lungs very slightly inflamed, and the blood exhibited a brownish hue. From these circumstances it may be conjectured, that nitrous gas produces its deleterious effects after it has been absorbed, either by acting on the blood immediately, or on the air cells of the lungs and the blood conjointly, when converted into nitrous acid in the course of the pulmonary circulation.

On the admission of nitrous oxide into the pleura, I have made one experiment only. About 30 cubic inches of this gas, contaminated with 25 per cent. common air, were passed into the pleura of a dog. The animal exhibited no uneasy feeling, and immediately after appeared to be rather exhilarated. It continued apparently in good health for 24 hours, when it was killed. Five cubic inches of air were procured from the pleura, which consisted of 10 per cent. oxygene and 90 azote, being quite deprived of nitrous oxide. The pleura and lung

exhibited no unusual appearances that could be referred to the gas absorbed.

Mr. ABERNETHY, in his ingenious Essay on the Functions of the Skin, has proved that that texture is possessed of a power of absorbing and exhaling certain gases, which it exercises according to laws peculiar to the animal economy.* The preceding experiments seem to show that the pleura is possessed of a similar power in respect to absorption, and that in exerting this power, like the skin, it prefers one gas to another. Whether the analogy will hold good as regards exhalation also, must be decided by future inquiry

Fort Pitt, Chatham, April 12, 1823.

APPENDIX,

CONTAINING

An account of a case of Pneumato-thorax, in which the operation of tapping the chest was performed; with some additional observations on air found within the body; and on the power of mucous membranes to absorb air.

IN the preceding pages I have given some particulars of a case of tubercular consumption, which proved rapidly fatal in consequence of the supervention of Pneumato-thorax; I have now the honour of communicating another case, in which the existence of air in the cavity of the chest was detected during life, and the patient was relieved from very distressing and

* Surgical and Physiological Essays, Part II. by JOHN ABERNETHY.

alarming symptoms, by perforating the chest, and allowing the accumulated air to escape.

PATRICK CALNON, of the 50th regiment of Foot, was admitted into the medical division of the General Military Hospital, at Fort Pitt, on the 9th of May last, immediately on his return from Jamaica, from whence he was sent home invalided on account of hæmoptysis, produced by a severe fall on the left side of the chest, 18 months ago, previous to which accident he had enjoyed uninterrupted good health.

Till the 13th of May his complaint exhibited nothing peculiar. Early on the morning of that day, after a violent fit of coughing, the symptoms of pneumato-thorax began to appear, and they continued to increase till the 21st. The most prominent symptoms were, a feeling of extreme tightness about the chest and abdomen; rapid and difficult respiration, between 30 and 40 in a minute; great anxiety of countenance and agitation of mind, accompanied with a small pulse of 130; cold sweats frequently breaking out on the face and neck; and a considerable prostration of strength. On examining the chest, the left side was found more protuberant, and in all its dimensions larger than the right; it was tense, and on percussion sounded remarkably hollow and tympanitic, giving the idea of its being distended with air; and the heart was found beating on the right side under the mamilla.

In consultation with Dr. SKEY, Physician to the Forces, and Mr. SCHETKEY, Surgeon to the Forces, the operation of tapping the chest, which I recommended, was approved of, and, with the consent of the patient, immediately performed.

With a small trochar, attached to a flaccid bladder, I carefully perforated the left side of the chest, between the 8th

and 9th ribs, having previously divided the integuments and the intercostal muscles with a scalpel. On withdrawing the stilette a little air rushed out, and was collected in the bladder, but not in the quantity that I expected; it did not exceed five cubic inches; and on examination it was found to consist of azote, and a little carbonic acid.

Conceiving that the operation had failed in consequence of adhesions in the part of the pleura punctured, and, encouraged by the composition of the air collected, and the slight relief which the patient experienced, a repetition of the operation was decided on, and performed the next day.

The chest was perforated just below the left papilla. Now, on withdrawing the stilette into the bladder, a large quantity of air rushed out and distended the bladder; and on separating the bladder from the cannula (by cutting it off, after having secured the air in the former by a tight ligature,) air from the chest continued for several seconds to rush out with violence, as if from a blow-pipe. When the rushing of air ceased, and it was found that air began to pass in on inspiration, the cannula was withdrawn, and the wound was closed by adhesive plaster.

The patient experienced sudden and great relief, exceeding his power to express. Since the operation he has continued to improve, and now, June 17, he is as well as, or better, than when first admitted into the hospital; his appetite is good, his cough little troublesome; he can lie on the left side, which he was unable to do for many months prior to the operation; both wounds are healed; and the left side of the chest is diminished considerably in volume, and is much less tense and tympanitic. Though the heart still beats

on the right side, and the fluctuation of a fluid in the left cavity of the chest is very distinct on any sudden motion of the body, I indulge the hope, if his lung be not tuberculated, that he will eventually recover completely.

The air collected in the bladder amounted to 25 cubic inches. Examined by means of lime-water and phosphorus, it was found to consist of 93 azotic gas and 7 carbonic acid gas: thus, in composition, proving almost exactly the same as the air found in the fatal case described in the preceding part of this Paper; and, as in that instance, it had not the least offensive smell.

Whether the origin of the air in this instance was the same as in the former, it is not easy at present to decide; most probably it was, considering the nature of the preceding disease, and the sudden supervention of the symptoms of pneumato-thorax after a violent fit of coughing; when it is likely the pleura was ruptured, and a kind of valvular communication established between its cavity and the aspera arteria, permitting air to enter, and preventing its return.

Relative to the secretion of air in the human body, and its effusion into closed cavities, I have ventured in this Paper to make some remarks, and to express an opinion in favour of such an occurrence. Very recently I have met with two fatal cases, in which shortly after death, and before there was the least indication of putrefaction having commenced, I detected air, apparently secreted and accumulated in sufficient quantity to admit of its being collected and examined. As the subject is quite novel, I trust a brief notice of these two instances may prove not unacceptable to the Royal Society.

On the 23rd of May, on examining the body of a soldier, aged 27, who had died of chronic dysentery, complicated with an ulcer of the larynx, the cellular membrane in both mediastina was found vesicular, and distended with air. The vesicles were burst under water, and a half cubic inch of air collected, which was found to consist of

7 oxygene,
4 carbonic acid gas,
89 azote.

The surrounding parts were carefully examined, particularly the trachea, lungs, and œsophagus; but no passage could be detected through which air could have entered the mediastina; nor could any air be forced into them by distending the lungs by means of a double bellows. Probably the oxygene found was extraneous, and was derived partly from common air adhering to the surface of the cellular membrane, and partly by penetrating through the delicate vesicles during the preparatory dissection, when they were exposed to the atmosphere for half an hour at least.

On the 2nd of June, on examining the body of a soldier, aged 36, who had died of tubercular consumption, I found air vesicles on the surface of the lungs, similar to those described by Dr. BAILLIE in his *Morbid Anatomy*,* and considered by him as formed by the secretion of air, and not by the extravasation of air under the pleura, agreeably to the opinion lately advanced by Dr. LAENNEC.† The air contained in the vesicles, in this instance, consisted of 5 parts azote and 1 part carbonic acid. The quantity of air collected

* Fifth edit. p. 80.

† A Treatise on the Diseases of the Chest, &c. p. 89.

and examined did not exceed $\frac{1}{20}$ of a cubic inch, and I could not detect in it any traces of oxygene.

After the experiments detailed in this Paper were made, on the absorption of different kinds of air introduced into the pleura, it appeared probable, on reflection, that mucous membrane, like serous membrane and the skin, might possess the power of absorbing air. In relation to this view, I thought it worth while to examine the air contained in the antrum maxillare and in the frontal sinus. I chose for the experiment the head of the sheep, in which these cavities are large, the openings by which they communicate with the atmosphere small, and the membrane with which they are covered, an active secreting surface. I collected the air by perforating the cavities under water about 15 minutes after the death of the animal. In two different instances the results of the examination of the air were the following: the air from the antrum maxillare in one instance consisted of

4.3 carbonic acid gas,
13.0 oxygene,
82.7 azote;

from the frontal sinus of

13.5 oxygene,
86.5 azote,

without any carbonic acid gas, the absence of which may have been owing to the presence of a good deal of mucus in the cavity, by which it might have been absorbed. In another instance the air from the antrum maxillare consisted of

4.2 carbonic acid gas,
13.8 oxygene,
82.0 azote;

from the frontal sinus of

4.5 carbonic acid gas,

9.5 oxygene,

86.0 azote.

On the supposition that the air, previous to its entering these cavities, had undergone a partial change from respiration, the results described seem to indicate an absorption of oxygene.

Other facts might be adduced, which, like the preceding, though not conclusive, tend to support the idea, that mucous membranes are capable of absorbing air. Of this kind, I conceive, are the results of the experiments of Messrs. MARGENDIE and CHEVREUL, on the composition of the air contained in the human stomach and intestines;* and very recently, I have met with a fact, the bearing of which appears to be similar. In examining the body of a soldier, who had died of complicated disease, I found the head of the colon and the cœcum exceedingly distended with air, and of a bright red colour, as if highly inflamed, whilst the ascending colon was unusually contracted. The air collected under water amounted to 36 cubic inches, and consisted of 11 carbonic acid gas, or air absorbable by lime-water, and of 89, chiefly azote, judging from its extinguishing flame, and not being itself inflammable. I regret I had not the means of ascertaining if any traces of carburetted hydrogen were present.

The question, whether mucous membranes are capable of absorbing gases, I need not say is one of great importance in relation to the theory of respiration, and on that account

* Ann. de Chim. et Phys. ii. 292.

deserving of particular attention. The theory which is now most generally adopted, is recommended by its simplicity, but is not well supported by the analogies and facts of physiology, which seem to favour the doctrine of the absorption of oxygene into the blood, and the evolution of carbonic acid; and *that*, perhaps, not in the air-cells of the lungs alone, but likewise along the whole tract of the primæ viæ, and over the whole of the external surface of the body.

Fort Pitt, Chatham, June 17, 1823.