TABLE I (*continued*)

Day of admission.	Patient's sex and age.	Nature of calculus and duration of symptoms.	Day of discharge.
1822—July 11	M. 40	Years (II)	Nov. 28. Out patient
1823—Oct. 2	M. 23	Years (II)	Nov. 20. Cured
1824—Jan. 8	M. 65	Lithic acid, 10¾ drms., 1¾ in. long, 1¾ in. thick, and 1⅝ inch broad; months (V)	Feb. 20. Died *post dies* 30
1825—Feb. 17	M. 58	3 years (II)	April 21. Cured
„ March 24	M. 12	Years (IV)	May 5. Died *post dies* 20
„ Aug. 4	M. 8	3 years (II)	Sept. 8. Cured
„ Nov. 24	M. 60	3 years (II)	Mar. 16. Cured
„ Nov. 24	M. 68	3 years (II)	Mar. 2. Cured
„ Dec. 22	M. 9	3 years (IV)	Mar. 9. Cured
1826—Jan. 26	M. 4½	*Lithic acid; 3 years (IV)	Mar. 2. Cured
„ Aug. 10	M. 4	3 years (VI)	Sept. 14. Cured
„ Aug. 24	M. 6	*Oxal. of lime; 3 years (IV)	Sept. 21. Cured
1827—Jan. 18	M. 17	Years (II)	May 17. Cured
„ April 5	M. 2	6 months (VI)	May 3. Cured
„ Nov. 8	M. 11	*Oxal. of lime; 3 months (IV)	Dec. 20. Cured
„ Dec. 20	M. 21	Years (II)	Jan. 31. Cured
1828—May 8	M. 30	3 wks. (II & VI)	1829—May 7. Died
„ July 31	M. 68	3 years (II)	Sept. 25. Relieved
„ Aug. 7	M. 5	4 years (IV)	Sept. 25. Cured
„ Oct. 23	M. 20	5 years (II)	Dec. 11. Cured
1829—Oct. 29	M. 46	6 months (IV)	Dec. 31. Cured
„ Nov. 12	M. 47	Years (II)	Dec. 17. Cured
1830—Jan. 14	M. 11	6 months (II)	April 22. Cured
„ May 27	M. 70	Years (IV)	July 22. Cured
„ June 24	M. 51	1 year (VI)	Aug. 4. Cured
„ Aug. 5	M. 75	2 years (II)	Oct. 7. Cured
„ Aug. 26	M. 45	6 months (II)	Oct. 7. Cured
1831—April 28	M. 11	Months (V)	Aug. 11. Cured
„ June 2	M. 4	Years (VI)	Dec. 31. Cured
1832—March 1	M. 55	1 year (IV)	April 12. Cured
„ March 22	M. 7	Years (VI)	April 26. Cured
1833—July 25	M. 6	6 months (VI)	Aug. 29. Cured
„ Sept. 5	M. 3	Years (IV)	Oct. 17. Cured
„ Oct. 10	M. 6	Years (VI)	Nov. 14. Cured
1834—Sept. 24	M. 7	Years (IV)	Oct. 29. Cured
1835—Feb. 25	M. 12	Years (VI)	April 15. Cured
„ May 6	M. 18	6 months (IV)	June 24. Cured
„ May 13	M. 5	1 year (IV)	June 17. Cured
„ June 3	M. 6	Years (IV)	July 8. Cured
„ Aug. 12	M. 5	6 months (IV)	Sept. 16. Cured
„ Aug. 10	M. 34	*Nucleus a pea; 6 mths. (IV)	Sept. 3. Died;—scarlatina
„ Sept. 9	M. 10	Years (VI)	1836—Sept. 21. Relieved
„ Nov. 4	M. 60	2 calculi; 2 years (VI)	Dec. 23. Cured
1836—May 4	M. 5	Years (IV)	June 22. Cured
„ June 8	M. 34	Years (IV)	July 20. Cured
1837—May 31	M. 22	Large calculus; many years (IV)	June 27. Died; exhaustion
„ July 12	M. 68	*Lithic acid; years (IV)	Aug. 9. Cured
„ July 26	M. 68	Months (VI)	Sept. 20. Cured
„ July 26	M. 3	Mths. [calculus not found] (VI)	Aug. 30. Cured
„ Aug. 30	M. 14	3 years (V)	Dec. 27. Cured
„ Nov. 15	M. 4	1 year (V)	Dec. 27. Cured
1821—May 3	F. 32	9 months (V)	Aug. 30. Cured
1837—Nov. 1	F. 4½	Weight, 1 dr. 2 scruples; a year (IV)	Nov. 22. Cured

TABLE II.—*Cases since the publication of the Report in the Transactions.*

Day of operation.	Patient's sex and age.	Nature of calculus and duration of symptoms.	Day of discharge.
1852—Nov. 1	M. 64 (195)	Flat oval, lithic acid, 3 drs. 29 grs.; 12 mths.	Dec. 1. Cured
1854—Jan. 30	M. 12 (212)	Lithic acid and lithate of ammonia, 8 drs. 4 years	Feb. 24. Died; peritonitis
„ June 26	M. 5¾ (220)	Lithate of ammonia, 105 grs.; 4 years	Sept. 20. Cured

Note. In addition to the former Statistical Report (*Transactions*, vol. xix.)

CASE. A girl, aged 12 years, underwent operation in March 1838, in whom symptoms had existed for six years, at times with great suffering and considerable emaciation. Although it was known that there was a stone in the bladder, her mother resisted the performance of any operation—perhaps from the case exciting the attention of charitable persons. The child had been admitted into the infirmary when seven years old, and it was hoped that dilatation might be then effected; but her unmanageable temper and the interference of the mother hindered anything being done. Upon her being admitted a second time, a dose of laudanum (forty minims) was given, which, in about an hour produced considerable coma, and she was barely conscious when placed on the table. In this state the operation was performed without trouble. The calculus weighed seven drachms, and was composed of oxalate of lime, with a thick coating of phosphates. (3.)

Oxford, April 1855,

THE BREATHING AND THE PULSE UNDER THE INFLUENCE OF CHLOROFORM.

By JOHN SNOW, M.D., President of the Medical Society of London.

IT seems physically impossible that the breathing should not be noticed during the administration of narcotic vapours, for it is by the breath that they are exhibited; and it is extremely improbable that the state of the respiration has ever been disregarded. Even a stranger to medicine could hardly go on giving chloroform after the breathing of the patient became stertorous and laboured, especially as a state of complete insensibility always accompanies this kind of breathing. In treating of sulphuric ether in 1847, I made the remark that, "if there is the least snoring, I always leave off the vapour entirely";* and, in treating of chloroform, I have always stated that the inhalation should be suspended whenever the breathing becomes stertorous. In doing so, however, I never supposed that I was propounding anything new; I looked on the matter as one of those truisms that every one would at once assent to, but which could not with propriety be omitted in treating systematically of the subject.

I have always considered the pulse amongst the secondary symptoms in administering chloroform, not because any serious affection of the pulse would be a trifling matter, but because the vapour should be so given that it would be impossible for it to exert any serious effect on the pulse. After stating, in a paper written four or five years ago, that the most important point in giving chloroform is to take care that its vapour is systematically diluted with a sufficient quantity of air, I said that, the above precaution having been taken, "it is chiefly by attention to the respiration and the eye that danger is to be avoided"; and I

* The Inhalation of Ether in Surgical Operations, p. 38.

added, "The pulse may be felt as a physiological inquiry, or with reference to the operation, but gives no guiding information concerning the chloroform, for the following reasons: when the vapour is diluted to a safe extent, it might be continued till death, as I have ascertained in animals, and the pulse would still beat distinctly for many seconds after the respiration had ceased; and if, on the other hand, the vapour be of dangerous strength, the heart might suddenly cease to beat, and the first intimation of danger from the pulse would come only too late."* In several of the deaths from chloroform which have since occurred, the pulse, which was carefully noted, ceased suddenly, without giving previous warning of danger.

When the vapour of chloroform is so diluted that it does not constitute more than four or five per cent. of the air that is breathed, its effects are produced very gradually: and I have ascertained, by very numerous experiments on animals, that when the vapour is continued of this strength till they are killed, the breathing ceases gradually, being first embarrassed and feeble; and in all cases the pulsations of the heart continue freely for one or two minutes, or even longer, after the breathing has ceased; the circulation being ultimately arrested in consequence of the absence of the respiration, as in asphyxia. I have satisfied myself of this by keeping the stethoscope carefully applied to the chest of the animals whilst they were dying. During the interval that the heart is still beating after the respiration has ceased, the animal can easily be restored by artificial respiration. It moreover often happens that the animal takes one or two deep gasps just at the moment when the heart is ceasing to beat; and if the chloroform have been removed, so that fresh air is allowed to enter by these gasps, they usually have the effect of re-establishing the action of the heart, and recovery takes place.

The fact of chloroform not acting directly on the heart, when given in this way, does not arise from its want of power to do so, but from the circumstance that the functions of the medulla oblongata and nerves of respiration can be arrested by a smaller dose of the vapour than that which is required to arrest the functions of the ganglionic system of nerves, on which the contractions of the heart depend. This is the case with sulphuric ether, as well as with chloroform, as I pointed out in 1847.† The power of chloroform to arrest the contractions of the heart by its direct action can be proved by blowing some of the vapour on the surface of that organ, when the chest and pericardium have been opened whilst it is still beating, and also by continuing the chloroform by artificial respiration immediately after the natural breathing has ceased. Frogs go on absorbing the vapour of chloroform by the skin after the respiratory movements have ceased; and I took advantage of that circumstance to ascertain the exact amount which is required to arrest the action of the heart.‡

It unfortunately happens, also, that, when the air is charged with vapour to the extent of about ten per cent., the motion of the heart may be arrested by the direct action of chloroform in the ordinary way of inhalation; and it is due to this circumstance that accidents have occurred; for it does not appear that any patient has died by the mistaken continuance of vapour so diluted that it caused death by acting only on the function of respiration. In several experiments on cats, rabbits, and other animals, with air containing ten per cent. or upwards of chloroform, I always found that the action of the heart ceased as soon as the breathing, and in a few cases even before it.§ In some of the experiments, the lungs and heart were exposed whilst the animals were under the influence of chloroform vapour of moderate strength, and artificial respiration was performed. On inflating the lungs with air containing ten per cent. of the vapour, the right cavities of the heart, and in one instance the left also, became immediately distended from the loss of power of the heart, which in fact ceased to beat; the lungs not being congested, but, on the contrary, turning paler.

A few simple facts and considerations will show how it is that chloroform may suddenly arrest the action of the heart. This agent, when inhaled, acts on the nervous system, by coming in contact with all parts of it, through the medium of the circulating blood. Without alluding to the facts and experiments which prove that all narcotics act in this way, it is only necessary to mention that, in some experiments in which I assisted Dr. Sibson, we found that chloroform and ether produced their effects after both pneumogastric nerves had been divided, exactly the same as before. I ascertained, by experiments which I performed very carefully in 1848,* that the blood, in a state of very complete insensibility from chloroform, contains one twenty-eighth part as much as it will dissolve, or one part by measure of chloroform to rather more than eight thousand parts of blood. To arrest the respiratory movements, about one twenty-second part as much chloroform as the blood will dissolve is required; and to stop the action of the heart, one eighteenth part. If we take the estimate of Valentin, that the average quantity of blood in the human adult is thirty pounds, then the quantity of chloroform in the body, when the inhalation has been carried as far as it can be with safety, is twenty-four minims: the quantity that would be required to arrest the breathing, supposing the chloroform were equally distributed throughout the circulation, would be thirty minims and a half; and the quantity, in like circumstances, to stop the action of the heart, thirty-seven minims.

When the vapour of chloroform is largely diluted with air before it is inhaled, it enters the lungs gradually, and each portion of the blood is gradually impregnated with chloroform as it passes the pulmonary circulation; the whole circulating fluid being by degrees charged with chloroform to the requisite amount. The symptoms become developed one after another in a regular manner; the proper moment for leaving off the inhalation can be observed; and there is never any great amount of chloroform in the lungs at one time. As the blood in the lungs becomes charged with chloroform, it passes first to the left cavities of the heart, and thence into the aorta; and, as the first vessels given of from the aorta are the coronary arteries, the heart receives its dose of this agent a little before the other organs, and is always somewhat in advance of them as regards the amount of chloroform it receives throughout the process of inhalation. As the heart can bear more chloroform than the other organs, it is not much affected as long as the vapour is slowly and gradually introduced; but when it enters the lungs in a concentrated form, it is easy to perceive how the heart may be paralysed by a very small quantity. According to the experiments mentioned above, a little more than a minim of chloroform, entering any single pound of blood as it passes the lungs, would suffice to arrest the action of the heart; and patients have died suddenly, like Mdlle. Stock of Boulogne, in 1848, after a few inspirations of the vapour, without being brought under the influence of the agent.

Each minim of chloroform produces very little more than a cubic inch of vapour; in fact, twenty-five minims produce twenty-six cubic inches. The vapour of chloroform, it is true, cannot exist alone, under the ordinary pressure and temperature of the atmosphere; but the whole of a fatal dose of it may be contained in a very limited quantity of air. Eighteen minims is about the average amount that requires to be absorbed in the adult, in order to produce sufficient insensibility for a surgical operation. Twenty-four minims, as was stated above, will cause a very profound state of insensibility; and thirty minims, or rather more, being present in the system at one time, would have the effect of stopping the process of respiration. One hundred cubic inches of air, at 60° Fahr., will take up fourteen cubic inches of chloroform vapour; and at 70° they will take

* Medical Times, August 1850, p. 228.
† Opus cit., p. 81.
‡ See Medical Gazette, 1848, vol. xlii, p. 415.
§ See Medical Gazette, 1848, vol. xlii; and London Journal of Medicine, April 1852.

* See Medical Gazette, vol. xli.

up twenty-four cubic inches: it is quite possible, therefore, that the patient may breathe air containing ten per cent. of vapour, if no means be taken to prevent such an occurrence. In this way, thirty minims of chloroform would be contained in three hundred and twelve cubic inches of air and vapour; but, since about one-half of the vapour which is taken in by inspiration is expired again without being absorbed,* six hundred and twenty-four cubic inches, containing a fluid drachm of chloroform, is the average quantity that an adult would require to inhale in order to get a fatal dose. As the whole of this might be taken into the lungs in a very few deep inspirations, it must be very evident that systematic means for ensuring the copious dilution of the chloroform vapour are absolutely necessary.

The quantity of air in the lungs of the adult, in ordinary breathing, is about two hundred cubic inches. Therefore, if air containing ten per cent. of vapour were breathed in ever so leisurely a manner, there would be twenty cubic inches of vapour in the lungs at the moment when the inhalation might be discontinued; or, at all events, this quantity *minus* what is being carried away by the blood in its passage through these organs. But twenty cubic inches of vapour contain rather more than nineteen minims of chloroform. About half of this would be expired again without being absorbed; but the remaining nine minims is a fearful quantity to be added to that already in the system. If the ordinary quantity of eighteen minims had been absorbed, the patient might be brought to the brink of death, or still more certainly if about twenty-four minims were already in the blood, even if the additional nine minims were distributed equally throughout the circulation; but, as they certainly would not be so distributed, the result would be what I have met with in experimenting with vapour of this strength on animals, viz., sudden death, with arrest of the action of the heart.

If the inhalation of chloroform be not left off very gradually, the symptoms may be observed to increase for about twenty seconds, in the adult, after the exhibition of it is discontinued; owing to the absorption and circulation of the vapour that remained in the lungs at the moment when the chloroform was removed. I had the honour of pointing out this, together with many of the above mentioned sources of danger, to the Westminster Medical Society, on January 8, 1848, before any accident had yet happened from this agent.† The danger from the accumulation of the effects of chloroform is of course in direct proportion to the strength of the vapour, and the quantity of it in the lungs at the moment when inhalation is suspended. A great number of the accidents from this agent have occurred just after the inhalation was left off, and have been caused by the vapour remaining in the lungs at the moment of its discontinuance. The fact of fatal accidents not having happened to children, is chiefly due to the circumstance that the effects of chloroform show themselves much more quickly after the vapour has been received into the lungs, than in the adult.

It must be quite evident, from the above considerations, that it is unsafe to cause insensibility very quickly. It was the occasional practice in some quarters to make the patient insensible in half a minute, when chloroform was first introduced; but, as two-thirds of this time are occupied in the absorption of the vapour from the lungs and the development of its effects, this period does not allow of the gradual production and proper noting of the symptoms. In fact, there are cases in which death has occurred within a minute after the beginning of inhalation; and it is probably owing to the circumstance that the irritability of the air-passages generally opposes the inhalation of strong vapour, in the first instance, that such accidents have not happened more frequently. I consider it decidedly unsafe to cause insensibility in less than two minutes. Four minutes is the most suitable period to occupy in this process in the adult; and in strong robust persons it is desirable to take rather more time than this. It is not enough to take sufficient time in giving the chloroform, but care must also be taken that it is given in such a manner that the air is never, even for a moment, too highly charged with the vapour; for accidents have happened after the patient had been inhaling more than five minutes; and in the fatal case which occurred in an out-patient of the Western Dispensary, in 1849, half an ounce of chloroform was used without making the patient insensible, and when a fresh supply was procured, two hours afterwards, the patient suddenly died.

The patients requiring most care in the administration of chloroform are strong, muscular, persons, accustomed to hard labour, or to athletic sports. Such patients are nearly always affected with muscular rigidity and involuntary struggling before they are quite insensible. These symptoms do not occur till three-quarters as much chloroform has been absorbed as can be present in the system with safety; and, as the patients often hold their breath whilst struggling, and take deep inspirations suddenly and at long intervals, the greatest care is required that the vapour be administered in a very diluted state. Several accidents have happened whilst the patients were struggling and excited. Dr. Black, in commenting on a fatal case of inhalation of chloroform which occurred in St. Bartholomew's Hospital, attributes the accidents, in the cases where the patients have struggled violently, to a supposed exhaustion caused by the struggling.* This, however, is contrary to everyday experience; for the patients who struggle violently are precisely those who bear chloroform the best, provided they do not get an overdose of it; they are generally cheerful and exhilarated after it, and are certainly the least liable to the depression which sometimes follows its use. In speaking of an overdose of chloroform, I am making no allusion to the quantity used, but to the fact of the blood, or some part of it, being at some moment charged too highly with the vapour. Dr. Black admits in his communication that no attention had been paid at St. Bartholomew's Hospital to the percentage of vapour in the air breathed by the patients, though he thinks that the inhaler employed might be made to afford information of that kind.

There is an opinion which has often been expressed with regard to chloroform that cannot be too strongly combated, as it is of the most dangerous kind. The opinion to which I allude is, that chloroform vapour requires to be administered with plenty of air, merely for the purposes of respiration, just to prevent its suffocating a person, as hydrogen or nitrogen gas might do. Now, plenty of air is a good thing of itself; but, if it contain too much vapour, the more air the patient gets the greater his danger. The Academy of Medicine of Paris advocated the above opinion, in their report of the fatal case that occurred at Boulogne;† and M. Malgaigne, their reporter, even denied that chloroform could cause death by its direct action, and especially by poisoning. He supposed that we had in chloroform the strange anomaly of a powerful narcotic or soporific, which was incapable of causing death by its narcotic action. That it can do so, and that its fatal effects are not due to the exclusion of air, the following, amongst other reasons, sufficiently prove. 1. The patients generally breathe more air during the inhalation of chloroform than at another time, because the respiratory movements are usually increased both in frequency and extent, and the vapour does not occupy more than about one-tenth of the volume of the air, even in cases where fatal accidents occur. 2. The vapour of ether may occupy a much larger volume in the air breathed by the patient, without his incurring any risk. 3. Another anæsthetic vapour, that of hydrocyanic acid, will cause death when present in the air in very much smaller amount than that of the chloroform which may be breathed with safety. 4. The blood is quite florid in colour, immediately after death, in the lungs and left cavities of the heart of animals that are killed by chloroform with great

* See Medical Gazette, vol. xli.
† See Lancet, February 12th, 1848.

* Med. Times and Gazette, 1853, vol. ii, p. 562.
† See London Journal of Medicine, April 1849.

rapidity. I have not time to enter in this place on the *modus operandi* of chloroform; but I have done so at some length in the concluding volume of the *Medical Gazette* for 1851.*

In some of the cases where death from chloroform has been threatened, the medulla oblongata and nerves of respiration have been overpowered by the vapour, whilst the heart has been less seriously affected; but, in all the fatal cases in which the symptoms have been recorded, the heart has been directly paralysed by the chloroform, or so weakened by it as to be unable to carry on the circulation. In some of these cases the medulla oblongata, etc., have had their functions also suspended, at the same time, by the direct action of the chloroform; in other cases they have not, for the respiration has continued after the heart has ceased to beat.

As the fatal accidents from chloroform have been caused by its direct action on the heart, it seems a ready and natural conclusion to watch the pulse in order to prevent such accidents. Many medical men have inculcated this rule, and I may mention Mr. Stanley and Mr. Erichsen as having published their opinions to this effect; but, when we remember that the fatal symptoms have always occurred without any warning, and that sudden accidents may be entirely prevented by taking care that the vapour is so diluted that it shall never form more than five per cent. of the air breathed by the patient, the fallacy of relying too much on the pulse is evident. I do not, of course, mean that there is any harm in attending to the pulse as closely as possible, for that need not divert the attention from other symptoms; but the placing too great reliance on the pulse is an evidence that the true source of danger, in giving chloroform, is not understood.

On the other hand, the mere fact of not attending to the pulse is no proof that the source of danger is rightly appreciated. We learn from a clinical lecture recently delivered by Mr. Syme, that the pulse is very much disregarded in Edinburgh, from a belief that danger always begins with the respiration. The medical profession in Edinburgh appear to be influenced very much by a paper of Mr. Bickersteth's, which appeared in the *Monthly Journal* for September 1853. Mr. Bickersteth performed some experiments on animals, and found that the breathing ceased before ths pulse; and he concluded that this must be so in all instances, although out of four cases of suspended animation from chloroform, in operations which he witnessed and relates, there is distinct evidence that the action of the heart was nearly suspended by the direct effect of the chloroform in three of the instances; and this was probably the case in the fourth instance also, but the pulse is not mentioned. I ought to remark, in passing, that four cases of suspended animation from chloroform are a very large number to fall within the observation of one practitioner, however great his experience, and indicate, in my opinion, that the method of giving this agent in Edinburgh is not the right one. Mr. Bickersteth also mentions some cases in which the pulse became suspended for four or five seconds, just when the surgeon was making his first incision, but recovered itself immediately. He attributes this circumstance to the effect of the knife, notwithstanding the insensibility. It is a phenomenon I have not met with; and I am inclined to think it due to the chloroform. The moment when the surgeon is commencing his operation is usually that when the greatest effect of the vapour remaining in the lungs, at the time of leaving off the inhalation, would be produced.

Mr. Bickersteth relates two experiments, in which he introduced chloroform by artificial respiration, after the chest had been opened and the heart exposed. They are exactly the same as one I detailed more than a year previously,† with the single exception that, instead of employing air charged with ten per cent. of vapour, he merely employed air strongly charged with vapour. If the sudden arrest of the circulation by the direct action of chloroform, at the same time as, or even before, the breathing ceases, were the ordinary mode of death in giving chloroform to animals, it might fairly be asked why accidents are not of everyday occurrence in the human subject, instead of happening only once in about a thousand times, even when no special care is taken to dilute the vapour. The truth is, that although I have been able to kill animals at will, in the above manner, ever since 1848, it requires a little care and contrivance to make the air take up eight or ten per cent. of vapour in every instance. It is reasonable to suppose that, if the chloroform is given to animals merely as it is given to patients, one would have to wait a good while before meeting with the kind of sudden death that has happened now and then to patients. For it must always be remembered that the accidents have not happened through mistaking or disregarding the symptoms, and continuing the inhalation too long.

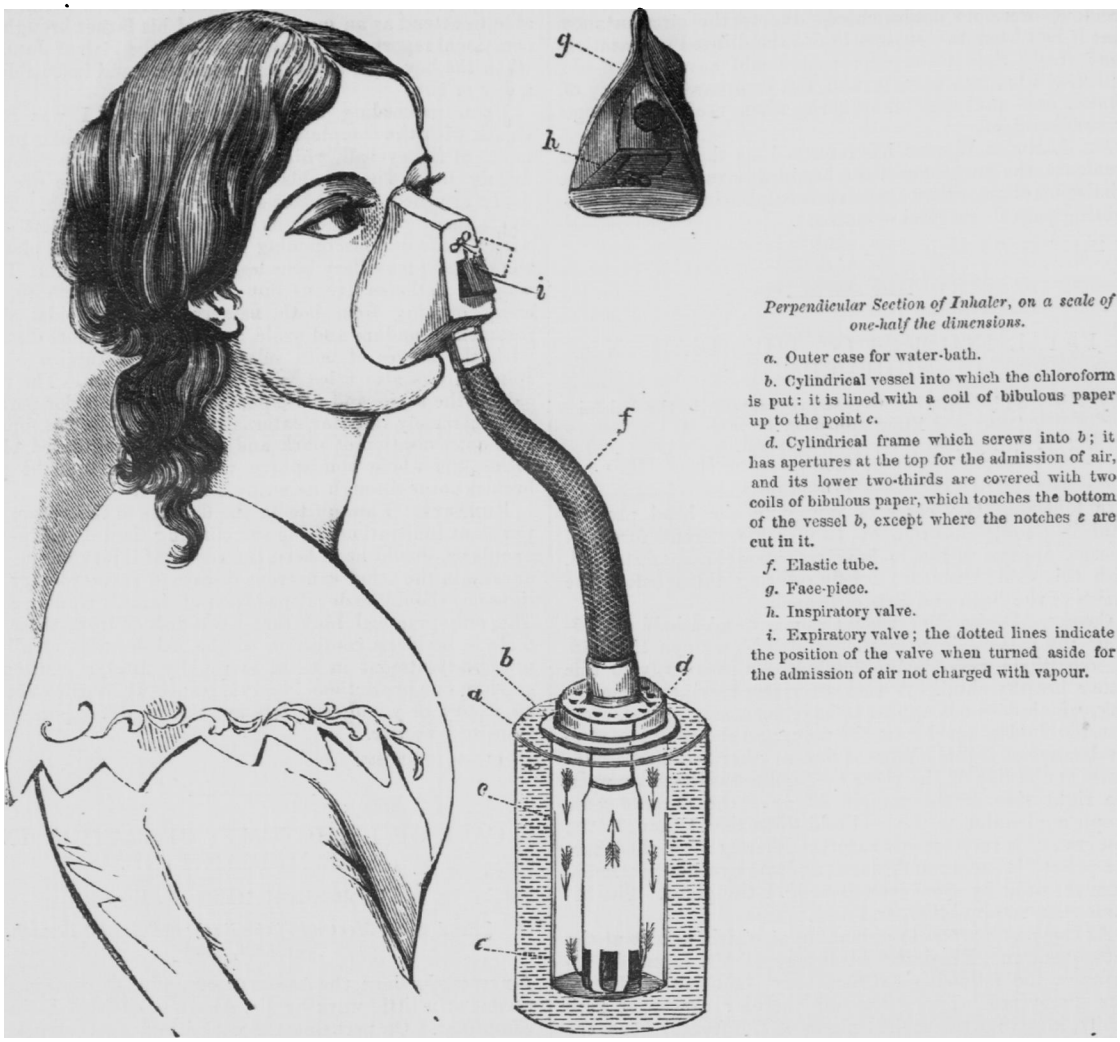
I still consider, as I have all along, that artificial respiration, promptly and efficiently applied, is the best means of affording the patient a chance of recovery from an overdose of chloroform; but I know from experiments that this will not answer if the heart is completely paralysed. The way in which artificial respiration acts is no doubt as follows. It first empties the lungs of any remaining vapour, and then frees the blood, present in the lungs, of some of the chloroform it has absorbed. By these means, and by the action of the air, the passage of the blood through the capillaries of the lungs is assisted; the right side of the heart becomes a little relieved of its over-distension; and if some of the blood in the lungs, which has been deprived of chloroform by artificial respiration, passes forward into the left cavities of the heart, and is thence thrown into the coronary arteries by any slight power remaining in the left ventricle, there must be a fair prospect of recovery. From what I have observed in animals, I believe that taking a little blood from the jugular vein might be of service in some cases, by relieving the distension of the right cavities of the heart.

From the above facts and considerations, it must be very clear that the most important rule in giving chloroform is to take care that the vapour is diluted to a sufficient extent with air. In administering sulphuric ether, it was sufficient to watch the symptoms in order to prevent danger, although even then a knowledge of the strength of the vapour was a useful guide; but, with chloroform, the proper dilution of the vapour becomes more important even than the symptoms. However, when the quantity of chloroform that is required to make a patient insensible is diffused through as much air as was occupied by the dose of ether vapour, the one anæsthetic is as safe as the other. The most perfect way of diluting chloroform vapour is to mix it with air in a very large hydrogen balloon. I gave it in this way in several cases of tooth drawing, in St. George's Hospital, in 1848, the proportions being four per cent. of vapour and ninety-six per cent. of air; and the results were very uniform and satisfactory. In practice, however, it is often necessary to sacrifice perfection more or less to convenience. I have since the latter part of 1847 used an apparatus for the administration of chloroform, which allows me to regulate the proportion of vapour in the air with sufficient accuracy for practical purposes. It was described in one or two of the medical journals soon after its introduction, but after this lapse of time it may perhaps not be amiss to allude to it again; and the accompanying wood-cut, with the explanatory references, will make it sufficiently understood.* (See next page.)

The receptacle for chloroform is surrounded by a bath of cold water, for the purpose of regulating the amount of vapour taken up by the air, and supplying the caloric, which is carried off by the evaporation of the chloroform. I have ascertained that air passing through the inhaler, in the way of ordinary respiration, takes up six per cent. of vapour at the temperature of 60° Fah.; and by turning the expiratory valve a little on one side, the amount of vapour

* See also Association Journal, 1853, p. 1114.
† London Journal of Medicine, April 1852.

* It is made by W. Matthews, 8, Portugal Street, Lincoln's Inn Fields.



Perpendicular Section of Inhaler, on a scale of one-half the dimensions.

a. Outer case for water-bath.

b. Cylindrical vessel into which the chloroform is put: it is lined with a coil of bibulous paper up to the point *c*.

d. Cylindrical frame which screws into *b*; it has apertures at the top for the admission of air, and its lower two-thirds are covered with two coils of bibulous paper, which touches the bottom of the vessel *b*, except where the notches *e* are cut in it.

f. Elastic tube.

g. Face-piece.

h. Inspiratory valve.

i. Expiratory valve; the dotted lines indicate the position of the valve when turned aside for the admission of air not charged with vapour.

can be reduced at pleasure. It is desirable to begin the inhalation with the vapour very much diluted, till the air passages get accustomed to the vapour, then to increase the strength to the requisite amount, by gradually closing the valve more or less. When the breathing is much deeper and more rapid than natural, it is desirable to have the valve a little more open, as also in hot weather, when the water is above 60°. The air passes over the surface of the bibulous paper during inhalation, and meets with no obstruction, provided too much chloroform is not poured in at once. About two drachms is the best quantity to introduce at a time; but it must be remembered that the amount of this which the patient may inhale is to be regulated by the observation of the symptoms.

Care should be taken that the bibulous paper is rightly arranged; and it should be dried from time to time, to free it from the minute quantity of water contained in all the chloroform at present in the market. This water remains in the paper after the chloroform is inhaled, and would ultimately accumulate, so as to stop the action of the inhaler.

The best criterion that an operation may begin, is the suspension of the sensibility of the conjunctiva. When the free edge of the eyelid can be touched without causing decided winking, the patient will hardly ever show signs of pain from the surgeon's knife. The chloroform, as I said before, must always be suspended if the breathing becomes stertorous; but it is seldom necessary to wait for this symptom.

During the removal of tumours of the jaw, and in other operations on the face, in which the inhaler cannot be applied after the surgeon begins, I apply chloroform on a hollow sponge, first diluting it with an equal quantity of rectified spirit, to limit the amount of vapour given off. Dr. Warren, of Boston, in America, long ago recommended what he called strong chloric ether, which consisted of one part of chloroform and two of spirit by measure. The patient inhales hardly any of the spirit, as the chloroform evaporates first, leaving nearly all the spirit behind. The process of inhalation is not uniform, owing to the varying strength of the solution as the chloroform evaporates; but this plan is well worthy the attention of those who wish to give this agent with no other appliance than a handkerchief or sponge. Either one or two parts of spirit have the effect of so limiting the quantity of vapour taken up by the air, that no sudden accident could happen.

The following circumstances show very clearly the influence of diluting chloroform with spirit. The so called strong chloric ether of Dr. Warren had been employed on a sponge in the Massachusetts General Hospital for three or four years without accident; when one day a new dispenser handed pure chloroform in mistake for that solution, and two accidents happened in two consecutive operations: one was fatal, but in the other case the patient was

resuscitated from a state of suspended animation.* The accidents were, no doubt, chiefly due to the circumstance that it had been the custom to use the diluted preparation more freely than pure chloroform would have been used; still they illustrate equally well the comparative safety of diluted and undiluted chloroform, when used on a sponge or handkerchief.

Dr. J. Mason Warren has informed me that, since these accidents, the governors of the hospital have prohibited the inhalation of any other agent than sulphuric ether, for preventing pain in surgical operations.

18, Sackville Street, March 1855.

FATAL INJURIES OF THE HEAD IN CHILDREN.

By AUGUSTIN PRICHARD, Esq., Surgeon to the Bristol Royal Infirmary.

[*Read at the Meeting of the Bath and Bristol Branch, March 29th*, 1855.]

The following two cases of injury to the head proving fatal in young children, by two very different forms of disease, appear to me to have considerable interest; and, with this view, I venture briefly to bring them before the notice of the Bath and Bristol Branch.

Case I. Louisa Birt, when two years and a half old, became my patient, in consequence of a blow upon the nose received three weeks before, having been previously to this time a healthy child. A week after the receipt of the injury, which does not appear to have been very severe, some thin red fluid escaped from the nose, and she complained of intolerance of light. When I first saw her, she had ecchymosis of the lids of the right eye, and a hard tumour upon the right side of the temple. I gave the parents some simple application to use, and told them that I thought the case was of a very serious nature. Shortly after this time, the patient became much worse, and the eye was protruded from the orbit by some growth behind the globe. She became then totally blind, and died.

At the *post mortem* examination, at which, as also at the subsequent one, I had the advantage of Mr. Leonard's assistance, the following extraordinary condition of disease was discovered. There was soft vascular cancer of both orbits, involving the orbital plates of the frontal bone, the ethnoid, sphenoid, and the contiguous dura mater. There were several tumours within the cranium, between the bone and the dura mater, upon the temple, the vertex, the occiput, and base, but exactly opposite each separate internal tumour (all of which were somewhat flattened), was a rounded or oval cancerous swelling in a corresponding part of the scalp. The intermediate bone, as far as appearances went, was healthy. The rest of the body was not examined.

Case II. A boy, Edward Bailey, aged 9 years, received a blow upon the left side of his face and nose, three weeks before he was admitted as my patient. The blow made his nose bleed at the time, and, after a week, he had headache, giddiness, and sickness. When the second week from the receipt of the injury had elapsed, the eye began to suffer. Upon his admission, three weeks after the blow, he had prominent eye (exophthalmos in ophthalmic language), amaurosis, complete ptosis or drooping of the lids, and immovable eye, with very dilated pupil and entire destruction of sight. I suspected suppuration in the orbit; but there was no evidence of any abscess pointing, nor was there any special indication for surgical or medical treatment. I gave him a small dose of grey powder, a simple lotion for the eyes, and applied a blister to his temple. This was on the 27th of last December. On the 31st, he was evidently worse, and appeared to be suffering from sleeplessness, with headache and giddiness. I ordered him four drops of laudanum at bed-time. He now became unable to attend as an out-patient; and his father brought an occasional report of his symptoms until the 11th of January, when the boy died, after being convulsed and insensible for a day or two.

Upon proceeding to examine the head, I was much struck with the complete absence of anything like prominence of the eyeball, which had been so marked a symptom during life. The friends informed us that the eye suddenly returned to its place some time after death. There was a small quantity of pus on the floor of the left orbit, with a little carious opening through the orbital plate of the superior maxillary bone leading into the antrum. There was pus in the cavernous sinus of each side, extending into every opening from both, namely, the sphenoidal sinus, foramen rotundum and ovale, and running a short distance with the nerves of both sides. The sella turcica of the sphenon was also filled with purulent matter. The right side of the brain, and more particularly its anterior portion, was extremely vascular externally; and within was found a vast extravasation of dark and partially coagulated blood, filling the whole hemisphere, which appeared to be quite broken down through its entire structure.

Remarks. I am quite in the dark as to the reason why purulent infiltration of the surrounding tissues, followed by apoplexy, should have been the result of injury in one case, or why in the other cancerous disease of extraordinary malignancy should be developed from an exactly similar cause. The only practical hint that I can deduce from these two facts is, besides a confession of the helplessness of all our present treatment in cases so rapidly fatal, a caution regarding our predictions in any instance where the effects of an injury in young subjects are not of a temporary and transitory nature.

Clifton, March 1855.

CASE OF LITHOTOMY: OPERATION IN THE MEDIAN LINE.

By JOSEPH HINTON, Esq.

[*Read at the Meeting of the Bath and Bristol Branch, March 29*, 1855.]

A few weeks since, the Association Journal contained the review of a little work by Mr. Allarton, entitled *Lithotomy Simplified*. On perusing the work itself, I was struck with the apparent simplicity of the operation, and determined, if opportunity offered, to adopt it. At that very time, one of the miners on the Blaina works, aged about 40, was suffering from symptoms of stone; and, on a careful examination, the calculus was detected. He had been suffering for more than twelve months, but did not like to apply for relief, until at last his distress and suffering forced him. He was apparently healthy; and, after some persuasion, I prevailed on him to allow me to remove the calculus.

Accordingly, about three weeks since, assisted by my friend Mr. Scott, of Newport, and my own assistant, I proceeded to operate after the plan laid down by Mr. Allarton. Although, on sounding him in the morning, I had plainly felt the stone, and he himself distinctly heard the sound strike it, we could not detect it when he was placed on the table previous to operating. The injection of a little water removed the difficulty. The perineum was exceedingly deep; and, on piercing it in the median line, I feared that I must have missed the groove, and accordingly I withdrew the knife, and explored the wound with my finger. I found that the staff had not been reached; this was immediately done, and the incision completed. The urethra being opened, no water escaped. On the first introduction of my finger as a dilator, I immediately felt the stone; but it appeared so small that I could not believe it to be the only cause of his distress. Accordingly, I did not wait to remove it, but proceeded with my efforts at dilatation; in a very short time I found the calculus in the wound, and with one finger in the wound, and the other index finger in the rec-

* New York Journal of Medicine, vol. x. New series, 1853.