The right cavities of the heart were found full of blood in this case, and it is probable that they became so much distended, as the patient was in a state of alarm, and scarcely breathing, that, in the thin and diseased state of the walls of the right ventricle, the action of the heart was arrested. Sudden death not unfrequently takes place during mental emotion, and, in many of the cases, the mode of dying is probably that just mentioned.

SYMPTOMS IN THE FATAL CASES OF INHALATION OF CHLOROFORM.

Out of the fifty cases of death from chloroform, related above, there are five in which the symptoms at the time of death are not detailed, viz., Cases 6, 7, 21, 24, and 50 ; in the two first cases it is merely related that the patient suddenly expired, and, in the two last cases, no one was watching the patient at the time when death took place. In considering the remaining cases they may be conveniently divided into groups, according to the period of the inhalation at which the accident occurred. In six of the cases the fatal symptoms came on suddenly, at the beginning of the inhalation, before the patient had been rendered unconscious ; in each of these cases there was the most unequivocal evidence of the sudden arrest of the action of the heart. In cases No. 4 and No. 11 there was sudden pallor of the face at the moment when the circulation ceased. In Nos. 14 and 26 the face became livid at the time of the fatal attack, and, in Nos. 45 and 46, the colour of the face is not mentioned. In all these cases there were also symptoms as if of a sudden shock to the system, such as stretching out of the limbs, foaming at the mouth, rolling of the eyes, or a sudden convulsive start. In Case 4, the patient at Boulogne had just complained of a choking feeling, one sign that the vapour she was breathing was not

well diluted. In Case 11 the fatal symptoms occurred immediately on a full inspiration; and in the other cases also the strength of the vapour was left to accident, and the result leads to the conclusion that it was very great at the moment before the fatal symptoms occurred.

In thirteen cases the inhalation was discontinued on account of the sudden appearance of dangerous symptoms, after consciousness had been apparently suspended. These cases are numbered 9, 15, 17, 20, 27, 30, 33, 35, 37, 40, 41, 44, and 47. In the greater number of these cases the over-action of the chloroform appeared to be exerted simply on the heart, the only dangerous symptoms being referrible to the paralysis of that organ; whilst in some of these cases symptoms of over-narcotism of the brain were conjoined with those connected with the heart. In the case of J. Verrier, No. 9, and in the case at Stockholm, No. 15, the sudden and entire cessation of the pulse was the symptom which first called attention to the danger of the patients, whilst the breathing was still going on. In Case 30 the woman became suddenly insensible and pulseless, after a short period of excitement. In Cases 35 and 40, although the pulse did not absolutely and entirely cease at once, its sudden failure was the first alarming symptom. In Case 20, at the Cavan Infirmary, the breathing and action of the heart ceased at the same moment. In Case 41, at the Middlesex Hospital, at a time when the pulse was full and steady, seventy in the minute, it gave a few rapid and irregular beats, and then ceased, and the breathing, which was free and deep, but not stertorous, ceased at the same time. In Case 15, which occurred at Jamaica, the patient, after a period of excitement, made one stertorous inspiration, when the breathing ceased. There were afterwards a few distant inspirations. The pulse is not mentioned; but it is pretty certain that it must have ceased about the time of

the stertorous inspiration, or the additional inspirations which took place after the chloroform was withdrawn, would probably have restored the patient; to say nothing of the measures that were resorted to with a view to his resuscitation. Of Case 27, which happened at Melbourne, it is merely related that the patient spluttered at the mouth, and suddenly expired, just after a fresh portion of chloroform had been applied on the handkerchief. The symptom of spluttering at the mouth is recorded as occurring in other cases, just at the moment when the pulse had suddenly ceased.

In Case 44, at the Royal Ophthalmic Hospital, the narcotism of the brain and nervous system proceeded as far as the third degree, which was attended with strong muscular spasms, as not infrequently happens; and an overdose of chloroform appears at this moment to have acted on the heart, for the pulse could not afterwards be felt. In Cases 33, 37, and 47, the narcotism of the brain proceeded as far as the fourth degree, producing stertorous breathing, when the chloroform caused paralysis of the heart, by its direct action on that organ.

There are six cases in which the fatal symptoms came on just after the patient had been rendered insensible, and the inhalation had been discontinued; the operation being about to be commenced. They are numbered 32, 34, 39, 43, 48, and 49. All these cases bear a very close resemblance to each other. In all of them the patient had been made insensible (satisfactorily so as it was thought), when in a few seconds the pulse suddenly stopped, or failed and fluttered just prior to stopping; in Case 32 Dr. Dunsmure thought the time was longer between the discontinuance of inhalation and the cessation of the pulse. The breathing continued a little time after the pulse ceased or failed in all these cases, and there was an absence of the spluttering at

the mouth, stretching of the limbs, and other spasmodic actions, which occurred in all the six cases where the heart was paralysed at the beginning of the inhalation, before unconsciousness had been induced, and in some of those when the paralysis of the heart took place at a later period of the inhalation, when the patient had been apparently rendered unconscious, but was not yet insensible. In each of the six cases now under consideration, the fatal event was evidently occasioned by the vapour of chloroform, which remained in the lungs at the moment when the inhalation was discontinued. A portion of this vapour becoming absorbed, and added to that already in the blood, had the effect of paralysing the heart, when it circulated through the coronary arteries.

There remain twenty-two cases in which the fatal symptoms came on during the course of the operation. In twenty of these cases the symptoms are described with more or less detail. I made some remarks respecting cases No. 1 and No. 2, in the place where they are related. In case No. 3, as in these cases, the patient appeared not quite insensible, and showed signs of pain during the operation, when "in a moment his pulse, which was full and natural, sank." In case No. 5 the patient was probably dead when the incisions on the finger were commenced; the extreme suddenness of the death, and the absence of bleeding, show that death occurred in the way of syncope. The convulsive movements which just preceded death are worthy of note in connection with the other cases, in which death occurred immediately after the commencement of inhalation. Some remarks were appended to case No. 8. In case No. 10 paralysis of the heart is indicated by the absence of bleeding from the arteries, and the absence of pulse, whilst the breathing still continued for a short time. I made some remarks respecting case No. 12 when it was related. The

patient seemed to die by embarrassed respiration, but whether that was caused by the action of the chloroform on the brain is doubtful. In case No. 13 the patient died in a moment. In No. 16 the face turned pale, and the pulse and breathing ceased soon after the chloroform was discontinued, showing the effect of the vapour which was present in the lungs at the moment when the inhalation was left off.

In Case 18 the livid countenance and sudden stopping of the pulse prove cardiac syncope. In Case 19 the blood which was gushing out suddenly stopped, and the patient expired. The congested state of the lungs and the blood in the right cavities of the heart prove that the syncope of which he expired was not the ordinary anæmic syncope from hæmorrhage; it was therefore cardiac syncope from the chloroform.

In Case 22 the change of countenance and sudden character of the death are evidences of cardiac syncope. In Case 23 there was sudden cessation of the bleeding and of the pulse; in Case 25 the pulse suddenly ceased. In Case 28 the patient died suddenly, but the pulse was apparently not examined at the time. Some remarks have already been made on Case 29, which happened in the Manchester Infirmary. In Cases 31, 36, and 38 the suddenness of the death showed that it took place by syncope. In the last of these cases the pulse was being examined at the time it ceased. In Case 36 there was no examination of the dead body; but in 31 and 38 the presence of blood in the right cavities of the heart indicates that the kind of syncope was cardiac syncope. Respecting Case 42, some remarks have already been made. The death commenced by deep coma, which embarrassed, and then suspended, the respiration, and cardiac syncope quickly followed. The chloroform was administered by a method which precluded the medical attendant from observing properly the most important symptoms.

The accompanying table of the fatal cases of the inhalation of chloroform contains such short particulars respecting them as seemed capable of being tabulated, and it may assist the reader in retaining a more connected recollection of the facts previously related more in detail.

MODE OF DEATH IN THE ACCIDENTS FROM CHLOROFORM.

In all the cases in which the symptoms which occurred at the time of death are reported, there is every reason to conclude, as shown above, that death took place by cardiac syncope, or arrest of the action of the heart. In forty of these cases the symptoms of danger appeared to arise entirely from cardiac syncope, and were not complicated by the over-action of the chloroform on the brain. It was only in four cases that the breathing appeared to be embarrassed and arrested by the effect of the chloroform on the brain and medulla oblongata, at the time when the action of the heart was arrested by it; and only in one of these cases (No. 42) that the breathing was distinctly arrested by the effect of the chloroform, a few seconds before that agent also arrested the action of the heart.

It was previously shown that chloroform vapour has the effect of suddenly arresting the action of the heart when it is mixed with the respired air to the extent of eight or ten per cent., or upwards; and we must therefore conclude that, in the fatal cases of its inhalation, the air the patients were breathing just before the accidents occurred contained this amount of vapour. There was no means adopted, so far as is reported, to regulate the proportion of vapour in the inspired air, in any case in which an accident happened; and there was the liability in every case that ten per cent. or more of vapour might be present in the air the patient breathed; and in no case did death occur in the manner that it occurs when the vapour of chloroform does not exceed five per cent. of the inspired air.

TABLE OF FATAL CASES OF INHALATION OF CHLOROFORM.

No.	Patient.	Age in yrs.	Operation for which the chloroform was inhaled.	Position whilst inhaling.	Means by which the chloroform was exhibited.	Time from the commencement of inhalation to the beginning of dangerous symptoms.	Apparent mode of death.	Previous inhalations.
1	Girl	15	Removal of toe-nail.	Sitting	Towel	Half a minute	Cardiac syncope	Ether once.
2	Married lady .	35	Extraction of teeth.	Sitting	Inhaler	About two minutes	Cardiac syncope	None.
3	Patrick Coyle .	—	Operation for fistula in ano	Lying on the side	Handkerchief	About one minute	Cardiac syncope	One.
4	Single lady . .	30	Opening of sinus in thigh	Lying	Handkerchief	Probably half a minute	Cardiac syncope	None.
5	Young woman .	—	Amputation of the middle finger	———	Handkerchief	A very short time	Cardiac syncope	None stated.
6	Young man . .	22	Transcurrent cauterisation of wrist	———	Inhaler	Five minutes	Symptoms not described	None stated.
7	Young man . .	—	Intended removal of toe-nail.	———	Probably handkerchief	Not stated	Death very sudden	None stated.
8	Seaman . . .	31	Removal of hæmorrhoids	Lying on the side	Napkin	About ten minutes	Cardiac syncope	One.
9	Miner	17	Intended amputation of middle finger	Lying	Handkerchief	About five minutes	Cardiac syncope	None.
10	Labourer . . .	36	Amputation of toe	———	Handkerchief	Died at the close of the operation	Cardiac syncope	A previous attempt.

11	Married lady .	33	Intended extraction of tooth	Sitting	Handkerchief	A very short time	Cardiac syncope	One.
12	Porter	48	Removal of toe-nail	Lying	Inhaler	A little more than two minutes	Probably asphyxia	None.
13	Married woman	—	Removal of eyeball	Probably lying	A sponge	Died during the operation	Cardiac syncope	None stated.
14	Young lady . .	20	Intended extraction of tooth	Sitting	A sponge enclosed in a napkin	Just after beginning to inhale	Cardiac syncope	Previous attempts.
15	A man . . .	—	———	———	A sponge	Died before the operation	Probably cardiac syncope	None.
16	Artilleryman .	24	Amputation of middle finger	———	Handkerchief	———	Cardiac syncope	None.
17	Bookkeeper . .	30	Intended operation on testicle	Lying	Napkin	Within five minutes	Cardiac syncope	None.
18	Boy	8	Sounding the bladder	Lying	Piece of lint	A few minutes	Cardiac syncope	None.
19	Policeman . .	34	Removal of portion of hand	———	Napkin	Died during operation	Cardiac syncope	None.
20	Man	24	Intended amputation of leg	Lying	Folded lint in a hollow sponge	A few minutes	Cardiac syncope	None.
21	Man	—	Intended operation on the penis	Lying	———	———	"Suddenly expired"	None stated.
22	Married lady .	36	Extraction of teeth	Sitting	Handkerchief	Less than a minute	Cardiac syncope	None.
23	Mulatto seaman	45	Removal of testicle.	Lying	Napkin	About seven minutes	Cardiac syncope	None.
24	Married woman	37	Removal of impacted fæces	Lying	Handkerchief	Eight or nine minutes	Symptoms not observed	Two.
25	Man	23	Ligature of vessels near vascular tumour	Lying	Inhaler	Five to ten minutes	Cardiac syncope	One.

26	Married lady .	32	Intended extraction of tooth	Sitting	Sponge surrounded by handkerchief	Four or five inspirations	Cardiac syncope	None stated.
27	Man	—	Intended operation for fistula *in ano*	Lying	Handkerchief	Not more than a minute	Cardiac syncope	None.
28	Cattle dealer .	—	Applic. of potassa fusa to ulcers of leg	———	Handkerchief	Died during operation	Probably cardiac syncope	None.
29	Factory operative	—	Removal of malignant tumour of thigh.	Lying	Inhaler	About twelve minutes	Probably cardiac syncope	None.
30	Single woman.	28	Intended application of nitric acid to ulcers of pudenda	Lying	Folded lint	———————	Cardiac syncope	None.
31	Soldier . . .	25	Removal of small tumour from cheek	Lying	Hollow sponge	Five minutes	Cardiac syncope	None.
32	Tobacconist . .	43	Intended perineal section	Lying	Handkerchief	A few minutes	Cardiac syncope	Two.
33	Woman . . .	40	Intended operation for strangulated hernia	Lying	Folded lint	About five minutes	Simultaneous deep coma and cardiac syncope	None.
34	Single woman .	22	Intended application of actual cautery to sore of vagina	Lying	Inhaler	About five minutes	Cardiac syncope	One.
35	Young man . .	19	Intended forcible extension of knee	Lying	Inhaler	Fifty seconds	Cardiac syncope	None.
36	Girl	13	Removal of tumour from back	Apparently sitting	———————	———————	Cardiac syncope	None stated.
37	Married woman	59	Intended reduction of old dislocation of humerus	Lying	Hollow sponge	About five minutes	Deep coma and cardiac syncope	None.

38	Woman . . .	40	Removal of uterine polypus	Lying	Folded lint	A few minutes	Cardiac syncope	None stated.
39	Married woman	45	Intended removal of breast	Lying	Sponge, handkerchief, and inhaler	Three-quarters of an hour.	Cardiac syncope	None.
40	Tailor	18	Intended operation for phymosis	Lying	Inhaler	About seven minutes	Cardiac syncope	None.
41	Labouring man	65	Intended amputation of thigh	Lying	Inhaler	Between 13 and 14 minutes	Cardiac syncope	None.
42	Shoemaker . .	39	Catheterism	Lying	Folded lint	A few minutes	Deep coma, apnœa, and cardiac syncope	None.
43	Woman . . .	56	Intended amputation of leg	Lying	Folded lint & piece of oiled silk	About three minutes	Cardiac syncope	None.
44	Man	40	Intended excision of eyeball	Lying	Inhaler	About five minutes	Cardiac syncope	None.
45	Married lady .	29	Inhaled to relieve neuralgia	Sitting	Inhaler	A few seconds	Cardiac syncope	Two or three.
46	Married lady .	36	Intended extraction of teeth	Sitting	Handkerchief	A few seconds	Cardiac syncope	Four.
47	Sailor	30	Intended removal of necrosed bone from finger	Sitting	Sponge and folded lint	Three or four minutes	Deep coma and cardiac syncope	None.
48	Boy	9	Intended removal of tumour of scapula	Lying	Cotton wool & folded lint	A few minutes	Cardiac syncope	None.
49	Labourer . . .	35	Intended amputation of thigh	Lying	Folded lint	A few minutes	Cardiac syncope	One.
50	Young woman .	17	Application of nitric acid to syphilitic sores	Lying	Inhaler	———————	Symptoms not observed	Two.

There is in a great number of the cases an evident connection between the accident and the probable strength of the mixture of vapour and air. In six cases the accident occurred just after the commencement of the inhalation; in two of the cases, Nos. 27 and 37, the fatal symptoms occurred just after fresh chloroform had been applied on the handkerchief and sponge; and in several cases, in which the circulation was suddenly arrested just after the patient had been rendered insensible, the insensibility had been induced so quickly as to prove that the vapour must have been inhaled in a very insufficient state of dilution.

THE TWO KINDS OF SYNCOPE.

Dr. Patrick Black has made an objection to the fact of the patients having died of paralysis, or over-narcotism of the heart, in the accidents from chloroform.* He says that paralysis of the heart would be death by syncope, but that the symptoms before death, and the conditions of the organs met with afterwards, are not in accordance with such a view of the case. In order to show that both the symptoms and the after death appearances, in the fatal cases of inhalation of chloroform, are consistent with paralysis of the heart, it is necessary to point out the difference between ordinary syncope and cardiac syncope. One of the best examples of ordinary, or what may be called anæmic syncope, is that which occurs in a common blood-letting, whilst the patient is in the sitting posture. When the bloodvessels, especially the veins, which at all times contain the greater part of the blood in the body, do not accommodate themselves fast enough to the diminished quantity of blood, the right cavities of the heart are supplied with less and less of the circulating fluid; and in a

* Chloroform: How shall we ensure Safety in its Administration? Pamphlet. London: 1855.

little time are not supplied at all, when the heart ceases to beat, in accordance with the observation of Haller, that it does not pulsate when it is not supplied with blood. The moment the heart ceases to supply blood to the brain there are loss of consciousness and stoppage of respiration; but on the patient being placed in the horizontal position the blood flows readily into the right cavities of the heart from the great veins of the abdomen and lower extremities; the heart immediately recommences its contractions; the brain is again supplied with blood, and respiration and consciousness return.*

The blood may remain in the ordinary quantity; but if the bloodvessels do not keep up their usual support, and exert a sufficient pressure on their contents, the same kind of syncope will occur as that from blood-letting. The late Sir George Lefevre related the case of a lady who fainted whenever she left her bed, and assumed the upright posture; no cause could be found for this until it was ascertained that she suffered from varicose veins of the legs: bandages to these extremities prevented the fainting. It is obvious that in this case the mechanism of the syncope was the same as that in blood-letting; the distension of the varicose veins under the weight of the superincumbent blood had the same effect in preventing the supply to the right cavities of the heart, as if the blood had been entirely removed. The faintness which often occurs on first rising, when a person has long kept the recumbent posture from

* See some interesting papers on the value of recumbent position in syncope, by Dr. Richardson, in the *Association Medical Journal* for 1854. I entirely agree with Dr. Richardson that no kind of syncope commences at the brain, and that, during recovery, the heart always resumes its functions before consciousness is restored. The restoration of the heart's action in ordinary syncope by the re-supply of blood to its cavities, without any alteration in the condition of the brain, was well proved by Dr. Richardson by means of some interesting experiments on animals which I had the opportunity of witnessing.

any local cause, is probably of the same kind; the veins not having had to support the weight of the usual column of blood for some days or weeks, lose their tone we may presume, and yield when they are all at once subjected to the weight of a column of blood extending from the lower extremities to the heart, so that this organ ceases to be properly supplied with the circulating fluid.

In cardiac syncope, on the other hand, the cavities of the heart, or at all events the right cavities of this organ, are always full, whether the syncope depend on paralysis of the heart by a narcotic, or inherent weakness of its structure, or on its being overpowered by the quantity of blood with which it is distended. After death from this kind of syncope, if the blood have not been displaced by artificial respiration or other causes, the right cavities of the heart and the adjoining great veins will be found filled with blood, and the lungs will in many cases be more or less congested. The appearances in short will be very much the same as in asphyxia by privation of air, which ends in a kind of cardiac syncope, the stoppage of the heart being partly due to over-distension of its right cavities, and partly to loss of power in its structure, from the want of a supply of oxygenated blood through the coronary arteries. In death by anæmic syncope, on the contrary, all the cavities of the heart are found empty, or nearly so, and the same is frequently the case with the adjoining great veins, whilst the lungs are usually pale.

The syncope occasioned by some kinds of mental emotion is of the ordinary or anæmic kind, and consequently the condition of the brain must act first on the bloodvessels, and not directly on the heart. Certain persons are liable to faint on witnessing a surgical operation. Now if the mental emotion of these persons acted directly on the heart, whilst the rest of the vascular system was unaffected, the distribu-

tion of the blood would be nearly the same as in asphyxia, where the circulation is first impeded in the lungs, and is ultimately arrested by loss of power in the heart. If the action of the heart were weakened, or stopped, in the first instance, by the kind of emotion under consideration, the arteries would be emptied by their contractility and elasticity, and the blood would accumulate in the right cavities of the heart and the great veins leading to them. In a medical student fresh from the country, who is by no means deficient in blood, the jugulars would become distended and the face livid, and the recumbent posture would probably do but little towards removing the symptoms. The phenomena which are witnessed, however, indicate a very different condition of the vascular system. The person about to faint from the cause indicated, frequently becomes pale before he feels anything wrong; and when requested to retire and sit down, often says that there is nothing the matter with him. In a short time he faints, and falls, if no one catches hold of him; but the moment he is in the recumbent posture he recovers. In such a case as this, the effect of the mental emotion must be first exerted on the veins, or the veins and capillaries, through the nerves which supply these vessels; they allow themselves to become distended, and the heart ceases to act for want of its supply of blood, as in syncope from bloodletting, and anæmic syncope from any cause.

Several authors have attributed the empty state of the heart met with after death, in certain cases of fatal syncope, to want of power in the left ventricle to supply the right cavities of the heart; but this is to argue as if the blood passed out of the body after leaving the right ventricle, and the left ventricle had to supply a newly formed fluid. The effects of want of power in the left ventricle are the same as those of an obstruction at the origin of the aorta; the lungs become congested, and the right cavities of the heart more

or less distended, from the blood not being able to pass readily through the lungs. Patients who die of heart disease die with the cavities of that organ full. Some patients, indeed, with fatty disease of the heart, die suddenly of anæmic syncope, and the heart is found empty; but in these cases it is evident that death is not occasioned by the disease of the heart, but by some condition of the bloodvessels which accompanies it.

Chevalier was, I believe, the first to draw marked attention to cases of sudden death arising from an empty state of the heart, in a paper in the first volume of the *Transactions* of the Royal Medical and Chirurgical Society; and he rightly attributed the emptiness of the heart to a loss of power in the bloodvessels. His words are as follow:—

"The disease I have now described may, perhaps, be termed *asphyxia idiopathica*. The essential circumstances of it evidently denote a sudden loss of power in the vessels, and chiefly in the minuter ones, to propel the blood they have received from the heart. In consequence of which, this organ, after having contracted so as to empty itself, and then dilated again, continues relaxed for want of the return of its accustomed stimulus, and dies in that dilated state."

The word asphyxia has become so closely connected by physiologists with death by privation of air, where the symptoms and appearances are the reverse of those in Chevalier's case, that it is necessary to discard his name of the disease which he describes, although it is etymologically correct. His cases come under the definition of what is now universally called syncope, and what I have called anæmic to distinguish it from cardiac syncope.

Chevalier speaks of a want of power in the vessels to propel the blood, and as it is not now believed that the vessels take any active share in the propulsion of the blood, this may be the reason why the views of this author have received less attention than they deserve; but it is very ob-

vious that a want of tone in the vessels, or any great diminution of that power which enables them to support and compress the blood, is an adequate cause why the blood should be unable to reach the right side of the heart. In the case of varicose veins, previously mentioned, it was physically apparent that the cause of the syncope lay in the vessels. Disease of the arteries is well known to be usually associated with degeneration of the heart; the veins are also large and distensible in old people, who furnish the greater number of those who are liable to anæmic syncope; but the pathology of the veins, as regards both their functions and structure, is not yet sufficiently known.

Persons with disease of the heart, who die suddenly in a fit of anger, probably die always with the heart distended; that is, of cardiac syncope. Dr. Joseph Ridge, however, in his able and interesting remarks on the disease and death of John Hunter,* states his belief that that celebrated man, who had been long subject to attacks of angina pectoris, died at last of syncope, with an empty heart. He died, as is well known, during a fit of anger, and the coronary arteries were found ossified. It is not said that the heart was empty, but that it was small, and that there were no coagula in any of its cavities. It is probable that there was not much blood in its cavities, at the time of the *post mortem* examination, but the body of Hunter was conveyed in a sedan-chair, from St. George's Hospital to Leicester Square, a little more than an hour after his death, so that the fluid blood would gravitate downwards. It is related that the stomach and intestines were unusually loaded with blood, and that those parts which were in a depending position, as in the bottom of the pelvis and upon the loins, were congested in a greater degree than the others; and that "this evidently arose from the fluid state of the blood."

* Oration before the Hunterian Society. Pamphlet, 1855.

In syncope from muscular exertion, the cavities of the heart are distended, and its walls have occasionally been ruptured, both from violent exercise and fits of anger.

Fear probably occasions each kind of syncope in different cases. In some cases, the right cavities of the heart become distended owing to impeded respiration, and possibly to a diminution of power in the heart itself. More frequently, the syncope appears to be of the ordinary or anæmic kind, the effect of the mental condition acting first on the more distant parts of the circulation. The pallor caused by fright is proverbial.

Pain is also capable of causing both kinds of syncope. I have alluded to cases (page 55) in which the patients strained and held their breath till the pulse became intermittent, and the action of the heart was temporarily suspended by the arrested breathing; on the other hand, patients often become pale, if they are undergoing any slight operation when seated, and syncope of the anæmic kind occurs, without any previous disturbance of the respiration, but passes off as soon as they are placed in the horizontal posture. I have seen an apparently strong man faint in this manner, during the removal of a tumour from the back not larger than a nut, and where only a few drops of blood were lost. Chloroform was not employed.

SUPPOSED CAUSES OF DEATH FROM CHLOROFORM.

Many writers have supposed that the deaths from chloroform have arisen from some peculiarity in the patient; and when any notable change of structure has been met with after death in any of the vital organs, this has been thought to afford a sufficient explanation of the event; whilst in the cases in which the organs were in a healthy state, surprise has been expressed at the occurrence. In looking over the account of the cases in which the inhalation of chloroform

has been fatal, there is reason to conclude, however, that the subjects of them were, as regards health and strength, quite equal to the average of the multitude who have inhaled this agent without ill effects. In fifteen out of the fifty cases above related, there was no examination of the body after death. In one of these fifteen cases, the patient was in a state of debility, and had hectic fever, apparently from the disease of the ankle-joint, for he had no cough; in another of these cases, the patient was reduced to a state of great debility from cancerous disease of the uterus. In fourteen out of the thirty-five cases, in which an examination of the dead body took place, all the chief organs were found to be healthy, if we except the local congestions of blood connected with the mode of dying, and a flabby state of the heart in a few of the cases, which probably depended on its being full of blood at the time of death, or its not being in a state of post mortem rigidity, at the time it was examined.

In one case, No. 25, the only morbid appearances were adhesions of the pleura of small extent; and in No. 47, the only disease was fatty liver. In Case 17, there were signs of chronic disease of the membranes of the brain; and in two cases, Nos. 16 and 22, there was emphysema of the lungs. In the remaining sixteen cases, there was some alteration of the heart, accompanied in a few instances by disease of other organs. In Cases 23 and 32, there was fat on the surface of the heart, but the structure was not degenerated. In Case 43, the right ventricle was thinned, but not fatty. In Case 44, there were slight deposits on the mitral valve, the heart being otherwise healthy. In Case 50, there were deposits of lymph on the mitral valve and also on the surface of the heart, which was somewhat enlarged. In Case 8, the heart is merely stated to be large; and in Case 27, hypertrophied. In Case 3, the heart was enlarged, pale, and soft, and the lungs were tuberculous. In Case 15,

there was said to be some amount of disease of the aortic valves, and some amount of fatty degeneration of the heart. In Case 37, incipient fatty degeneration was present; and in Case 40, that of a youth of eighteen, the heart was slightly enlarged, with some amount of fatty degeneration. In Case 46, the right ventricle was thinned and slightly fatty. There remain three Cases, Nos. 30, 33, and 42, in which the fatty degeneration was more decided; and one case, No. 41, in which it is spoken of as being present in an extreme degree. This was in a man, aged sixty-five, the oldest person included amongst those who died from chloroform.

When we consider how common is fatty degeneration of the heart, especially amongst old persons and those for a long time confined to bed, it is very probable that this affection has been proportionally as frequent, amongst the patients who have inhaled chloroform without ill effects, as in the fatal cases of its inhalation.

There are nine of the fatal cases in which the age of the patient is not stated. In the other forty-one cases, the ages, when grouped in decennial periods, are shown in the following table, the last column of which shows the proportion which the deaths bear at each period to the number living at that period, out of a thousand persons of all ages in England and Wales.

Under 5 years	0		0
5 and under 15	3		$\frac{1}{76}$
15 „ 25	11		$\frac{1}{18}$
25 „ 35	10		$\frac{1}{15}$
35 „ 45	11		$\frac{1}{10}$
45 „ 55	3		$\frac{1}{27}$
55 „ 65	2		$\frac{1}{26}$
65 and upwards	1		$\frac{1}{44}$

The nine persons whose ages are not given were all adults; one is spoken of as a young man, and another as a young woman, and the rest are mentioned in such a manner that it is certain they were not old people. It follows, therefore, that so far as is known, there has been a complete immunity from death by chloroform at both extremes of life. I have already given my reasons for rejecting Dr. Aschendorf's case of an infant, and also the case of a gentleman, aged seventy-three, who died whilst inhaling chloroform. The youngest patient who died from chloroform was seven or eight years of age, and the oldest sixty-five, being the only death above sixty. The above table of the ages shows that the number of deaths, in proportion to the number living, increased rapidly after the age of twenty-five, and decreased rapidly after the age of forty-five. The small number of deaths between fifteen and twenty-five may be partly due to the circumstance that surgical operations are but seldom required at this period of life; but the decrease after the age of forty-five cannot be explained in this way; for persons become more liable to require surgical operations as they advance in years. Operations are often performed in infancy and old age, periods at which deaths from chloroform have not been recorded. The greatest proportion of deaths having occurred from thirty-five to forty-five, when the system is often more robust than at any other period, it cannot be supposed that an inability to bear the usual dose of chloroform, when carefully administered, is the ordinary cause of death from this agent.

Idiosyncrasy. The accidents from chloroform have frequently been attributed to idiosyncrasy in the patient. This, it may be observed, is not to give an explanation of them, but merely to state that they depend on something we do not understand; that something, however, being in the person to whom the accident happens. This view receives

apparent support from the supposition that the chloroform has been inhaled in exactly the same manner in the fatal cases as in other instances; but this apparent support fails when it is pointed out that the supposed same manner is only an equally uncertain manner. The different effects that have been produced on the same patient at different times, and the great number of instances in which medical men have failed to make the patient insensible, show that most of the usual modes of exhibiting chloroform are extremely uncertain.

What most completely meets the question of idiosyncrasy, however, is the circumstance that in no fewer than eleven out of the fifty recorded cases of death from chloroform, the patient had previously inhaled this medicine without ill effects. In two other cases also, previous attempts had been made to make the patient insensible without success, on the day on which the accident occurred. In the above table of the fatal cases, those are indicated in which previous inhalations had taken place. In twenty-nine cases, I have concluded that the patient had not previously inhaled, for the medical man, having given an account of the state of his patient, and his reasons for administering the chloroform, would certainly have mentioned such a material fact as a previous inhalation if it had occurred. There are ten cases of which only a meagre account is given, and where a previous administration of chloroform may possibly have taken place without being mentioned; but if only eleven, out of the fifty patients, who died from chloroform, had inhaled it previously without ill effects, it is very clear that the fact of having inhaled it with a favourable result, gives no immunity from the possibility of accident. It would be impossible to say what proportion of the patients who have inhaled chloroform have inhaled it more than once, but it is not probable that they amount to more than 22 per cent., if so many.

Alleged Impurity of the Chloroform. At one time accidents from chloroform were loosely attributed to impurity in the medicine, but this was only a guess, and is opposed to the facts. No case of accident has been traced to this cause, and in nearly all the cases of which the details are given, it is distinctly recorded, either that the chloroform was examined and found to be of good quality, or else that chloroform out of the same bottle had been used in other cases without ill effects. I have not thought it necessary to state this in quoting the individual cases.

Apparatus employed. Accidents were at one time, and in one quarter, attributed to the use of inhalers; and it is curious that this allegation was made at a time when no death from chloroform had yet occurred in any cases in which an inhaler was used, except one in America, and one in France, the accounts of which had not reached this country. It is possible that death might be occasioned by want of air from the use of a faulty inhaler, and a case will be mentioned in which this apparently occurred in the administration of sulphuric ether, but there is no recorded case of accident from chloroform in which death was occasioned in this way. In the cases of death previously recorded, a handkerchief, a piece of folded lint, hollow sponge, or some such simple contrivance, was used in thirty-four instances; in twelve cases, an inhaler of some kind or other was used; and in four cases, it is uncertain what were the means employed.

Alleged Exclusion of Air. The assertion has often been made that death might be caused by the vapour of chloroform excluding the air, and so causing asphyxia; but it has already been pointed out in this work that the physical properties of chloroform do not allow it to yield a quantity of vapour which would have that effect, and in much smaller quantity than this the vapour kills by a quicker way than

asphyxia, I believe that the only elastic fluids which can cause death simply by excluding the atmospheric air are nitrogen and hydrogen.

Alleged Closure of the Glottis. At the trial which took place in Paris respecting the death of a porcelain dealer previously mentioned, M. Devergie gave evidence, and after saying that chloroform might cause death as a poison, if given in undue proportion, he added: "Also it closes the glottis, and offers an obstacle to respiration. Employed by M. Demarquay on himself, in very small doses, closure of the glottis was occasioned. It was possible that Le Sieur Breton had experienced that accident, and in that case the most able surgeon could not prevent death."

I have not met with M. Demarquay's account of his experiment, but I am happy to know that he did not die of the closure of the glottis. It may fairly be denied that a person could commit suicide in this manner if he wished, for he would either have to give up the attempt, or receive the vapour into his lungs, and experience its specific effects. When animals are placed in mixtures of vapour and air, they always breathe them, whatever the strength; and if the vapour amounts to eight or ten per cent., they die much more quickly than they would of mere closure of the glottis. Vapour of chloroform, when not largely diluted with air, is apt to cause cough and closure of the glottis, as soon as a little of it reaches the lungs; but this, so far from being a source of danger, is, as a general rule, a safeguard, by its preventing the patient from readily breathing air which is highly charged with vapour.

In commenting on the fatal case No. 12, which occurred in St. Thomas's Hospital, I have suggested that the accident might have happened from liquid chloroform being dropped into the throat; but liquid chloroform is very different from the vapour; it causes a lasting irritation if applied to a

mucous membrane; when used for toothache, it often blisters the gums. The irritation caused by the vapour, on the contrary, is only momentary, and its local action ceases directly it ceases to be inhaled; for what is left in the air passages is immediately absorbed or expelled with the expired air. The glottis is not a vital organ of itself. Its closure only causes death by preventing the access of air to the lungs. The glottis does not remain permanently closed, I believe, from the contact of any elastic fluid, however irritating;* but it does from the contact of a liquid, and persons who die by drowning, die with the glottis closed, for they do not fill their lungs with water. Therefore, if the vapour of chloroform did cause persistent closure of the glottis, and if a person were to hold it by force to the patient, the death it would occasion would be precisely like that in drowning. Death by asphyxia is a comparatively slow one. I find that when the access of air to the lungs is entirely cut off, death does not take place in less than three minutes and a half in guinea pigs, and four minutes in cats. In dogs, the process of asphyxia is still slower. Mr. Erichsen states, that on taking the average of nearly twenty experiments, the contractions of the ventricles continued for nine minutes and a quarter after the trachea had been closed, and that the pulsations of the femoral artery also were perceptible for an average period of seven minutes and a half. The process of drowning in the human subject is well known to occupy some minutes; and even if the pungency of the vapour of chloroform should entirely prevent the patient from breathing, and the medical man could overlook the fact that breathing was not going on, it cannot be supposed that he would use the force, and have the perseverance to

* Hydrochloric acid gas and ammonia are no exceptions to this rule, for they cease to exist as gases so soon as they come in contact with the moist lining membrane of the air passages. Carbonic acid gas will be treated of in another part of this work.

cause his patient to die slowly by asphyxia. If any patient, therefore, has died from closure of the glottis, it must have been one in whom there was a great tendency to sudden death from any slight interruption to respiration. I do not know the particulars of the case respecting which M. Devergie was giving his evidencc, but in those fatal cases previously related, in which the symptoms are sufficiently described, it is not probable that death took place in any instance from closure of the glottis. In the sudden death at St. George's Hospital (page 209), it is possible that the slight pungency of the vapour might assist the fear under which the patient was labouring in impeding the breathing, and thus add to the distension of the right cavities of the heart, under which the patient apparently died.

In 1855, two years after M. Devergie had given the above opinion, Dr. Black, of St. Bartholomew's Hospital, who has had great experience in the administration of chloroform, advanced a similar theory in the pamphlet previously alluded to. He did not, however, confine the effects of the supposed closure of the glottis to possibly causing a death here and there, as M. Devergie had done, but he attributed all the accidents which had happened to this cause, and not to the effects of chloroform in the system. He says that "the chloroform has not been even inhaled: its pungency was felt at the glottis, and its inspiration was immediately arrested. The patient would have removed the apparatus, but in this he was restrained. The struggle forthwith commenced, but up to the moment of his death, not a single inspiration took place." These remarks were not applied to a single case, but generally to the accidents from chloroform. Dr. Black says: "Any concentration of the vapour of chloroform which can be breathed is safe; any condition of dilution which forces the patient to cough or hold his breath is dangerous, and if persevered in for even half a minute,

may be fatal. . . . . We have only to attend to the breathing; we may disregard all considerations affecting the relative proportion of the chloroform in the air which is breathed; . . . . if the patient breathes easily he is in safety, whatever be the amount of chloroform which is passing into the lungs."

In Experiment 28, previously related, where the respiration was kept up by a tube in the trachea, there could be no error in respect to the vapour of chloroform entering the lungs, when a bladder of air charged with ten per cent. of that vapour was substituted for the bladder of simple air; and the immediate paralysis of the heart was evident. An examination of the fatal cases, of which the particulars have been recorded, shows that death did not occur in the manner Dr. Black suggests. In the majority of the cases, the patients were rendered quite insensible by the chloroform, and the operation had either been commenced, or was on the point of commencing, when the fatal symptoms set in. In several other cases, the patients were partially under the influence of the vapour before the symptoms of danger commenced; and in the six cases where death occurred at the beginning of the inhalation, without loss of consciousness having been induced, the patients were not restrained in any way, and it was observed that they did breathe the chloroform; three of them were speaking up to the moment when the pulse stopped, and one took a full inspiration the moment before the fatal symptoms set in. It is only in eighteen of the fatal cases that there is any reason to suppose that the patient required to be held, and then only from mental excitement or muscular spasm, arising from the physiological effects of the absorbed chloroform. It is hardly possible that the struggles of a conscious patient from inability to breathe, would be mistaken for excitement or spasm caused by chloroform.

In a case, No. 34, which occurred at St. Bartholomew's Hospital whilst Dr. Black was present, and long before his pamphlet was written, the patient inhaled for five minutes, and sank off into a state of complete insensibility without alarming symptoms. The inhalation was discontinued, the patient moved into a proper position, and the operation just about to be commenced, when Dr. Black found the pulse to become extremely feeble and fluttering. Surely this patient breathed the chloroform, and died without any spasm of the glottis. In Case 48, so minutely related by Mr. Paget, the boy made one long inspiration, and became suddenly insensible. In a few seconds, the pulse suddenly failed, and then ceased to be perceptible, but the breathing continued for at least a minute afterwards. There was certainly no closure of the glottis in this instance.

Alleged Exhaustion from Struggling. In cases where the patients have struggled violently whilst getting under the influence of chloroform, the accidents have been attributed to a supposed exhaustion caused by the struggling.* This opinion is, however, contrary to experience; for the patients who struggle violently are precisely those who bear chloroform the best, provided they do not breathe it in an insufficient state of dilution. They are generally cheerful and exhilarated by it, and are less liable to be depressed by its prolonged use, than those who come quietly under its influence. Although the patients who struggle bear the chloroform well, when it is carefully and judiciously administered, it is not improbable that the struggling has been now and then an indirect cause of accident. The muscular spasm and rigidity do not occur till about 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 sud-

* See Med. Times and Gaz., 1853, vol. ii, p. 562.

denly and at long intervals, the greatest care is required that the vapour be administered in a very diluted state. In Cases 9, 44, and 47, the fatal symptoms came on whilst the patients were struggling; and in some other cases, the sudden failure of pulse occurred just after the struggling had ceased, rendering it probable that the patient inhaled too much of the vapour whilst struggling, or just as the spasmodic condition of the muscles was subsiding.

The circumstances just mentioned, are probably the cause why so many of the fatal cases occurred at that period of life when the body is most robust. Very nearly two-thirds (twenty-seven out of forty-one), of those cases in which the ages are recorded, occurred in persons of twenty years and under forty-five years of age, although the proportion of persons living at this period of life, in England and Wales, is only a little more than one-third of the entire population. The majority of the accidents from chloroform occurred also in the stronger sex, in which muscular rigidity and spasm are most frequent:—twenty-nine of the fatal cases happened to males, and only twenty-one to females. According to my experience, the females who inhale chloroform for surgical operations are nearly twice as numerous as the males; and although this may not be the proportion in every one's practice, it is probable that females inhale this agent quite as frequently as the other sex, in every part of the world.

Sitting Posture. In some of the early cases of death from chloroform, the patients were inhaling it in the sitting posture, and it was surmised that this circumstance was the cause of death.* An examination of the account of the fatal cases, however, does not bear out this supposition. In thirty-one instances the patients were lying, in nine instances sitting, and there are ten cases in which the position

* See above, p. 75.

is not mentioned, and where from the nature of the operation it may have been either one or the other. In fully one-fourth of the cases of which I have kept notes of the administration of chloroform, the patients were seated in an easy chair; and as in forty fatal cases in which the position is known, only nine, or less than one-fourth, were seated, it does not appear that the position of the patient has had any share either in causing or preventing accidents.

Supposed Effect of the Surgeon's Knife on the Pulse. Mr. Bickersteth alluded to a peculiar circumstance,* which he thought would account for several of the deaths attributed to chloroform. He relates three instances in which the pulse suddenly ceased on the first incision by the surgeon, and commenced again in a few seconds, the breathing going on naturally all the time. All the three cases were amputation of the thigh, and occurred in the latter part of 1851. Mr. Bickersteth did not observe the circumstance again during the two following years, and I have never observed it, although I have very often examined the pulse at the moment when the operation began, especially after reading Mr, Bickersteth's remarks. He supposes that the action of the heart was arrested by the shock of the incision, notwithstanding the patient was insensible. I should attribute the temporary stoppage of the pulse in these instances to the direct influence of the chloroform on the heart. The moment when the operation is commenced, is usually a few seconds after the inhalation has been discontinued, and when the effect of the chloroform is at its height. A portion of that which was left in the lungs having been absorbed, in addition to that which was previously in the system. And if the vapour inhaled just at last was not sufficiently diluted, it might paralyse the heart, but not so completely as to prevent the natural respiration from restor-

* Edin. Monthly Jour., 1853, vol. xvii, p. 220.

ing its action, in those cases where respiration continues. I found in experiments on animals that, when the action of the heart has been suspended by the effect of chloroform, it can very often be restored by artificial respiration instantly applied; and it is extremely probable that an accident of this kind not unfrequently occurs during the administration of chloroform, and is remedied by the breathing, without being noticed. The pulse recovered itself, in the cases mentioned by Mr. Bickersteth, just as it does in animals after the heart has been nearly overpowered by chloroform. In the first case, the pulse remained imperceptible for a period of four or five seconds, the countenance at the same time becoming deadly pale. As it returned, it was at first very feeble, but in a few seconds, it regained its usual strength. In the second case, Dr. Simpson administered the chloroform, and after the operation remarked that the pulse had stopped suddenly just as the knife was piercing the thigh, and had recovered itself with a flutter almost immediately.

Mr. Bickersteth's reason for attributing the stoppage of the pulse to the effect of the knife, rather than the chloroform, was that he had arrived at the conclusion from some experiments which he performed on animals, that the action of the heart cannot be arrested by chloroform, until the breathing has been first suspended. One of Mr. Bickersteth's experiments (No. 5, on a half-grown cat) exactly resembles the experiment (No. 28 in this work) on a rabbit, which I had published upwards of a year before Mr. Bickersteth's paper appeared, with the exception that in my experiment the artificial respiration was performed with air containing ten per cent. of vapour, and in Mr. Bickersteth's the vapour was an unknown quantity. In both experiments, the heart of the animal was exposed. In that which I performed, three or four inflations of the lungs almost paralyzed the heart; and nine or ten inflations, which did

not occupy half a minute, had the effect of paralyzing that organ irrecoverably. In Mr. Bickersteth's experiment, the effect of the artificial respiration was as follows:—"After continuing it for seven minutes, the diaphragm, hitherto unaffected, began to move very irregularly and imperfectly; then its movements became slow and hardly perceptible; and, at the expiration of eleven minutes, they had ceased altogether. During all this time the heart's action remained strong and regular, but now it got weaker and more rapid, and, in four minutes from the time the diaphragm had ceased acting, had become so feeble (still quite regular) that I feared every moment it would stop." Mr. Bickersteth says he performed artificial respiration with air saturated with chloroform; but saturated or not, the vapour certainly did not exceed six per cent., and most likely was only between four and five, if the artificial resembled the natural respiration in quantity and frequency. The vapour which can be breathed for seven minutes without causing serious symptoms, and for eleven minutes without arresting the breathing, is of course incapable of stopping the action of the heart by its direct effect. It is scarcely so strong as that which one administers every day to patients with impunity. The vapour which is so diluted as to require to be added by small increments during one hundred and fifty inspirations, before the brain is even narcotized, cannot act directly on the heart, an organ which can bear a much larger amount of chloroform. Mr. Bickersteth fell into the error into which the Committee of the Society of Emulation of Paris afterwards fell, and argued from the rule to the exception. What he witnessed was the mode of death which would occur, if vapour of chloroform of the strength which can be safely inhaled, were deliberately continued till the death of the patient. But an accident from chloroform is an exception, and the mode of dying is as much an exception

as the death itself, if the inquiry is extended to what this agent is capable of doing, instead of confining it to what one endeavours to effect with it in the human subject alone.

So many of the deaths during the inhalation of chloroform have occurred before the operation had commenced, or after it had proceeded some way, that Mr. Bickersteth's explanation would not apply to a great number, even if it were correct; and when it is remembered that the operation is always commenced when the effect of the chloroform is expected to be at its height, the number of cases of cardiac syncope which have happened at the beginning of the operation is not greater than might be expected as the result of the effect of chloroform.

Sudden Death from other Causes. It has been more than once suggested that the deaths which have occurred, during the inhalation of chloroform, are of the same nature as the sudden deaths which have often occurred about the time of surgical operations, apparently without any adequate cause; and that in fact the accident and the chloroform may be a mere coincidence, and not connected as cause and effect. It has been already shown that the Commission of the Academy of Medicine of Paris made this suggestion in treating of the case of Madlle. Stock, and Dr. Simpson has more than once made a similar remark. On one occasion,* he remarked, in speaking of chloroform:—"The first surgical cases in which it was used were operated upon in the Royal Infirmary here, on the 15th of November, 1847. Two days previously, an operation took place in the Infirmary, at which I could not be present, to test the power of chloroform; and so far fortunately so; for the man was operated upon for hernia, without any anæsthetic, and suddenly died after the first incision was made through the skin, and with the operation uncompleted." I should say, so far unfor-

* Med. Times and Gaz., 1852, vol. i, p. 627.

tunately so, for whatever the cause of the man's death, that cause could hardly have been present if the patient had been made insensible by chloroform; and so his life would in all probability have been saved. If he died either from fear or from pain, the chloroform would have prevented his death, by removing and preventing these causes; and if his death arose from simple exhaustion, it must be remembered that chloroform is a stimulant, during the first part of its administration, and, as a general rule, so long as it is actually in the system. Even Mr. Bickersteth, who thinks that the knife of the surgeon may have a direct influence on the heart when the patient is quite insensible, expresses his conviction that such an occurrence is far less likely to happen under the influence of chloroform than in the waking state.

I have omitted from the list of deaths by chloroform two cases which are usually attributed to that agent, namely, the case of Mr. Robinson's patient, and the one at St. George's Hospital, and have attributed them to fear; and I also rejected the case of the infant on which Dr. Aschendorf operated, for the reasons I stated; and it is quite possible that amongst the fifty cases I have retained, there may be one or two in which the death was not caused by chloroform, especially as the details of some of the cases are very meagre; but when all the circumstances of the cases are examined, and especially when the mode of death is compared to that which chloroform can be made to produce in animals, it cannot be supposed that the fatal event was a mere coincidence in the whole fifty cases, or in any great number of them.

There are numerous instances recorded of sudden death during surgical operations, or just before intended ones, without any evident cause, except fear or pain, before the use of narcotic vapours was known; and some even since, in cases in which it was not thought worth while to use

them. After the passage quoted above, Dr. Simpson continues:—"I know of another case in Edinburgh, where death instantaneously followed the use of an abscess-lancet without chloroform,—the practitioner, in fact, deeming the case too slight to require any anæsthetic." Such events have, no doubt, often happened without being recorded; and it is extremely likely that the deaths of this kind which chloroform has prevented are quite as numerous as those it has occasioned by its own effects, but the medical profession will very properly not be satisfied with a result of this kind, if more can be done; and the endeavour of the practitioner of course is, whilst saving life as well as preventing pain by the use of this agent, to avoid as far as possible having any accident from its use.

Falling back of the Tongue. It has been alleged that the falling back of the tongue into the throat, under the deep influence of chloroform, might be the cause of death by suffocation; but this appears to be an error; for the muscles of the larynx and neighbouring parts preserve their action as long as the diagraphm, and contract consentaneously with it. When the breathing has ceased, the tongue is indeed liable to fall backwards, if the person in a state of suspended animation is lying on the back, and this circumstance requires to be attended to in performing artificial respiration.

STATE OF THE CHIEF ORGANS AFTER DEATH FROM CHLOROFORM.

A few years ago, I examined the viscera of the chest, and kept notes of the appearances, in thirty-seven animals killed by chloroform. They consisted of two dogs, twenty-two cats, one kitten, three rabbits, three guineapigs, two mice, two larks, and two chaffinches. Many of the animals were opened immediately after death, and the rest within a day or two. The lungs were not much congested in any in-

stance. In seven of the animals, they were slightly congested; but in the remaining thirty, they were not congested. They were generally of a red colour, but in a few of the cats they were quite pale. I ascertained the specific gravity of the lungs of two of the cats, in which they presented the amount of vascularity I have most usually met with. The specific gravity was 0·605 in one instance, and 0·798 in the other. As many of the animals died in a way resembling asphyxia, the respiration ceasing before the circulation, it might at first be supposed that we should meet with the same congestion of the lungs; but by the time that the respiration is altogether suspended by the action of chloroform, that agent has begun already to influence the heart, which does not inject the blood into the lungs with the same force as when the respiration is mechanically prevented, whilst it is in full vigour. Besides, in the gaspings which so often take place when the heart is ceasing to act, the animal inhaling chloroform draws air freely into the lungs, whilst the asphyxiated animal is prevented from doing so.

As regards the condition of the heart, it was found in the two chaffinches that the auricles were filled with blood, whilst the ventricles were empty. The condition of the heart in the larks is not mentioned, but in all the thirty-three quadrupeds, the right auricle and ventricle were filled with blood. In ten of them, these cavities were much distended; and in some of these instances, the coronary vessels on the surface of the heart were distended also. The left cavities of the heart never contained more than a small quantity of blood, not exceeding a quarter of what they would hold.

The head was examined in only ten of the animals. The substance of the brain was found to be of the natural vascularity, and the sinuses were not very much distended, except in two instances.

With respect to the state of the blood, it may be mentioned, that in every instance in which the chest was opened within an hour after death, the blood which flowed from the cut vessels coagulated immediately and firmly. In eighteen of the animals in which the blood was examined in the heart or large vessels, a day or two after death, it was found to be well coagulated in ten, loosely coagulated in seven instances, and quite fluid in one instance. I have not met with air in the bloodvessels, either in the above thirty-seven examinations, or in any of the numerous other animals that I have opened, after they have been killed by chloroform. The appearances I have met with in animals killed by this agent have usually been such as I have described in the above thirty-seven instances; but I long since ceased, as a general rule, to make careful notes of the appearances, as I did not meet with anything new.

In the fatal cases of inhalation of chloroform previously quoted, the lungs are related to have been congested more frequently, and to a greater extent, than I have met with in animals. But there is no standard of what should be called congestion; and probably many of the medical men who made the examinations were speaking by comparison with cases where persons die after illness, in a state of inanition. In the human subject, the right cavities of the heart, although generally full of blood, were found empty in several cases; but as I previously stated, it is almost certain that they were emptied after death, either by the artificial respiration which was employed, or in some other way.

The blood remained fluid in eighteen out of twenty-five cases of fatal accident from chloroform, in which an examination of the body was made and the condition of the blood recorded; whereas it was only quite fluid in one instance out of eighteen of the animals which were killed by chloroform, and not opened till a day or two afterwards.

The fact of the blood coagulating more generally, in the animals on which I have experimented, than in the human subjects who died from chloroform, is probably due to their smaller size. I was formerly of opinion that the fact of the body of a small animal cooling more quickly than the human one was the probable explanation of this, but Dr. Richardson appears to have proved that the blood is kept in a liquid state by the presence of ammonia; and ammonia, we might expect, would escape more readily from the body of a small animal than from the human body. However this may be, it is pretty certain that the blood generally remains fluid in the human body after death from chloroform, only because it usually remains fluid in every kind of sudden death. When a patient dies slowly of illness, the body cools gradually before death takes place, and ammonia keeps exhaling in the breath, if Dr. Richardson is correct, whilst the formation of this alkali must be almost suspended. In many cases, we know that coagulation of the blood commences before the respiration and circulation have ceased. The blood which flows during surgical operations coagulates as quickly and firmly when the patient is under the influence of chloroform as at other times; and, as was mentioned above, the blood which flows from animals, just after they are killed by this agent, coagulates as well as usual; it follows, therefore, that if the coagulation of the blood were prevented by the chloroform, and not by the mere fact of sudden death, it would be by the presence of this agent in the blood after death, and not by any action which it exerted during the life of the patient.

FURTHER REMARKS ON THE PREVENTION OF ACCIDENTS FROM CHLOROFORM.

In consequence of the prevailing opinion that accidents from chloroform depended chiefly on the condition of the

patient, the main endeavours to prevent a fatal result have taken the direction of a careful selection of the persons who were to inhale this agent. It may be doubted, however, whether this line of practice has had so much effect in limiting the number of accidents, as in curtailing the benefits to be derived from the discovery of preventing pain by inhalation. In nearly all the recorded cases of accident from chloroform, it is stated that the patients had been carefully examined, and such proofs of disease as were met with after death were chiefly those which had not been detected; and, as already has been stated, were probably not greater on an average than in the cases in which no accident happened.

I have not myself declined to give chloroform in any case in which a patient required to undergo a painful operation, whatever evidence of organic disease I have met with on careful examination; and although I have memoranda of upwards of four thousand cases in which I have administered this agent, I have not, as I believe, lost a patient from its use; the only person who died whilst under its influence having, in my opinion, succumbed from other causes, as I have already explained.

Many writers have stated that accidents from chloroform might always be prevented by a close attention to the symptoms, or to some particular symptom, as the pulse or the breathing. Several authors have attached the utmost importance to feeling the pulse, and have considered this measure of itself sufficient to avert danger; whilst others have asserted that attention to the pulse is of no use at all. Mr. Bickersteth, for instance, writes as follows, in the article from which I previously quoted. "But the pulse should not be taken as any guide during the administration of chloroform. It should be wholly disregarded except under certain circumstances, when syncope is to be feared from loss of blood during the performance of a capital operation.

The pulse is only affected secondarily in consequence of the failure of the respiration."

If the person administering chloroform was always quite sure that the vapour did not constitute more than five per cent. of the inspired air, it is quite true that the pulse might be wholly disregarded. I can never produce more certain and uniform results with chloroform than when I am giving it to small animals enclosed in glass jars, where of course the pulse cannot be felt. In surgical practice, however, where the amount of vapour in the inspired air is often very uncertain, watching the pulse may be of great service, irrespective of loss of blood; and although it will not always prevent accident, I am persuaded that it has saved many lives. In some of the accidents that have happened, the pulse has ceased suddenly, whilst it was being very carefully watched; but more usually it would show some signs of failure before entirely ceasing.

In giving chloroform freely to animals from a napkin or sponge, whilst the ear or the hand was applied over the heart, I have usually found that its pulsations became embarrassed and enfeebled before they ceased; and by withdrawing the chloroform when the heart's action first became affected, the life of the animal could often be saved.

The importance of attending to the respiration of the patient has been previously noticed, and it is so obvious a symptom that it can hardly be disregarded, if anyone is watching the patient; it speaks, moreover, almost to one's instincts, as well as to one's medical knowledge. It is probable that no patient has been lost by disregard of the respiration, unless it be one or two whom no one was watching, or in which the head and shoulders were covered with a towel.

It has already been shown in this work, from experiments on animals, and from the physiological effects and physical

properties of chloroform, that accidents from this agent would arise by its suddenly paralyzing the heart, if it were not sufficiently diluted with air; and a careful review of all the recorded cases of fatal accident shows that nearly every one of them has happened in this way, and not from any neglect in watching the symptoms induced, or mistaking their import.

The first rule, therefore, in giving chloroform, is to take care that the vapour is so far diluted that it cannot cause sudden death, without timely warning of the approaching danger; and the next rule is to watch the symptoms as they arise. A description of those symptoms, and what they indicate, has already been given.

I have previously stated that the most exact way of giving chloroform to a patient is to put so much of it into a bag or balloon as will make four per cent. of vapour when it is filled up with the bellows; but I have not often resorted to this plan, on account of its being somewhat troublesome. I have previously described (p. 81) the inhaler which I employ. By arranging the bibulous paper suitably, and by ascertaining, with the inhaler in the scales, how much chloroform a given quantity of air carries off at different temperatures, I am able to produce very uniform results in the administration of chloroform. But, as I previously stated, those who do not wish to have the trouble of studying a suitable inhaler, may give chloroform on a handkerchief without danger, and with results sufficiently certain, by diluting this agent with an equal measure of spirits of wine. As the spirit (nearly all of it) remains behind, it is desirable, in a protracted operation, to change the handkerchief or sponge, now and then, for a dry one.

TREATMENT OF SUSPENDED ANIMATION FROM CHLOROFORM.

It is probable that artificial respiration, very promptly

applied, will restore all those patients who are capable of being restored from an overdose of chloroform. All the patients who are related to have been restored after this agent has occasioned a complete state of suspended animation, have been resuscitated by this means. It is only by artificial respiration that I have been able to recover animals from an overdose of chloroform, when I felt satisfied that they would not recover spontaneously. And under these circumstances I have not been able to restore them, even by this means, except when a tube had been introduced into the trachea, by an incision in the neck, before giving them what would have been the fatal dose.

M. Ricord succeeded in restoring two patients who were in a state of suspended animation by mouth to mouth inflation of the lungs. The first was a woman, aged twenty-six, who had been made rapidly insensible by a few inspirations of chloroform from a sponge. He had scarcely commenced the operation of removing some vegetations, when his assistant informed him that the pulse had ceased. The breathing also ceased about the same time.

In the second case, he completed the operation of circumcision, and the patient, a young man, not coming to himself, M. Ricord found that the breathing had ceased, and the pulse was becoming more and more extinct, and very soon ceased entirely, till restored by the artificial respiration.

After these cases, hopes were expressed that M. Ricord had discovered the means by which all patients might be restored from the overaction of chloroform; but these hopes have not been verified by events. In the first of the cases, the heart had probably not been so entirely paralyzed by the action of the vapour as sometimes happens, and in the second case, that organ was apparently not paralyzed by the chloroform at all. It was only after the breathing had ceased, that M. Ricord found the pulse was failing. This

was a case, therefore, in which artificial respiration might reasonably be expected to restore the patient.

The following cases of resuscitation, from the over effects of chloroform, are related by Mr. Bickersteth in the paper previously quoted. They occurred in Edinburgh:

"*Case* 1. A boy was cut for stone by my friend Mr. Hakes, on the 29th of March, 1849. Chloroform was administered on a piece of sponge, and the full anæsthetic effect produced, before proceeding to tie him up in the ordinary position: the inhalation was continued, without any regard to his condition, until the operation had been completed—altogether about five minutes from the time he first became insensible. It was noticed that during the operation scarce a drop of blood escaped. When it was over, the child was found, to all appearance, dead; the muscles were flaccid; the surface of the body pale; the respiration had ceased; the pulse could not be felt; the heart sounds were not audible (but the room was by no means quiet); the eyes were half open; the jaw dropped; the pupils dilated; and the corneæ without their natural brilliancy. Several means were tried to resuscitate him, but without effect. At length artificial respiration was commenced; the air escaped with a cooing sound, as if from a dead body. After continuing it for a while, the breathing commenced, at first very slowly and feebly. Soon it improved. In two hours the child had quite recovered."

"*Case* 2. In December 1851, a child, a few months old, was put under the influence of chloroform for the purpose of having a nævus removed from the right cheek. As soon as insensibility was produced, the operation was commenced—the handkerchief containing the chloroform remaining over the face, as some difficulty had been experienced in keeping up the anæsthetic effect. Suddenly the breathing ceased; the muscles became flaccid; the countenance pale and col-

lapsed, and the lips of a purple colour. Artificial respiration was employed, and in less than a minute the breathing returned, and the child was restored."

"*Case* 3. On the 6th of March, 1852, I had occasion to remove the finger of a robust, healthy-looking young man, in the Royal Infirmary. He was already under the influence of chloroform when I entered the room, and as there had been some difficulty in producing complete anæsthesia, and the last of the chloroform in the bottle was already on the handkerchief, it was thought advisable by my friend in charge of its administration to keep up the inhalation, in order to produce a coma sufficiently profound to last until the completion of the operation. It was therefore left over his face, and I commenced and removed the finger, slowly disarticulating it from the metacarpal bone. I distinctly recollect hearing the man breathing quickly and shortly; and I also remember, that when just about to look for the vessels, my attention was attracted to his condition, by not any longer hearing the respiration. The handkerchief was still on his face. I took it off, and found, to my consternation, that the breathing had ceased; the face was livid; the eyes suffused; the pupils dilated; the mouth half-open. He was to all appearance dead; still the pulse could be distinguished as a small, hardly perceptible thread, beating slowly. Immediately artificial respiration was commenced. For a minute or two, his condition did not alter in any respect—then the lividity of the countenance increased, the pulse was no longer perceptible, and the sounds of the heart could not be satisfactorily heard. During the whole of this time, artificial respiration had been diligently employed, but still the air appeared to enter the chest very imperfectly. I despaired. I felt certain that the man was dead, and that no human aid could restore him; and if it had not been that those standing near me urged me to persevere, I

believe I should then have deserted the case as hopeless. Just at this time it occurred to me to put my finger in the mouth and draw forward the tongue, in order to secure there being no impediment to the air entering the lungs. Retaining it in this position, we again began the artificial respiration, and found that then the chest was fully expanded by each inflation. After keeping it up for a minute or two, the gentleman, who had all along kept his hand on the pulse, exclaimed, to our delight, that he could again feel it—'It was just like a slight flutter that reached the uppermost of his four fingers,' all of them being placed over the course of the artery. It gradually became more distinct and firmer, and at the same time, the lividity of the face decidedly lessened. In another minute, the man made a slight inspiratory effort. I ceased directly the artificial respiration, and merely assisted the expiration by pressure upon the ribs. Another and another inspiration followed, and in a short time he breathed freely without assistance. The countenance became natural, and he appeared as if in a sound sleep. In half an hour, he spoke when roused; then he vomited, and complained of giddiness. In an hour afterwards, he had recovered sufficiently to walk home.

"Moments of intense anxiety appear much longer than they really are; but even allowing this, I am quite sure that, at the very least, five minutes elapsed from the time when the man ceased breathing before the first inspiratory effort took place, and that for not less than one minute the pulse was imperceptible, and the heart's action almost, if not altogether, inaudible."

"*Case* 4. A few weeks after the occurrence just described, I was assisting Mr. Syme in removing the breast of a lady. A gentleman, my superior in the hospital, was conducting the inhalation of chloroform. Anæsthesia was complete, and the breathing good, when the operation commenced.

The chloroform was allowed to remain over the face during the whole time of its performance. Before it was over, I noticed the respiration become very quick and incomplete, and suggested, in consequence, the propriety of removing the handkerchief. My remark was neglected for eight or ten seconds, and then, just as it was taken away, the breathing ceased suddenly. The face became deadly pale; the eyes vacant; the lips livid. Instant dissolution appeared inevitable (the pulse was not felt). Artificial respiration was immediately commenced, but the air not entering the lungs freely, the tongue was pulled forwards, and retained so by the artery forceps. The chest then expanded freely with each inflation, the air escaping with a cooing sound. In rather less than a minute, the respiratory movements recommenced, but at first so slowly and imperfectly that it was necessary to assist expiration. When recovery was a little more established, the operation was completed. Before the putting in of the sutures, sensation had partially returned, and in a short time the lady had perfectly recovered."

Mr. Bickersteth very properly adds: "There can be no doubt, that in the foregoing cases, a grievous error was committed by continuing the inhalation after anæsthesia was produced, and that it was in consequence of this, the accidents, so nearly fatal, occurred."

As these accidents seem to have occurred from continuing the inhalation too long, they differ entirely from nearly all those which were actually fatal, and which, as we have seen, arose from the too great concentration of the vapour, and not from any want of care in watching the patient, so as to be able to leave off at the right moment, if it were possible. I have previously stated, that after breathing vapour of the proper strength for inhalation, animals may always be readily restored by artificial respiration after the

breathing has ceased, provided the heart is still beating. In the cases related by Mr. Bickersteth, the heart had ceased to beat before the patients were restored; but in the third case, there is distinct evidence that the heart continued to beat for four minutes after the breathing had ceased. It was, therefore, certainly not paralyzed by the direct action of the chloroform. The patient was nearly in the condition of a drowned person, where we know that there is a good prospect of recovery by artificial respiration during the first few minutes after the breathing has ceased, even if the action of the heart be imperceptible. In the other three cases, also, it is probable that the breathing ceased before the action of the heart; and, at all events, this organ was not paralyzed so thoroughly as in the cases in which artificial respiration was promptly applied without effect.

Several other cases have been related in the medical journals in which patients have been restored by artificial respiration, after animation had been suspended, more or less completely, by chloroform; but the above remarks would, I believe, be applicable to all these cases.

Where patients have recovered under the use of other measures, without artificial respiration, it is probable that animation was not completely suspended, and that the recovery was spontaneous.

M. Delarue related a case of accident from chloroform to the Academy of Medicine, on August 20th, 1850, which was apparently of this nature. After administering the vapour, and when he was about to divide some sinuses in the thigh, he found that his patient (a woman) was in a state of collapse, and the breathing and pulse, "*pour ainsi dire*", insensible. The face was injected, and there was a bloody froth at the mouth. The uvula was titilated, and there was immediate movement of the eyelids, which was

soon followed by copious vomiting, and the patient recovered.*

Such measures as dashing cold water on the patient, and applying ammonia to the nostrils, can hardly be expected to have any effect on a patient who is suffering from an overdose of chloroform; for they would have no effect whatever on one who has inhaled it in the usual manner, and is merely ready for a surgical operation, but in no danger. I have applied the strongest ammonia to the nostrils of animals that were narcotized by chloroform to the third or fourth degree, and it did not affect the breathing in the least. They recovered just as if nothing had been done. It is difficult to suppose a case in which the breathing should be arrested by the effects of chloroform whilst the skin remained sensible, yet it is only in such a case that the dashing of cold water on the patient could be of use. There is, however, no harm in the application of this and such like means, provided they do not usurp the time which ought to be occupied in artificial respiration; for this measure should be resorted to the moment the natural breathing has entirely ceased.

I have only seen two cases in which the patients seemed in imminent danger from the direct effects of chloroform. One of these occurred in 1853. It was the case of a child, aged six years, but small and ricketty, which had the greater part of the eyeball removed on account of melanotic disease. The usual inhaler was employed, and when the child seemed sufficiently insensible, it was withdrawn. The operation was commenced by introducing a large curved needle, armed with a thick ligature, through the globe of the eye, in order to draw it forward. As the needle was introduced, the child cried out a very little, and thinking the parents, who were in the adjoining room, would be

* L'Union Médicale, 1850, p. 411.

alarmed, I poured some undiluted chloroform hastily on a rather large sponge, and placed it over the nostrils and mouth. The sponge became pressed by the surgeon's hand closer on the nose than I intended, but it was removed after the child had taken a few inspirations. The operation was quickly concluded without any further sign of sensation than that mentioned above. At the end of the operation, the breathing was natural, but the face was pale, and the lips blue, and the limbs were also relaxed. I tried to feel the pulse at the wrist, but did not discover any. The chloroform had at this time been left off half a minute at least. The palor and blueness continued, and in a little time the breathing became slow and embarrassed, and appeared about to cease altogether, the pulse being still absent. The windows were opened, and cold water dashed freely on the face. The child made gasping inspirations now and then, but they did not follow immediately, or seem connected with each application of the water. The gasps became more frequent, till the breathing was thoroughly reestablished, when the colour returned to the lips, and the pulse was again felt at the wrist. In a minute afterwards, the child was red in the face, and crying violently from pain, which was relieved by a little more chloroform. It appeared to be a minute or a minute and a half from the time when the sponge with chloroform was removed, till the breathing became of a gasping character. There is no doubt that in this case the heart was paralyzed, or nearly so, by the chloroform, and that its action was restored by the spontaneous gasping inspirations of the child. The accident could have been prevented by having the chloroform, which was put on the sponge, diluted with spirit.

The other case occurred in the latter part of 1852. I have no notes of it, as it took place at the beginning of an illness, which prevented me from writing for some time;

but I recollect the chief particulars of it sufficiently well. The patient was a lady rather more than sixty years of age, rather tall and thin. She required to have a polypus removed from the nose. Mr. Fergusson, who was about to operate, was nearly an hour after the appointed time, and during this interval she was pacing up and down the room, apparently in a great fright. She was placed in an easy chair for the operation, and the pulse was small and feeble when she began to inhale. Nothing particular occurred during the inhalation, but just at the time when the patient was becoming insensible, the breathing ceased, and the pulse could not be felt. She appeared to have fainted, and was immediately placed on a bed which was in the room. I applied my ear to the chest, but could hear no sound whatever. Mr. Fergusson applied his mouth to that of the patient, and with a very strong expiration, inflated her lungs, so as to expand the chest very freely. I immediately heard the heart's action recommence with very rapid and feeble strokes, as I had so often heard it recommence in animals. The patient soon began to make distant gasping inspirations, and the natural breathing and pulse were soon reestablished. Mr. Fergusson made only one or two inflations of the lungs after the first one, which of itself was the means of restoring the patient. It was about twenty minutes, however, before she became conscious; and during the greater part of this time there were spasmodic twitchings of the features and limbs on one side. In about an hour, she was pretty well; and on the following day the operation was performed without chloroform.

The most ready and effectual mode of performing artificial respiration is undoubtedly the postural method, introduced by Dr. Marshall Hall a little time before his death. It consists in placing the patient on the face and making pressure on the back; removing the pressure, and turning

the patient on his side and a little beyond; then turning him back on the face and making pressure on the back again; these measures being repeated in about the time of natural respiration.

Whether the artificial breathing is successful or not must depend chiefly on the extent to which the heart has been paralyzed by the chloroform, as was previously observed. The fact of the breathing continuing after the action of the heart has ceased, in some of the fatal cases, shows that the heart may be so paralyzed as not to be readily restored by the breathing. It is probable that in all cases in which artificial respiration can restore the patient, its action would be very prompt; still it is desirable to persevere with this measure for a good while.

As already stated, there is every reason to conclude that the right cavities of the heart are distended with blood, in all cases of suspended animation by chloroform, and therefore it would be desirable to open one of the jugular veins if the artificial respiration does not immediately restore the patient. In opening animals, just after death from this agent, I have observed the contractions of the heart to return, to a certain extent, when the distension of its right cavities was diminished by the division of the vessels about the root of the neck. Opening the jugular veins has been resorted to in a few of the cases of accident from chloroform, but hitherto without success.

I have not succeeded in restoring an animal from an overdose of chloroform, by means of electricity, in any case where I felt satisfied that it would not recover spontaneously; and I have not heard of any patient being restored by its means. For keeping up respiration, mechanical means, such as the postural method, are better; as they cause air to enter the lungs without exhausting the remaining sensibility. If electricity be used, it should be directed

towards restoring the action of the heart. It is probable that the electric current would not reach the heart without the help of the acupuncture needle; but it would be justifiable to use this in a desperate case, when other measures had failed. The needles should be coated with wax, or some other non-conductor of electricity, except near the points.

In the fatal cases Nos. 40 and 48, previously related, the action of the heart partially returned during the efforts that were made for the restoration of the patient, but did not become thoroughly reestablished. It is probable that the circulation through the coronary vessels of the heart was not restored in those cases, or else the blood which must have been freed from chloroform, in its passage through the lungs, would most likely have enabled the heart to recover completely. Dr. Cockle has expressed the opinion, which is very probable, that the blood enters the coronary arteries in a retrograde manner, during the diastole of the ventricles, when the aorta and other great arteries are contracting on their contents; if so, with a very feeble circulation, the elasticity of the aorta, perhaps, cannot sufficiently act to cause a backward current; and perhaps, also, the over-narcotism of the heart is itself an obstacle to the coronary circulation, on account of the congestion of the capillaries which always attends on narcotism.

The knowledge how seldom anything effectual can be done for a person who has inhaled a dose of chloroform from which he would not spontaneously recover, ought to impress the rule very strongly on every one, to use the greatest care in its administration.

EFFECT OF CHLOROFORM ON THE RESULT OF OPERATIONS.

Besides the great benefit conferred by chloroform in the prevention of pain, it probably confers still greater advantages by the extension which it gives to the practice of surgery. Many operations take place in children which could not be performed in the waking state; excisions of joints and tedious operations for the removal of necrosed bone are often performed on persons who would be altogether unable to go through them except in a state of anæsthesia; and the moving of stiff joints by force is an operation now frequently performed, although it would probably not have been thought of if narcotism by inhalation had not been discovered. The surgeon also obtains the ready assent of his patient to a number of other operations, where it would either not be obtained at all, or not at the most favourable time, if the patient had to suffer the pain of them.

The effect of chloroform cannot fail to be favourable, to a certain extent, in large operations. The patient is in a more tranquil and cheerful condition after the operation, than he would be in if he had suffered the pain of it. His pulse is usually of the natural frequency; and after an amputation, there is generally an entire absence of the starting of the stump, which was formerly so distressing. After all the minor operations in which chloroform is used, and which according to my experience comprise at least one-half of the cases, there is never a death; and the only inconvenience is a troublesome sickness of stomach in a very few instances. Moreover, when patients die after the more formidable operations, they succumb to causes which are well known, and were in operation before the practice of anæsthesia. I only know of a very few instances where there has been a reasonable doubt on the mind of the sur-

geon, whether the chloroform may not have had some share in preventing the recovery of the patient, after a severe operation. These were cases in which the sickness, which occasionally follows chloroform, continued for three or four days, indeed till the death of the patient. This is a point which it would be difficult to decide, for the latter part of the sickness might depend on the sinking state of the patient, and might have come on if chloroform had not been used. Moreover, as sickness is seldom very prolonged after chloroform in minor operations, except in persons who are not in a good state of health, it is most probable, that the patients who died after a great operation with continued sickness, would not have done well if no chloroform had been used.

Some attempts have been made to determine, by statistical inquiry, whether the result of operations has been more favourable since the introduction of anæsthesia. These attempts have been confined to the larger amputations, as they are the only operations which sufficiently resemble each other to admit of the application of statistical inquiry; and even in the case of these operations, the inquiries which had been made previously to the introduction of etherization differed widely in their results.

Dr. Simpson took great trouble, in the early part of 1848, to collect the account of the amputations of the thigh, leg, and arm, which had been performed under the influence of ether or chloroform in forty-nine of the hospitals in Great Britain; and for comparison, he collected from thirty British hospitals the results of the same amputations, for the two or three years preceding 1847. He found that the mortality in the period preceding the use of ether was 29 per cent. in these amputations, and the return of patients whose limbs had been amputated under the use of ether and chloroform gave a mortality of 23 per cent.; and he con-

cluded that 6 per cent. of the lives of those who had undergone these amputations had been saved by the use of these agents. In his application for an account of cases, however, Dr. Simpson merely asked for the number of cases, and the number of deaths. Nothing was said as to the time when the amputations had been performed; and there is reason to believe that a number of cases still under treatment may have been included; some of which may have ended fatally after the returns were made. The cutting part of a large amputation is of very short duration. The loss of blood is not great; and patients hardly ever died during the performance of an amputation, but some time afterwards, of diseases which ether and chloroform have not been found capable of preventing. It was therefore not to be expected that these agents should save the lives of so many as 6 per cent. of those who underwent the larger amputations.

In the early part of 1849, I published an account of fifty-five amputations of the thigh, leg, and arm, in which I had administered ether or chloroform, and the mortality was 27 per cent.*

Dr. James Arnott has lately been investigating this subject in a very persevering manner. During the last three or four years, all the cases of amputation performed in the London hospitals have been reported in the *Medical Times and Gazette*, together with their results; and Dr. James Arnott has stated that the average per centage of deaths, after the three kinds of amputation above mentioned, is 34·4 per cent. There is obviously no means of ascertaining what was the mortality after amputations in the hospitals of London before the use of ether and chloroform, but Dr. James Arnott brings forward four papers, which state the mortality for a short period, in four hospitals, a little time before the introduction of etherization. The number of

* Lond. Med. Gaz., vol. xliii, p. 230.

cases in these papers is 174, and the number of deaths 41. Dr. James Arnott states the per centage of deaths to be 21·9,* although it appears to me that it would be 23·5; and it may be remarked that the four papers from which these numbers are taken might probably not have been published if the numbers they contain had not been favourable. Dr. James Arnott, in a second table, gives the number of amputations and deaths from the several hospitals in London which are named. The cases are said to have occurred "during eighteen months from June 1855 to June 1856, inclusive;" here being obviously a mistake. The number of cases is 204, and the number of deaths 61; which would give a mortality of 29·9 per cent.; almost exactly the same as that which Dr. Simpson had obtained from thirty provincial hospitals before the use of ether. The numbers in Dr. Simpson's table are 618 cases, and 183 deaths, or 29·6 per cent. Dr. James Arnott does not, however, mention the per centage of deaths in his second table, but gives another table, for a different period, in which the names of the hospital are not given. The numbers he gives in this table are 430 cases and 148 deaths, giving a mortality of 34·4 per cent. Dr. James Arnott therefore concludes that chloroform causes the death of upwards of 12 per cent. of those who inhale it for the purpose of undergoing amputation. It is evident that he can have had no experience of the effects of chloroform, or he would have perceived at once the error of his conclusions, for this agent is given for a much longer time than in amputations, in numerous operations of which the entire mortality is less than 12 per cent. In the removal of tumours of the female breast, for instance, more chloroform is generally administered than in an amputation, and the loss of blood is also much greater, yet the entire mortality after this operation

* Medical Times and Gaz., 1856, vol. ii, p. 413.

is considerably less than that which Dr. J. Arnott supposes that chloroform adds to the ordinary mortality after amputations.

Dr. J. Arnott stated that the pyæmia, of which many of the patients died after amputation, had probably been rendered more prevalent and fatal by the use of chloroform; but Mr. Thomas Holmes, in one of his able replies to the remarks of Dr. Arnott, points out that pyæmia had been prevalent also in cases of compound fracture, and others in which the patients had no chloroform. He stated that this complaint had been more prevalent in St. George's Hospital during the three years in which Dr. J. Arnott's statistics of amputations had been collected, than in the previous five years, in which chloroform had been used.*

A very valuable paper on the result of operations performed in the Newcastle Infirmary, before and since the use of ether and chloroform, was published last year by Dr. Fenwick.† He says, respecting his tables, "in the first series are included the operations registered in the operation books of the Newcastle Infirmary from 1823 to 1843; but, as the record is imperfect, the actual period embraced is seventeen and a half years. In the second, are the operations registered since the first employment of ether; and as the use of anæsthetic agents has been general in all the more important operations since that time, these figures may be used to show any disadvantages likely to arise from the employment of chloroform." Dr. Fenwick continues:— "Before the use of chloroform, there were registered 225 amputations of the thigh, leg, and arm, of which 54, or 24 per cent., died. Since the use of anæsthetic agents, 149 cases of similar operations have been recorded, of which 36 died, showing also a mortality of 24 per cent.

* Med. Times and Gaz., 1856, vol. ii, p. 478. † Ib., 1857, vol. i, p. 559.

"Before, however, we can draw any conclusion from such facts, we must carefully exclude all those circumstances which are already known to produce an effect upon the mortality of amputations. It is, for instance, well known that amputations performed on account of accidents are, on the whole, nearly twice as fatal as those required for long standing disease. Now, if we divide the foregoing numbers into these two classes, we shall find that before the introduction of chloroform there were 144 pathological amputations, with a mortality of 19 per cent.; while since its employment there have been only 61, of which 13 per cent. have died; and while of 81 traumatic amputations which took place in the former period 32 per cent. died, only 31 per cent. perished in the latter period. The equal mortality obtained from a general average of all amputations is thus seen to have arisen from the smaller comparative number of operations performed for diseases."

After giving a table which shows the result of each kind of amputation in the two periods, he adds, "It is plain from the above table that since the employment of chloroform there has been a diminution of mortality; thus in amputations of the thigh for disease there has been 5 per cent. less death, while after accidents 17 per cent. have been restored to health, who formerly would have perished. In the pathological amputations of the leg there is a difference of 8 per cent. in favour of chloroform; and while one out of three died after the removal of the forearm for accidents in the former series of cases, no death had occurred out of eight in the latter. The only exceptions are to be found in the traumatic amputations of the leg, and in the pathological amputations of the arm. In the former there is an excess of deaths since the introduction of chloroform amounting to 5 per cent.; and in the latter, the cases, being

only two in number, do not warrant us in drawing any deduction from them."

Dr. Fenwick found that the mortality from lithotomy had been greater since the introduction of chloroform than before, but that the increase was confined to the cases occurring in adults; aud he justly attributes this to the fact of the more favourable cases having been operated on by lithotrity. He says, "However paradoxical it may appear, I believe that as surgery improves the general average of mortality, both after amputations and lithotomy, will increase; in the former, from the operation being confined more and more to those suffering from accidents, and in the latter, from those with a healthy condition of the kidneys and bladder being selected for the action of the lithotrite, and the worst cases only submitting to the knife."

Dr. Fenwick gives a table showing the causes of death in the fatal cases of lithotomy before the use of chloroform and afterwards, by which it is seen that, in the latter set of cases, a larger proportion of the patients had been afflicted with organic disease, in addition to the stone. He says:— "This table shows that the relative proportion of deaths arising from the operation in healthy persons has diminished since the use of chloroform, 58 per cent. having died in the former, and only 47 per cent. in the latter."

Dr. Fenwick inquires into the result of a considerable number of operations in the Newcastle Infirmary, before and after the use of chloroform, in addition to those mentioned above; and gives the following summary towards the end of his paper.* "We find that there has been a decrease in mortality since the introduction of chloroform in the following operations:—

* Page 648.

	Per cent.
Pathological amputations of the thigh	5
Traumatic amputations of the thigh	17
Pathological amputations of the leg	8
Amputation at the shoulder joint	7
Traumatic amputation of the arm	5
Pathological amputation of the forearm	33
Traumatic amputation of the forearm	16
Ligature of the brachial artery	20
Ligature of the arteries of the forearm	25
Amputation of the penis	11
Amputation of the testis	14
Excision of the elbow	30
Tumours of the axilla, etc.	8
Tumours of the bones, etc.	4

"There has been an increase of mortality in :—

	Per cent.
Traumatic amputation of the leg	5
Pathological amputation of the arm	41
Lithotomy	10
Herniotomy	12
Amputation of the breast	1
Tumours of the head, etc.	5."

Dr. Fenwick very properly remarks that other circumstances may have had an influence over the mortality of the various operations, as well as the fact of chloroform being used or not used: but his inquiry is very important, as it shows the result of operations in the same institution since the employment of ether and chloroform, and for a long period immediately preceding the use of those agents.

THE ADMINISTRATION OF CHLOROFORM IN THE DIFFERENT KINDS OF OPERATIONS.

General directions for the exhibition of chloroform have already been given, but it is desirable to say a few words regarding its employment in some of the individual operations of surgery.

Lithotomy. In this operation, it is advisable to have the patient placed on the operating table with his head supported by one or two pillows, and to administer the chloroform before the sound is introduced. This having been done, it is generally requisite to administer a little more vapour cautiously and gently, whilst the bandages are applied to the hands and feet, and the patient is drawn down towards the foot of the table. The bandaging should on no account be neglected in the adult patient. It would be an abuse of chloroform to carry its effects so far in every case that the slightest contraction of the muscles could not be excited by the use of the knife, merely to save the trouble of applying a bandage. In little children, the bandages are not usually employed; but in these cases, the person administering the chloroform should hold the head or shoulders of the little patient, just as the surgeon makes his first incision; for the two assistants who are holding the legs, and think they are doing a great deal of good, are really making a fulcrum to enable the child to push itself away from the surgeon, if it makes the least flinch, which it is almost sure to do, if the narcotism is not much deeper than there is any occasion for. In this operation the patient should be fully insensible when the surgeon makes his first incisions; and the chloroform must be repeated or not during the operation as occasion may require.

I have memoranda of fifty-seven cases in which I have administered chloroform in the adult, and thirty-four in

children, down to the present time, the end of March 1858. It was my expectation that I should be able to give the result of these, and all the other important operations; but I have in a few cases either not ascertained whether the patient recovered or not, or have neglected to make a note of the circumstances at the time; and although the deficiencies might perhaps be made up by private correspondence, and by searching the books of three hospitals, I regret that I have not time at present for such an undertaking.

A large proportion of the above cases of lithotomy were performed by Mr. Fergusson, either in his private practice, or in King's College Hospital, and the remaining operations were performed by a number of surgeons. On April 19th, 1855, Mr. Fergusson removed eight calculi, as large as pigeon eggs, from the bladder of a gentleman, aged sixty-nine, who had a favourable recovery.

On June 7th, in the same year, he removed fourteen calculi from the bladder of an elderly gentleman, who also recovered. In January 1857, he removed forty-two calculi from the bladder of a gentleman, aged sixty-six; twelve of them were nearly as large as chesnuts, and the rest about as big as hazel-nuts. This patient died, I think, within a fortnight. He had disease of the kidneys. A considerable number of the elderly men on whom lithotomy has been performed have had well marked symptoms of fatty degeneration of the heart; but the chloroform has acted favourably on all of them. In January 1853, Mr. Fergusson performed lithotomy in the country on a gentleman, aged sixty-four, removing a rather large calculus. The patient weighed eighteen stone; he had a pulse which was liable to intermit, some of his relations had died suddenly, and his usual medical attendant was very much alarmed about the chloroform; but its action was very satisfactory. The patient recovered his consciousness without sickness, or any

unpleasant symptom; and he had a favourable recovery. On August 11th, 1855, I administered chloroform in King's College Hospital to a man, aged seventy-five, whilst Mr. Fergusson performed lithotomy. The patient had suffered from apoplexy a year before; he was still paralyzed on one side, he had the arcus senilis well marked in both eyes, and the temporal arteries were very thick and rigid. He went through the operation well; the pulse being good all the time. He died on the fifth day, and the following appears in the *Medical Times and Gazette* respecting the appearances found after death. "At the autopsy, the cellular tissue of the pelvis was found infiltrated with pus. The kidneys were contracted, and occupied by many cysts; the ureters were inflamed and contained pus. The bladder was extensively sacculated, and its mucous membrane so much congested as to appear on the point of sloughing. There was no peritonitis. The heart was large and fatty, and its aortic valves diseased to a small extent. The brain was congested, and its blood-vessels extensively ossified." On December 22nd, 1855, I administered chloroform in King's College Hospital to a very fat man, aged sixty-one, with a soft weak pulse, and arcus senilis of the cornea. Mr. Fergusson performed lithotomy. He went well through the operation, and recovered promptly from the effects of the chloroform. He died on the seventh day, with purulent effusion into the left knee, and around the left shoulder. The heart was large and flabby, and the substance of the left ventricle was very friable. The right ventricle was dilated and thinned, and its walls were soft and friable, and encroached on externally by fat; at one place there seemed scarcely any muscular substance left.

I have memoranda of four cases of lithotomy in the female, in which the urethra was divided as well as dilated

to extract the stone; and I recollect two other cases of the same kind of which I have no notes.

Lithotrity. I have memoranda of 155 operations of lithotrity in which I have administered chloroform. The number of cases of stone in which these operations took place was sixty, but some of the patients had operations performed, either without chloroform, or when it was administered by some one else. The earliest cases of lithotrity in which I administered chloroform were in St. George's Hospital, and a great number of the patients to whom I have given it were the private patients of Mr. Fergusson, who is entirely satisfied of its utility in this operation. Speaking of this operation in his *Practical Surgery* (third ed., p. 800), he says: "I am of opinion that there is not any department of practical surgery in which anæsthesia has been of more service than in this." I have administered chloroform in a few operations of lithotrity by Sir Benjamin Brodie; but I believe that he does not approve of it in this operation, as a general rule. The following are amongst the other surgeons whom I have frequently assisted by giving chloroform in this operation: Mr. Cæsar Hawkins, Mr. Cutler, Mr. Coulson, Mr. Charles Hawkins, and Mr. Henry Lee. Mr. Fergusson, in one of his operations, extracted some portions of gutta percha bougie round which a phosphatic calculus had formed. He was not informed of the presence of the bougie in the bladder, until it was extracted. On another occasion, a patient was brought from the country soon after a bougie of this description had broken off, and he extracted with the lithotrite the piece remaining in the bladder. It was between two and three inches in length.

It is generally desirable to make the patient quite insensible during the operation of lithotrity; and the patient sometimes groans during its performance, when he is in a

condition that, so far as one can judge, he would show no sign of sensation under the use of the knife; but he, of course, has no recollection of the operation afterwards. The bladder is sometimes apt to expel the water which is injected, if the patient is not well under the influence of the chloroform; but when the vapour has been continued for a few minutes, and the narcotism is complete, the bladder will, I believe, always hold water as well as if the operation were performed in the waking state, and generally much better. There are some surgeons who occasionally raise the breech of the patient for a short time during this operation, so that the head becomes considerable lower than the body. Stout old men generally snore more loudly when in this position under the influence of chloroform; but I have not met with any ill effects, nor expected any, from the head being lowered for a short time. From ten to twenty minutes has been the most usual duration of the operations under chloroform at which I have been present.

I have administered chloroform six times in female children whilst Mr. Fergusson performed lithotrity. The patients were three in number. I think the calculus all came away after the first operation, and the second was only an examination of the bladder. I administered chloroform also, on one occasion, to a lady whilst Mr. Spencer Wells repeated the operation of lithotrity.

Section of the Urethra in the Perinæum. I have notes of 56 cases of this operation. A great proportion of them were performed by Mr. Fergusson, either in King's College Hospital, or in private practice. Amongst the other surgeons whom I have assisted in this operation were the late Messrs. Guthrie, Bransby Cooper, and Avery. In a great number of the cases, it was impossible to get a catheter into the bladder until after the incision was made in the peri-

næum, and many of the operations were very tedious; several of them lasting above an hour. It is very desirable to apply the bandages in this operation, as in that of lithotomy, especially if the assistants are not numerous.

Other Operations for Stricture, etc. I have notes of four operations in which the stricture was divided internally by a urethratome; and of two operations in which the orifice of the urethra was enlarged; and of nine plastic operations to restore deficiencies of the walls of the urethra, congenital or otherwise. I have memoranda of 66 cases in which I have administered chloroform for sounding the bladder or the introduction of a catheter. In catheterism under chloroform the patient, of course, lies on his back, which is indeed the position in which he ought to be during this operation, when chloroform is not administered.

Amputation of the Thigh. This operation is often performed for disease of the knee, when the joint is in such a state of tenderness that the least motion causes great pain. In such cases, I have administered the chloroform to the patient in bed, before his removal to the operating table, and given a little more chloroform just before the operation was commenced. In King's College Hospital, I have several times given the chloroform in the ward in such cases, before the patient was removed to the operating theatre; but in St. George's Hospital, the passages and doors being wide, the patient has been carried on his bed into the theatre, where the chloroform was administered just before his being lifted on the table. In those cases in which the tourniquet is applied, in preference to pressure with the fingers, it should be adjusted as the patient is getting under the influence of the chloroform, and tightened just before the operation begins. It is desirable to keep the patient quite insensible till the limb is removed, and the femoral artery is tied; after which a little chloroform may be given when-

ever the patient shows by a slight flinch, or contraction of his features, that sensation is returning. A few patients have recovered their consciousness during the tying of the smaller arteries, and have entered into a conversation without feeling the pain, but this condition is quite the exception. I have notes of 49 cases of amputation of the thigh in which I have administered chloroform. Some of the patients, who were almost grown up to the adult age, did not know that the limb was removed till three or four days had elapsed.

Amputation of the Leg. I have notes of 31 cases in which I have administered chloroform during this amputation. The remarks made above with regard to amputation of the thigh are applicable to this operation.

Amputation of the Arm. I have only administered chloroform five times in this operation, and only in one case during the last seven years. This case was that of a boy, aged sixteen; Mr. Hancock was the operator, and the patient recovered. I have no note of the disease for which the operation was performed, but in two or three of the remaining cases, the arm was amputated on account of malignant disease of the forearm. In one of the operations, the patient was seated in an easy chair, but in the others, the patients were lying on a sofa, or operating table, with the head and shoulders a little raised.

Amputation of the arm has apparently been much less frequently performed of late years, owing to the increasing practice of performing excision of the elbow; and it appears to me that all the great amputations are much less frequently performed now than they were a few years ago. During a little more than nine months of 1847, I administered sulphuric ether in 32 amputations of the thigh, leg, and arm; and in the last ten years and four months, I have only administered chloroform in 85 of the same operations;

in the last three years, indeed, in only 16 cases; so that the practice of amputation is still diminishing. This is due to the practice of anæsthesia, which enables the surgeon to explore and to remove diseased joints and portions of diseased bone by operations that would be too long and too painful to be endured in the waking state. This circumstance confirms the remark of Dr. Fenwick, previously quoted, that the mortality after amputations may be expected to become greater, as they will cease to be performed, except after accidents, or in very desperate cases.

Amputation of the Ankle. I have notes of 15 cases of amputation at the ankle. They were chiefly performed by Mr. Fergusson, and generally in the manner recommended by Mr. Syme, or nearly so; but latterly Mr. Fergusson and Mr. Partridge have, in three or four cases, adopted the modification of this operation introduced by Prof. Pirogoff, by which a portion of the os calcis is left.

Other Amputations. I have notes of nine cases of amputation of the forearm; four of these operations were performed in 1850, and only three since that year. I have memoranda of twelve cases in which I have given chloroform whilst Chopart's or other partial operations of the foot were performed. Also of three cases in which Mr. Fergusson performed amputation at the knee, and three cases in which he performed amputation at the wrist in King's College Hospital. I have notes also of 65 cases in which I have administered it during the amputation of one or more fingers or toes.

Operations for Necrosis. Anæsthesia is of the utmost service in these operations, which are often tedious, and would be of the most painful nature. The operations are of the most successful kind of any in surgery; they usually relieve the patient from a very painful affection, and leave no mutilation. I have administered chloroform in many

cases of necrosis in which an operation could not have been undertaken without its assistance; and in a still larger number, in which the operation could not otherwise have been satisfactorily completed. I have memoranda of 197 cases of necrosis in which I have given chloroform. In 70 of these, the tibia was the bone affected; in 15 cases, the femur; in 24 cases, the humerus; in 14 cases, the radius, or ulna, or both of these bones; in 29 cases, the bones either of the carpus or tarsus, or metacarpus or metatarsus. I have notes of six cases of necrosis of the sternum; in five of these the operation was performed by Mr. Fergusson, and in one case by Mr. Solly. Great care was required in some of the cases to avoid going through into the chest with the bone nippers. There have been nine operations for necrosis of the os calcis. In one of these, Mr. Wm. Adams lately removed, along with the necrosed bone, a small bullet which had been in the bone for six years.

The other cases of necrosis comprise the upper and lower jaw, the parietal bone, the edge of the orbit, the scapula and clavicle, the sacrum, the ileum, and the phalanges of the fingers and toes.

Excision of the Head of the Femur. I have notes of five cases of this operation. They all occurred in children from eight to thirteen years of age. Three of the operations were performed by Mr. Fergusson, one by Mr. Bowman, and one by Mr. French; I also recollect assisting Mr. Henry Smith in a similar operation in a child in 1848, at a time when I did not keep any account of the operations in which I administered chloroform. In one of Mr. Fergusson's operations, he removed some diseased portions of the acetabulum.

Excision of the Elbow. There is every reason to conclude that this excellent operation has been performed more frequently in consequence of the inhalation of narcotic vapours than it otherwise would have been. I have memoranda of

19 cases of this operation in which I have exhibited chloroform; 18 of them were performed by Mr. Fergusson, and the remaining one was performed by Mr. Coulson, whilst Mr. Fergusson was present.

Excision of the Knee. I have notes of 17 cases in which I have given chloroform during the performance of this operation. Thirteen of the operations were performed by Mr. Fergusson, two by Mr. Bowman, one by Mr. Partridge, and one by Mr. Henry Smith.

This operation had been rarely performed till within the last seven years, and there is every reason to believe that it never would have been frequently performed, if the practice of producing anæsthesia had not been introduced. I shall speak of this operation again in treating of amylene.

Excision of Wrist. There have been two cases of this operation performed by Mr. Fergusson in King's College Hospital.

The Removal of Tumours of the Upper Jaw. Mr. Syme, Mr. Lizars, and some other surgeons, expressed an opinion at one time that chloroform could not be safely used in this operation, as the blood would be liable to flow into the lungs. This is not the case, however, as the glottis retains its sensibility apparently unimpaired, if the influence of the chloroform is not too deep or long continued. It is only necessary to hold the head forward now and then, when the throat is very full of blood, in order to allow the patient the same opportunity of breathing that he would require if he were awake. A good deal of blood passes into the stomach in great operations about the mouth under the influence of chloroform; and if a few drops pass into the wind-pipe, they are coughed up again, as they would be in the waking state; there is, however, less appearance of suffocation in operations where the blood flows back into the throat, when the patient is insensible, than when he is

awake. The glottis appears to retain some sensibility as long as a creature is capable of breathing, for I have placed the head of more than one cat under water after making them thoroughly insensible with chloroform, and the action of the respiratory muscles lasted more than two minutes, but no water entered the lungs.

I have always made the patient insensible in the usual way, with the inhaler, before the operation of removing tumours of the jaw, and have kept up the insensibility during the operation by means of a mixture of chloroform and spirit on a hollow sponge; or in cases in which I have not been provided with this mixture, I have put not more than fifteen or twenty minims of chloroform on the sponge at one time. Owing to the hands of the surgeon and his assistants being very much in the way, I have not always been able to keep the patient quite insensible throughout the operation. He has sometimes struggled or cried out, but there has been hardly any case in which the patient afterwards remembered any considerable part of the operation.

I have notes of twelve cases of removal of the upper jaw in which I have administered chloroform, in addition to four cases to which I alluded in the *Medical Gazette*, in the early part of 1849. In some of the cases, the malar bone was removed, as well as the superior maxillary. Eleven of these operations were performed by Mr. Fergusson, and the others were performed by Mr. Partridge, Mr. Henry Charles Johnson, Mr. Hewett, Mr. Henry Smith, and Mr. Haynes Walton.

Mr. Fergusson introduced a great improvement in this operation about seven years ago; instead of the incisions through the cheek or lip, or both of these parts, he merely slits open the lip exactly in the mesial line, as far as the columna of the nose, and then carries the knife along one

side of the base of the columna into the nostril, next the tumour. He says: "By opening the nostril in this way as much relaxation was gained as if the knife had been carried from the root of the ala an inch up the side of the nose, and as much facility was given for the future steps of the operation, as if an incision three inches in length had been made through the lip and side of the nose, while a grand object was gained in leaving the slightest possible conspicuous appearance afterwards."* This plan has the further great advantage of avoiding the very copious hæmorrhage which arises from a deep incision in the side of the face.

In one of the operations which was performed before this improvement was introduced, the patient died of hæmorrhage. The case is related by Mr. Prescott Hewett in the *Medico-Chirurgical Transactions* for 1851. This operation was performed in St. George's Hospital, in May 1848, with the consent of the surgical staff of the hospital. The patient was a man, aged twenty-five; the tumour was of nearly six years duration. For some time previous to the operation, he had suffered occasionally from hæmorrhage from the affected nostril, to an extent which had reduced him considerably. The vapour was given to him rather slowly, with the apparatus I commonly employ, and he became gradually insensible, without previous excitement or struggling. In about three minutes, the inhalation was discontinued, the narcotism having reached the third degree. The patient was passive, but the muscles were not relaxed. The breathing was not stertorous. Some teeth were now extracted without causing any sign of pain. A little more chloroform was then given to him, and when the inhalation was discontinued a second time, he was in the same state as before the teeth were drawn. The operation was immediately commenced. The superior maxillary and malar

* Practical Surgery, 3rd ed., p. 682.

bones of the left side were removed. During the first part of the operation, whilst the flaps were made, the patient was perfectly quiet and silent; but afterwards he began to groan and move his limbs, and he was not again rendered altogether insensible; for although a few minims of chloroform were from time to time sprinkled over a sponge, which was, now and then, held near his face, yet, owing to the hands of the operator and his assistants being in the way, and the cavity of the mouth and nostril being laid widely open, he got very little of the vapour, and the only effect of it was partially to quiet him on one or two occasions. After the first two or three minutes of the operation, the effect of the chloroform never exceeded the second degree. The patient executed voluntary movements of his arms and legs; sometimes it was necessary to hold his hands, and at one time he appeared conscious, for he folded his arms as if making an effort not to raise his hands to the seat of pain. He coughed now and then, and seemed somewhat embarrassed with the blood in his throat. He was seated in a chair, but as there was no window in the operating theatre except the skylight, his head was obliged to be inclined rather backwards. He was leaned forwards once or twice, to allow him to get rid of the blood, and it appeared that he vomited some on one of these occasions. Towards the conclusion of the operation, and at a time when he was very little under the influence of chloroform, he fainted. He was laid down, and brandy was given to him. No more chloroform was administered after this time. He partially rallied from the syncope, but again became faint. The actual cautery was applied, but oozing of blood continued until the moment of death,—about half an hour after his removal into another room. During this interval, he was much exhausted; his pulse was small, and difficult to feel. He was tossing himself about in a restless manner, but there was no

difficulty of breathing. He seemed quite conscious, doing as he was told, but, of course, could not speak, from the nature of the operation. I left a few minutes before the patient's death. When he ceased to breathe, laryngotomy was performed, and artificial respiration exercised by the opening, with no beneficial result. In my opinion, this measure was not indicated, but of course it could do no harm.

One of the surgeons who was present when the patient died informed me that blood entered his windpipe from the wound, when he became moribund.

It was found during the operation that the tumour did not involve the superior maxillary or malar bones, but was situated behind them. In his address to the class immediately after the operation, Mr. Hewett estimated the loss of blood at sixteen ounces. It appeared to me to be much greater; besides that a great deal of blood would certainly be swallowed.

After death, portions of the tumour were found still remaining attached to the posterior and upper part of the cavity, and projecting into the foramen lacerum of the orbit and right nostril, as well as in other directions. The trachea and bronchi contained some frothy blood. Numerous small dark spots of congestion were met with in the lung, resulting from some of the small bronchi being filled with blood.

The late Mr. Liston lost a patient from hæmorrhage during the removal of a tumour of the upper jaw, before the prevention of pain by inhalation was discovered; and it is evident that the chloroform did not contribute either directly or indirectly to the death of Mr. Hewett's patient. His symptoms were simply those of exhaustion from loss of blood; he recovered from the effects of the chloroform some time before he died; and the small quantity of blood

which spotted the lungs, and was observed to enter as he was dying, would not have led to any immediate urgent symptoms if it had entered during the operation.

Tumours of the Lower Jaw. I have notes of twelve cases in which I have given chloroform during this operation. Eight of the operations were performed by Mr. Fergusson, and the others by Mr. Stanley, Mr. Tatum, Mr. Hancock, and Dr. Pettigrew. In some of the cases the jaw was divided on each side above its angles, and in most of the others it was disarticulated on one side, and divided near the symphysis. Three of the patients died within three days, from the hæmorrhage which occurred at the time of the operation, but the others all recovered.

The remarks which were made respecting the application of chloroform in the removal of tumours of the upper jaw are applicable here. After the operation has been commenced, one should endeavour to keep up the insensibility by means of a mixture of chloroform and spirit on a hollow sponge. In tumours, both of the upper and lower jaw, the operating table is preferable to an easy chair for the patient under chloroform. The head and shoulders must be raised by the moveable flap of the table, or by some other contrivance if the operation be performed in a private house. I have, however, seen the operation performed on a sofa, and with the patient in bed. The blood does not flow into the throat so much in the removal of tumours of the lower jaw, as in those of the upper one.

Tumours of the Female Breast. I have memoranda of 222 cases in which I have given chloroform during the removal of tumours of the breast, or tumours which returned after the breast had been removed. I do not include with these a considerable number of small tumours, situated upon, and near the gland, but not involving it. By far the greater number of the tumours of the breast were

looked upon as malignant, but I am not able to state the numbers which were believed to be malignant, and which were thought not to be so. I may state that there is no surgeon whom I am in the habit of assisting who does not occasionally remove malignant, as well as non-malignant, tumours of the breast. By far the greatest proportion of the above mentioned operations on tumours of the breast were performed in private practice. In a number of cases diseased glands were removed from the axilla, in addition to the mammary gland. It is desirable in the removal of large tumours of the breast that the surgeon should be well seconded, by assistants who are in the constant habit of assisting him, in order that the bleeding may be restrained and arrested as quickly as possible. I have not seen any case in which the patient did not go through the operation, and live, as far as I can remember, for two or three days. But a few of the patients have been very faint from bleeding during the operation, and faintness from hæmorrhage seldom takes place during the influence of chloroform unless the loss of blood is very great. The greater portion of the patients who have been faint during the operation have done well afterwards, but a few of them have not. In cases where there is a great loss of blood, and a very large wound remains, the patients are apt to sink and die in from three to five days. Most patients may recover from a considerable hæmorrhage, and most patients may be able to bear up during the healing of a large wound, but the combination of a great hæmorrhage and a great wound is apt to be fatal; especially to patients who are already reduced by illness. The largest tumour of the breast I have seen removed, was one on which Mr. Fergusson operated, in King's College Hospital, on Feb. 26th, 1853; it weighed eighteen pounds and a half. On the 4th of June, following, the same patient had a small tumour removed from the

same situation. It probably resulted from a portion of the large one which had been left behind.

There are a few surgeons who prefer to have the patient seated in an easy chair whilst removing a tumour of the breast; but it is more convenient, under the influence of chloroform, that the patient should lie on a table, or sofa, or in bed. I usually keep the patient unconscious till the wound is stitched up, and the plaster and bandage applied.

I have administered chloroform in four cases of tumour of the male breast. These tumours were all of them malignant, I believe.

Other Tumours. I have had to administer chloroform during the removal of several large and deep-seated tumours of the face, situated just in front of the ear, over the parotid gland, with which some of them were thought to be connected. These operations were generally extremely difficult and tedious, owing to the necessity of avoiding the division of the branches of the facial nerve which passed over the tumour. When the branches of the facial nerve are touched with the forceps, or back of the scalpel, during these operations, the muscles of the face to which the branches are distributed contract very freely, at a time when the patient is perfectly insensible. Mr. Stanley, Mr. Fergusson, and Mr. Tatum, are amongst the surgeons whom I have assisted in the removal of tumours of this kind.

I have memoranda of 41 tumours situated behind the angle of the jaw, in the removal of which I have exhibited chloroform. These tumours, which mostly consisted of diseased lymphatic glands, were often very deep-seated, passing near to the carotid artery, and it was necessary on that account to keep the patient quite insensible, to prevent his flinching during the operation. The greater number of these tumours were removed by Mr. Fergusson.

Seventy-one of the tumours of the removal of which I

have notes, are stated to have been of the encysted kind. Sixteen of them were situated on the eyelids, sixteen on the scalp, three or four in the orbit, several in front, or at the side of the neck, and the rest in different parts of the body.

I have memoranda of 66 fatty tumours which were removed from different parts of the body. Some of them were of great size; one weighed fifteen pounds. One which Mr. Fergusson removed in 1855 from the arm of a lady, the patient of Messrs. Maurice and Harris of Reading, was situated beneath the biceps muscle, and weighed two pounds six ounces and a half. The diagnosis of it was very difficult. The fatty tumours were easily removed, except in a few instances, in which the fat was infiltrated in the surrounding tissues.

I have notes of the removal of 87 other tumours of various kinds, as fibrous, scirrhous, epithelial, melanotic, fungoid, etc.

On February 11th, 1854, Mr. Fergusson removed a large fibrous tumour, situated over the right scapula of a stout gentleman about forty. It weighed about three pounds. The tumour was very adherent to all the surrounding tissues, and the removal of it occupied five or ten minutes, and was attended with considerable hæmorrhage. At the time when the tumour was completely detached, the patient became pale, and the pulse could no longer be felt in either wrist or in the temporal arteries. He did not faint, however, for the breathing continued to be well and regularly performed. He partially recovered his feeling once or twice, whilst the vessels were being tied, and more chloroform was given to him. At the end of the operation he was quite conscious, and did not complain of being faint, although no pulse could be felt. The pulse had not returned when I left him half an hour after the operation, and I was informed that it did not return for about three

hours. Four hours after the operation, when I called to see him, he had a frequent and very distinct pulse. He had some hot brandy and water just after the operation, and about ten minutes afterwards he insisted on going to the water-closet in the next room, and could not be persuaded to lie still. The moment he was raised on his feet, however, he fainted, but was immediately laid down again, when he as quickly recovered his consciousness, and was content to lie still. This was the only faintness he had. It is my opinion that the effect of the chloroform kept up the breathing and prevented syncope, whilst the smaller arteries of the exterior of the body contracted so as to confine the remaining blood very much to the vital organs. The patient seemed in some danger for two or three days, but was walking out quite well in less than a fortnight.

In April 1856, Mr. Paget removed a fibro-cellular tumour, weighing probably ten or twelve pounds, from a lady a few weeks out of her confinement. The tumour was situated over the sacrum and nates. Sir Benjamin Brodie was present at the operation. The patient recovered favourably.

Nævi. I have memoranda of 116 operations on vascular tumours, the greater part of them in infants. The operations have generally been performed by subcutaneous ligature, and have been extremely successful. The greater number of them have been performed by Mr. Fergusson and Mr. Bowman, in private practice and in King's College Hospital. Some of the nævi on the faces of infants, which were operated on by Mr. Fergusson, were very large, and required a succession of operations.

Ligature of Arteries. I have administered chloroform in three cases of ligature of the carotid artery, by Mr. Bowman, Mr. Lane, and Mr. Haynes Walton. Mr. Walton's patient was an infant six months old. The right common carotid artery was tied, on account of a tumour which

pushed forward the eye to a great extent. On the child being brought under the influence of chloroform, the prominence of the eye diminished very much, as I was informed that it had done when chloroform was given for some reason on a previous occasion. On the ligature being placed under the artery, the chloroform was discontinued, and its effects allowed to subside before the ligature was tied. As the effects of the chloroform went off, the eye became as prominent as before; and the tightening of the ligature had no effect on this prominence whilst I remained, although it instantly stopped the pulsation of the temporal artery. I was informed that this child was cured by the operation.

I have also administered chloroform in three cases of ligature of the external iliac artery, for aneurism of the femoral. Two of the operations were performed by Mr. Fergusson, and the other by Mr. Henry Smith. One of Mr. Fergusson's patients was a very stout gentleman; the external iliac artery was diseased at the usual situation of the ligature, and it had to be tied near to the common iliac. This patient died. Mr. Henry Smith's patient recovered, as I believe did the other of Mr. Fergusson's. It is necessary that the patient should be kept very insensible during the operation of tying the carotid or external iliac artery, to prevent the possibility of his flinching.

I have exhibited chloroform six times for the ligature of the superficial femoral artery, on account of aneurism in the popliteal space. Two of these operations were performed by Mr. Bowman on the same man with an interval of three weeks. He had an aneurism in the popliteal space of both limbs. There was a case of false aneurism of the radial artery, on which Mr. Fergusson operated by tying the artery above and below, and turning out the clot; and also a case in which Mr. Hancock tied the vessels for a

false aneurism, situated between the metacarpal bones of the thumb and forefinger. There were two cases also in which the radial artery was tied for a recent wound; one by Mr. Henry Charles Johnson, the other by Mr. Henry Lee.

Tumours of Bone. I have administered chloroform in a number of cases of the removal of enchondroma, and other tumours of bone. In June 1849 I assisted the late Mr. Aston Key whilst he removed a bony tumour from a youth about sixteen, situated at the inner and anterior part of the femur, just above the knee; and I have seen two or three other tumours of the same kind, exactly in the same situation. I have no notes of the other cases; but one was a patient of Mr. Quain, and another, I think, of Mr. Fergusson. After an incision is made, the tumour can be clipped clean off at once with a pair of strong, curved bone nippers. Unless the bone nippers are curved, the operation is troublesome and difficult.

Hare-Lip. I have notes of 147 operations for hare-lip, for which I have given chloroform. A few of these operations were performed by Mr. Arnott, Mr. Cæsar Hawkins, Mr. Bowman, Mr. Henry Charles Johnson, and others, but nearly nine-tenths of the whole number were performed by Mr. Fergusson, either in his private practice or in King's College Hospital. A great number of Mr. Fergusson's operations were in children from three to six weeks old; and some were younger than this, one being only eight days. There used to be an objection against operating for hare-lip on very young infants, as it was said that they often died of convulsions, which I believe to be true. The convulsions were supposed to be caused by the shock of the operation on the nervous system, which I believe to be entirely untrue. I believe they were caused by hæmorrhage; and I would not recommend the surgeon to perform his

first operations for hare-lip on very young and feeble infants. The great success of this operation of late years, in the first weeks of life, depends on the dexterity of the surgeon who performs the operation so quickly that scarcely any blood is lost. When Mr. Fergusson performs this operation, the infant is held by a nurse, who is seated opposite to him, whilst its head is placed in his own lap between his thighs. An assistant compresses the labial artery on the right side, by grasping the lip between his finger and thumb, just at the angle of the mouth; a sharp-pointed scalpel is pushed through the lip on the right side, just below the nose, and carried downwards so as to cut away the edge of the fissure; then the same performance is done on the left side of the fissure, while Mr. Fergusson compresses the labial artery on that side with the finger and thumb of his left hand. In about twenty seconds from the beginning of the operation, the hare-lip pins are introduced, and the cut edges of the lip being pressed together, the bleeding is at once entirely stopped. I have no doubt that many lives are saved by early operation, especially amongst the poor, as a child with a bad hare-lip cannot take the breast till it is operated on, and there is a very great mortality amongst infants brought up by hand.

The blood which escapes when the infant is laid on its back flows back into the throat, and it usually passes on each side of the epiglottis, and runs into the stomach without any act of deglutition. In a few cases of strong children, in whom the bleeding is rather free, the breathing gets embarrassed, and Mr. Fergusson turns the face of the child downwards for a moment to let the blood run out of its mouth. When the quantity of blood flowing into the throat is greater than can run down into the stomach, in the way I have mentioned above, the glottis closes and the breathing stops, which gives the indication for turning the

face downwards. I have seen a few operations in the hospital for hare-lip, without chloroform, whilst the children were on their backs. In these cases they cried violently from the pain, set the blood in the mouth into violent commotion, and then drawing a deep inspiration, drew a little of the blood into the larynx, which caused a violent cough; so that there was usually much more appearance of choking than in the cases where chloroform was given. Moreover, in these latter cases, it is usually towards the end of the operation that the children sometimes become embarrassed with the blood; not because the quantity of blood is greater, but because the sensibility is returning. I have seen one case which shows that the effects of chloroform, when deep or long-continued, will diminish the sensibility of the glottis. After an infant was made insensible some years ago for an operation for hare-lip, it was found that an instrument for dividing the projecting intermaxillary bone was wanting, and I kept the child insensible for several minutes, by administering chloroform occasionally, until the instrument was found; the bleeding was rather free, and some of it entered the windpipe and caused a tracheal râle. The child coughed it up on awaking, and no ill consequences followed; but the occurrence confirms the opinion previously expressed, that the insensibility should not be both deep and long-continued at a time when copious hæmorrhage is flowing into the throat. The effects of chloroform pass off very quickly in infants, and it is not often that they last till the operation of hare-lip is finished, short as that operation is. In private practice, indeed, when the parents of the infant are close by, I usually have an opportunity to apply a little chloroform, mixed with spirit, on a sponge, in the course of the operation, when it is required to prevent crying; but in the hospital, the children sometimes cry a little before the operation is concluded.

Cancer of the Lip. I have memoranda of nineteen cases of cancer of the lower lip, and three or four of the upper lip, in which I have administered chloroform. As there is never an easy chair in the operating theatre of an hospital, and it is difficult to keep the patient in a common chair when he is under the influence of chloroform, it is better to place the hospital patient on the operating table, with his head and shoulders raised during this operation; but in private practice the patient may either be placed on a sofa, or in a large easy chair with a high back. The effect of the chloroform often lasts to the end of the operation, if it be completed within two or three minutes; but I always go provided with a hollow sponge, and a mixture of chloroform and spirit to apply during the operation, if required.

Division of the Sensory Nerves of the Face. I have notes of nineteen cases in which I have administered chloroform during this operation. They were chiefly performed by Mr. Fergusson, but a few of them by Mr. Bowman. The operation is of so painful a nature, that I believe it was seldom performed before the practice of inhaling narcotic vapours was introduced. It is done subcutaneously, by means of a small sharp-pointed bistoury, by which the affected nerves are chopped up by twenty or thirty incisions, at and near the points where they issue from their respective foramina. In operating on the mental branch of the fifth nerve, the bistoury is sometimes introduced from the face, and sometimes from the interior of the mouth. The pain continues for two or three days, till the inflammation caused by the operation subsides, when there is usually a complete absence of pain for three or six months, at the end of which time the operation has often to be repeated. I am not aware whether the relief has been permanent in any case, but it has often been very complete for a time. One patient, on whom Mr. Fergusson operated in King's College Hospital, looked like

an old man at the time of the operation, but this was the effect of his severe suffering; for a week or two afterwards he looked his real age, which I think was less than forty. This operation is not performed for the milder cases of neuralgia, or for cases that can be cured by quinine or iron; but only for the more terrible forms of the complaint, which fortunately are somewhat rare. Rare as they are, however, they occur sometimes in near relatives.

Division of other Nerves of Sensation. I have notes of nine cases in which nerves in other parts of the body were divided, and a portion cut out, for neuralgia. On four occasions the nerve was situated in a stump following amputation; and on two occasions a tumour of the nerve was removed. The operations were performed by Mr. Fergusson, Mr. Solly, and Mr. Paget.

Operations on the Eye. The operations for cataract are frequently performed without chloroform, when the patient has sufficient resolution to keep his eye steady. I have, however, administered chloroform fifty-three times during the extraction of cataract; thirty of the cases occurred in the private practice of Mr. Bowman. On November 25th, 1851, I administered chloroform whilst Mr. White Cooper extracted a piece of flint from the interior of the eye; and on February 7th, 1852, whilst Mr. Bowman extracted the capsule of the lens. On February 17th of the same year, I assisted Mr. White Cooper with chloroform whilst he extracted a cataract from the eye of an elderly lady; and I assisted him in eleven other cases during that and the following year. I assisted Mr. George Pollock in two operations of the extraction of cataract in June 1852; and Mr. Lawrence in three operations in 1853. Eighteen of Mr. Bowman's operations were performed in the summer and autumn of 1854, and were of the usual kind; but in six out of the twelve cases in which I have since assisted him,

the cataract was first drilled and then removed, in a softened state, through a small opening in the cornea, by means of a small scoop. I have assisted Mr. Alexander in two cases, and Mr. Critchett also in two. Several of the patients were over eighty years of age.

The operation for the extraction of cataract is said not to be a painful one, but the patient requires to be as insensible during its performance as if he were about to undergo lithotomy, or a great amputation; without this, the eye and eyelids will not be steady. The insensibility must be kept up completely until the cataract is extracted.

It is necessary that the stomach should be empty when the patient inhales chloroform for this operation, in order that vomiting may, if possible, be avoided. There was a little vomiting in a very few of the cases in which I administered chloroform, but it was not attended with straining, and I believe it did no harm in any case. Mr. Bowman informed me of a case of his in which chloroform was administered in the Ophthalmic Hospital for the extraction of cataract, and the woman vomited violently afterwards, and the eye was destroyed. She, however, was a person of bad constitution, and the vomiting might have occurred without the chloroform. The patients were lying on a sofa in all the operations, except, I think, one by Mr. Alexander.

I have notes of nine cases of the drilling of cataract in which I have administered chloroform, and there were some other cases in 1848, of which I have no memoranda. Some of the early operations were performed by Mr. George Pollock, and the more recent ones by Mr. Bowman. Many of the patients were infants or children. There have been two cases of the removal of coagulated lymph from the interior of the eye, by Mr. Bowman and Mr. White Cooper; and six cases of the formation of artificial pupil, by the same surgeons, and Mr. Dixon; and in two cases lately, Mr. Bowman has removed a portion of the iris.

I have given chloroform in 25 cases of excision of the eyeball; 20 of the operations have occurred within the last two years, in addition to some in which I administered amylene. The whole of the operations were performed by Mr. Bowman, except one by Mr. Fergusson, and one by Mr. Hancock. The operation is of late years a much less formidable one than formerly, owing to the plan of commencing to dissect off the conjunctiva just around the cornea. After the eyeball is removed, the edges of the conjunctiva are drawn together by a fine suture, so that scarcely any wound is left, and the patient can generally begin to wear an artificial eye in four or five days. In cases of malignant disease extending beyond the globe, of course, the more formidable and extensive operation would still require to be performed.

I have administered chloroform for the removal of sparks of iron and other foreign bodies from the cornea, chiefly in cases in which the surgeon had previously tried without success. Under the influence of chloroform, the foreign matters were always removed very readily. There have also been operations for the removal of growths from the eye and granular growths from the conjunctiva, and also for staphyloma and pterygion.

I have memoranda of 54 operations for strabismus in which I have administered chloroform. The greater number of them were performed by Mr. Bowman, but several by Mr. Fergusson, and a few by other surgeons. One operation was performed by the late Mr. Dalrymple. Mr. Bowman generally operates on both eyes at the same time. A great number of the patients who have taken chloroform for this operation were children. They have nearly all been lying down during the operation.

There have been nine operations for ectropion and entropion, chiefly by Mr. Bowman. I have administered chloro-

form on four occasions whilst Mr. Bowman has performed a plastic operation for the formation of a new eyelid. On three occasions, the eyelid had been destroyed by a burn, and the material for the new one was taken from the integuments of the forehead. The operations were necessarily tedious.

Removal of Foreign Bodies and Polypi from the Ear. In May 1849, Mr. Henry Charles Johnson extracted a pea from the ear of a child, six years of age. The pea had been a month in the ear, and Mr. Johnson had endeavoured to examine the ear without chloroform, but could not do so. In May 1857, I administered chloroform to a child aged three years, a patient of Mr. Tuach, whilst Mr. Hewett extracted a glass bead with sharp edges from the ear. He got it out with a director. I have notes of four cases in which a polypus was removed from the ear by Mr. Partridge, Mr Fergusson, Mr. Henry Lee, and Mr. Henry Smith; and I recollect giving chloroform more than once at Mr. Toynbee's whilst he performed a similar operation, although I have no memoranda of the circumstances.

The Removal of Polypi and Foreign Bodies from the Nose. I have memoranda of fourteen cases in which I have administered chloroform for the removal of polypi from the nose. The operations were nearly all performed by Mr. Fergusson. The patient was nearly always seated in an easy chair, and the chloroform, in several cases, was repeated to keep up the insensibility till the operation should be completed. In one of the cases, the polypus caused a protrusion of the nasal bones; the nostril was slit up, and there was very great hæmorrhage as the polypus was brought away. The pulse became small for a time, but there was no syncope. The patient did well. In June 1852, I gave chloroform to a girl, five years old, and Mr. Fergusson scooped out some polypus growth from the right nostril, and also an oval

softened body, rather bigger than a horse-bean, which was a young orange that the child had pushed up her nose in India. The case had given rise to a good deal of difference of opinion amongst medical men in India and Malta, who generally discredited the child's account of the orange. In August 1856, Mr. Stanley removed a bean from the nose of a child.

Certain Operations in the Mouth. I have notes of six operations for cancer of the tongue, performed by the late Mr. Keate, Mr. Quain, Mr. Hancock, and Mr. Paget. Mr. Paget's was a case of epithelial cancer, in a lady, about twenty-five. The operation was one of excision of the tumour, and I lately heard that the patient remained free from the complaint. The other operations were by ligature. Mr. Quain's was a hospital patient, and I do not know the ultimate result of the case. The other patients had a return of the disease, and died after great suffering.

I have notes of ten operations for epulis, chiefly by Mr. Fergusson. The patient was generally on a sofa or the operating table, with the head and shoulders raised. As the operations were soon completed, the chloroform seldom required to be repeated. There have been some cases of cancerous disease of the gums and alveolar process in which I have administered chloroform. One of these was a patient of Mr. Bell, the dentist, on whom Mr. Hilton operated. I assisted the late Mr. Avery by giving chloroform in two operations for cleft palate. A large cork with a string to it* was kept between the molar teeth on one side during the operation; and the inhalation was repeated from time to time. The surgeon, however, much prefers to have the patient awake during this operation, when he can get his assent.

* I never allow of a cork or any such substance being put into a patient's mouth when insensible unless it is well tied to a string, lest it should be swallowed.

I have administered chloroform four times for the removal of the tonsils. Three times in children, and once in the adult. In the case of a child on which Mr. Curling lately operated, he removed one of the enlarged tonsils very easily and very well, but just as he was beginning to remove the other, the child began to vomit its breakfast, and the throat was afterwards so filled with mucus and blood, that we thought it better to defer the remainder of the operation till another day.

Plastic Operations. I have memoranda of 50 plastic operations in which I have administered chloroform, in addition to those on the eyelids, previously mentioned. Eight of the operations were for the formation of a new nose. Five of them were by Mr. Fergusson, two by Mr. Critchett when Mr. Fergusson was present, and one by Mr. Samuel A. Lane. I made the patients insensible with the inhaler before the operation was commenced, and afterwards kept up the insensibility by means of chloroform, diluted with spirit, on a hollow sponge. No fewer than 24 of the plastic operations were for the remedy or mitigation of deformity caused by burns. In fourteen of these cases, the operation was performed on the neck, but often extended to the breast and lower part of the face. The other ten operations were for burns on the face and arms and other parts of the body. Nearly all these operations were performed by Mr. Fergusson. One of his patients was a gentleman from New York, who had a most severe burn in the face when a child. The operations, without the action of a narcotic, would be of the most painful nature; and the greater number of those at which I have been present would not have been performed, except for the discovery of narcotism by inhalation. The remaining eighteen plastic operations were for a variety of purposes, such as replacing the loss of a lip, the closing of artificial anus, and of openings in the cheek, and a variety of other defects, either congenital, or

arising from injury or disease. They were nearly all performed by Mr. Fergusson.

Raising depressed Portions of Skull. In Dec. 1848, I administered chloroform to a gentleman in Norfolk, aged sixty-two, on whom the late Mr. Aston Key operated. The patient had been thrown from his horse four years previously, and probably kicked whilst on the ground. He believed that he did not lose his consciousness. There was a considerable depression of a portion of the right parietal bone, near its upper and posterior angle; but there were no symptoms of cerebral pressure or irritation for two years after the accident; but at that time he fell from his seat in some kind of fit, after which he had partial paralysis of the left arm, impaired vision, and a melancholy or apathetic state of mind. He was also subject to attacks of real or apparent suspension of breathing, and to occasional attacks of vomiting.

His ordinary medical attendant, Dr. Bell of Aylsham, objected to the chloroform, on account of feeble and irregular action of the heart, in addition to the above symptoms. The patient, however, became gradually insensible, without any unfavourable symptoms. After making incisions in the scalp, Mr. Key sawed out a good sized piece of the parietal bone with Hey's saw. The insensibility was kept up gently during the operation, which lasted above half an hour. There was pus under the bone, and the dura mater was diseased, and gave way during the operation. Mr. Key immediately expressed a bad opinion of the case. The patient recovered his consciousness in about a quarter of an hour, and in a little time was in the perfect enjoyment of all his faculties, being very cheerful, and in a totally different state from the one of apathy and almost unconsciousness, in which he appeared when we first saw him. He was attacked with inflammation of the brain on the third day, and died on the fifth.

In May 1855, I administered chloroform in St. George's Hospital to a young man who had been kicked by a horse. The frontal bone above the right eye was driven in to a good depth, and a little of the brain had escaped. Mr. Cæsar Hawkins cut a piece from the frontal bone, just above the depressed portion, with the bone forceps, to enable him to introduce the elevator. The depressed portion being quite loose, was removed, together with the roof of the orbit. The youth was partially comatose before chloroform was given, but made a resistance to the operation. A week after the operation, when I saw him, he was conscious, but feverish, and he died a week or two later.

Mr. Bowman, on one occasion, made an incision over the frontal sinus in a gentleman; and made an aperture in the outer table of the frontal bone, which gave exit to a quantity of pus which had been formed in the sinus.

In the summer of 1847 the late Mr. Liston performed a similar operation on a lady, the patient of Dr. Locock, who was present. I exhibited sulphuric ether on that occasion.

Operations for ununited Fracture. I have notes of seven operations by Mr. Fergusson and Mr. Bowman, for ununited fracture of the femur, humerus, radius, and ulna. The usual course has been to scrape and puncture the ends of the bones by subcutaneous incision, and where this has not succeeded, to cut down on the bones and saw off the ends; or to bore holes near the ends, and introduce ivory pegs.

The Reduction of Dislocations. I have notes of twenty-seven cases in which I have administered chloroform during the reduction, or attempted reduction, of dislocations. Only three of these were recent dislocations. One had existed a few days; and the other twenty-three for some weeks or months. Twelve of the operations were performed by Mr. Fergusson, and the others by Mr. Cæsar Hawkins, Mr. Cutler, Mr. Bransby Cooper, Mr. Partridge, Mr. Tatum, Mr.

H. C. Johnson, Mr. Charles Hawkins, Mr. Hewett, Mr. Henry Lee, and Mr. Price. Most of the dislocations at the shoulder were quite successfully reduced; one of them by the late Mr. Bransby Cooper, as long as ten weeks after the accident. Dislocations of the hip were successfully reduced in three weeks and five weeks after the accident. At longer periods, dislocations of the femur were often benefited by the operation, but not completely reduced. The dislocations at the elbow were not successfully reduced except when recent, although the position and motion of the forearm were improved in several cases by the operation. Pulleys were applied, often for a length of time, in the old dislocations; and many even of the successful operations could not have been performed except the patient had been in a state of anæsthesia. A full dose of chloroform is required in the attempts to reduce old standing dislocations, in order to suspend, as nearly as may be, the resistance of the muscles.

Forcible Movement of Stiff Joints. I have given chloroform in twenty-two operations of this kind, within the last three years, for the restoration of motion in the knee, elbow, and hip, after the joints had become fixed in one position, generally by adhesions resulting from disease. The first operation of the kind in which I assisted was one performed by Mr. Brodhurst, whom I have since assisted more frequently in these kind of operations than any other surgeon; but other operations have been performed by Mr. Fergusson, Mr. Cæsar Hawkins, Mr. Partridge, Mr. Bowman, Mr. Hewett, and Mr. Edwin Canton. These operations would evidently not have been performed except for the discovery of producing a state of anæsthesia by inhalation.

Tenotomy. I have memoranda of 78 cases of tenotomy in which I have administered chloroform. In some of the cases which have occurred during the last two or three years, forcible movement of a stiff joint has been resorted

to, in addition to the tenotomy. I applied chloroform in St. George's Hospital in tenotomy, when the agent was first introduced; and have also given it in King's College Hospital for ten years. During these ten years I have also administered chloroform to a number of the private patients of Mr. Fergusson, whilst he has performed tenotomy, and to those of other surgeons occasionally. During the last three years, I have given it in several operations by Mr. William Adams. I understand that several orthopædic surgeons had, at one time, an objection to chloroform in tenotomy, from an impression that it would relax the muscles, aud thus render the operation less easy of performance. But it is altogether unnecessary to carry the effects of chloroform so far as to relax the muscles. The pain of this operation can always be prevented without relaxing the muscles, which are indeed often more tense than if the patient were awake.

Operations for Strangulated Hernia. I have notes of only nineteen cases of operations for strangulated hernia in which I have administered chloroform since the end of 1849. This operation is, I believe, often performed without the use of this agent. Fifteen of the cases in which I have exhibited chloroform were inguinal or femoral hernia, and four cases were umbilical hernia. In these latter cases, the patients all died.

In one of the cases, there was a complication, in addition to the hernia. The patient was an old gentleman, and the surgeon had directed him to apply ice and salt, and had either given no directions respecting the time it was to be applied, or the directions were misunderstood. The patient was a scientific man, and applied the ice and salt most effectually for about four hours. When we arrived, a portion of the integuments around the umbilicus, larger than the palm of the hand, was as hard as a board, and of a dull

white colour. The surgeon said that he could not turn back the flaps of the integument, if he made them whilst it was in that hardened state. The part thawed whilst the patient was inhaling chloroform, and when the incisions were made some fluid blood of a light crimson colour flowed. Iced water was applied to the part immediately after the operation, for a short time. The integuments which had been frozen sloughed two days after the operation. The patient had peritonitis, and died on the fifth day.

On March 6th, 1848, a man was placed on the operating table in St. George's Hospital, with a strangulated femoral hernia. I administered chloroform to him at the request of Mr. H. C. Johnson; and when he became completely insensible and the muscular system relaxed, Mr. Johnson readily reduced the hernia by means of the taxis, although it was previously quite incapable of reduction. If the taxis had not been successful, the operation, for which the instruments were arranged ready, would at once have been performed whilst the patient was insensible. I do not think that chloroform has been sufficiently employed of late years during the application of the taxis to strangulated hernia.

In every case in which sickness was present, it was relieved by the chloroform. And vomiting returned in scarcely any instance, after the chloroform, so long as I remained in the room.

Operations for Hæmorrhoids and Prolapsus Ani. I have memoranda of 171 operations for these affections in which I have administered chloroform. A great number of these operations have been performed by Mr. Fergusson and Mr. Salmon; but I have also assisted Mr. Cæsar Hawkins, Mr. Bowman, Mr. Quain, Mr. Erichsen, and a number of other surgeons, whilst performing this operation. The patient always lies on one or the other side during this opera-

tion, with the knees drawn up towards the stomach. The chloroform should be inhaled till the patient is quite insensible, that is, till the edge of the eyelid can be touched without causing winking, otherwise he is apt to stretch out his legs, as soon as the operation is commenced. Ligatures always, or nearly always, introduced with a needle, have been applied to the mucous membrane in every case both of hæmorrhoids and prolapsus ani, except in two or three in which Mr. Henry Lee applied nitric acid and the actual cautery. In a great number of the cases, however, folds of redundant and diseased skin were cut away from around the anus, with a pair of large curved scissors, after the ligatures had been applied to the mucous membrane. It is the rule in these cases never to cut the mucous membrane, and never to tie the skin. It is desirable to get the patient to protrude the hæmorrhoids by bearing down at the night stool before he inhales the chloroform, and they always remain protruded during the operation; indeed, there is generally a good deal of bearing down during the operation under chloroform, and if the bowels have not been entirely emptied, they are apt to act as the operation is being performed. It is customary, and very desirable, to give a full dose of opium almost as soon as the patient wakes from the chloroform, to diminish the pain caused by the ligatures. I have, in a few cases, continued to administer the chloroform at intervals for an hour or two after the operation, till the opium began to take effect; and I consider that it would be useful, in some cases, to give the opiate two or three hours before the operation. I administered chloroform to two ladies, one a patient of Mr. Bowman, and the other of Mr. Wm. Adams, whilst hæmorrhoids were removed by the écraseur. The operations lasted rather more than half an hour; but the chloroform, after the commencement of the operation, required only to be kept up to a moderate

extent. There was no hæmorrhage in either case; and it seemed to me that the great pain which is caused by the presence of the ligatures would be prevented by this means of operating.

Hæmorrhoids and prolapsus ani are peculiarly prevalent in the upper class of society. That small portion of English people who dine in the evening seem to furnish more cases of hæmorrhoids for operation than all the rest of the population. And I am inclined to attribute the circumstance to the habit of taking the greater part of the food towards the close of the day, after a long fast; by which means congestion of the liver, and obstruction to the return of blood from the bowels is induced. Many of the patients with hæmorrhoids are ladies who are far from luxurious in their habits, indeed many of them are abstemious; and many of the male patients are the reverse of sedentary, as they spend a great part of their time in hunting, and other field sports. Again, the complaint cannot in my opinion be attributed to highly seasoned food, as I think the working classes use more pepper than fashionable people. I am inclined to believe that the habit of taking the chief meal of the day at twelve or one o'clock, is the principal reason why bad cases of hæmorrhoids are comparatively so rare in the working and middle classes, many of whom live luxuriously, and are more sedentary in their habits than the higher class of society.

Several of the patients operated on for hæmorrhoids were extremely blanched, from the continued loss of blood arising from the disease; but these patients underwent both the action of the chloroform and the operation very well. The operation, it must be remembered, is not attended with loss of blood.

Fissure of the Anus. I have notes of forty-four cases in which I have exhibited chloroform in operations for the cure

of this disease. Two of them were performed by the late Mr. Copeland. The sphincter ani was divided in the greater number of the operations. In addition to these cases, there were some in which fissure existed, along with hæmorrhoids, or fistula *in ano*. The patient was always placed on his side, in the same position as in the operation for hæmorrhoids.

Operations for Fistula in Ano. The position of the patient in this operation should be the same as in those for hæmorrhoids and fissure of the anus, unless the patient is placed on the back, in the lithotomy position, as I have seen in a few cases.

I have memoranda of 218 cases in which I have given chloroform in operations for fistula *in ano*. In many of the cases the sinuses were very numerous and extensive. It is necessary that the patient should be quite insensible during this operation, to prevent the possibility of his moving suddenly whilst the bistoury is being used.

Operations on Ovarian Tumours. I have notes of three cases in which I gave chloroform during the removal of an ovarian cyst. The first of these was in March 1850. Twenty-four pints of liquid were first evacuated from the tumour. It consisted of four cysts united together, two of which contained serous fluid of slightly different colour; the third contained serum tinged with blood, and the fourth and smallest cyst, a purulent fluid. An incision was made, twelve or fourteen inches in length, extending from the pubes to midway between the umbilicus and sternum. Some slender adhesions were removed at one spot. The tumour was attached by a membranous pedicle, with the left iliac fossa, and the fundus of the uterus. Needles were passed through the pedicle, and it was tied in three or four portions, when the tumour was removed. After the tumour was removed, the patient seemed to breathe entirely by the

ribs, the diaphragm remaining relaxed, and not contracting, whilst the wound in the abdomen was being closed. Scarcely any blood was lost during the operation. The patient died of peritonitis early on the fourth day.

The next case occurred on August 27th, 1850, and is reported in the *Medico-Chirurgical Transactions* for 1851. Mr. Duffin was the operator, and the patient made a favourable recovery.

The third operation was performed on the 31st of January, 1854. The patient was a spinster, twenty-eight years of age, and the tumour had not been tapped. It contained about two gallons of clear fluid, and was removed through an opening in the median line above the umbilicus, about seven inches in length. There was no depression when the patient awoke after the operation. She died within three days.

I administered chloroform in two cases where it was intended to remove an ovarian cyst. In one case the cyst was so adherent to the peritoneum that it could not be removed; in the other case, there was no cyst, but some serum in the peritoneal cavity, and a tumour growing from the fundus of the uterus. This tumour was allowed to remain. Several medical men, in addition to the operator, had diagnosed an ovarian tumour in this case. These two patients recovered.

I exhibited chloroform in four operations in which an ovarian cyst was opened, and the cut edges of it sewed to the wound in the abdominal parietes. These four patients, I believe, all died. I am quite certain as regards three of them.

On March 10th, 1852, I administered chloroform in St. Mary's Hospital to a woman, apparently about thirty-five, who had suffered from an ovarian cyst about eighteen years. Mr. Isaac Baker Brown made an incision, about six inches

in length, into the peritoneal cavity, drew out a portion of the cyst, tapped it, and removed several pints of clear serum. He then cut away a piece of the anterior wall of the cyst, about as large as the hand, and allowed the rest of the cyst to remain loose in the abdomen. The wound in the parietes of the abdomen was stitched up. If I remember rightly, the patient died, but I have no note of the result.

Operations for Cancer of the Vagina. I have notes of eighteen cases in which I have given chloroform for operations of this kind by the knife, which would have been extremely painful without the use of an anæsthetic.

I exhibited this agent, in 1848, to a lady, whilst the late Mr. Aston Key applied the actual cautery to malignant excrescence of the os uteri; and I have administered it in several cases in which potassa and other caustics have been applied to the os uteri. In operations on the vagina or perineum, the woman should inhale chloroform whilst lying on her back; and when insensible, should be drawn to the edge of the bed, or the foot of the operating table, and have the knees held back and separated.

Operations for Rupture of the Perineum. I have notes of fourteen operations for this accident. Six of them were performed by Mr. I. B. Brown, five by Mr. Fergusson, and the others by Mr. Paget, Dr. Protheroe Smith, and Mr. Henry Lee. Mr. Fergusson has, in five cases, performed an operation for prolapsus uteri, by paring the edges of the outlet of the vagina, and stitching them together so as to diminish the orifice.

I have given chloroform in several operations for vesico-vaginal fistula, some of which were performed by Mr. Spencer Wells; and also for the removal of warts and other growths from the labia pudendi, either by the knife or caustics.

Removal of the Testicle; Amputation of the Penis, etc. I have memoranda of twenty-seven cases in which I have ad-

ministered chloroform during the removal of a testicle, generally for malignant disease; and six cases in which I have administered it for amputation of the penis, always for malignant disease. There were six operations, also, in which a part of the penis was removed for malignant disease; and eleven cases in which warts were removed from the glans penis, generally with the knife. In two cases in August 1854, Mr. Acton destroyed a number of venereal warts on the glans penis and prepuce by a caustic composed of potassa and lime. In all the operations on the testicle and penis, under chloroform, the patients have been lying on the back.

Operations for Phymosis. I have memoranda of 76 operations for phymosis, in which I have exhibited chloroform. The operations were generally in the adult, although the complaint was, in most cases, congenital. I have known two cases in which cancer of the penis was produced by the patient's suffering a congenital phymosis to remain to about the age of fifty. The cancer commenced in the glans from the irritation of the retained urine. One of the patients died of the disease.

Removal of enlarged Bursa. I have notes of six cases in which the bursa of the patella was dissected out by the surgeons of King's College Hospital for housemaid's knee. The patients were charwomen and domestic servants. In two cases a bursa was removed from the forefinger.

Evulsion of the Nails. I have notes of twenty-five cases in which I have given chloroform for cutting down the nail of the great toe, and tearing away the whole, or the two edges of it; and also of three cases in which one or more finger-nails were removed by a similar process. This operation is one of the most painful of the minor operations of surgery. It is better that the patient should be lying when it is done under chloroform.

Laryngotomy. I administered chloroform to one or two infants in which Mr. Henry Smith performed laryngotomy for croup. I also administered it, on four occasions, to a patient of Mr. Partridge, a boy four years old, who was believed to have a button in some part of the air-passages. The larynx had been opened a few days previously to the first occasion in which I gave chloroform, and I administered it on a sponge, held near to the tube in the larynx. It was necessary to give the vapour gently at first, just as if it was entering in the usual way. When it was given at all strong, whilst the patient was still conscious, he showed exactly the distress that a patient experiences when he says that the vapour produces a choking feeling; which confirms my opinion that the feeling referred to the throat, from the action of pungent vapours and gases, is caused by their presence in the lungs. The chloroform was given to keep the child quiet whilst Mr. Partridge searched for the supposed button in the larynx and bronchi. When the child recovered from the chloroform, before the operation was concluded, the explorations in its air-passages embarrassed the breathing much more, and caused more apparent threatening of suffocation, than they did when he was under the influence of the vapour. This little boy remained for months in King's College Hospital; and at last the embarrassment in his breathing subsided, the tube was removed from the larynx, and the wound allowed to heal; and he left quite well, although the button, which was supposed to have gone down his windpipe at the moment when his symptoms first suddenly came on, was never found.

I have administered chloroform in a great variety of surgical operations, in addition to those mentioned above, but as they required only the usual management in the application of the vapour, I need not allude to them, but shall, however, make a few remarks regarding dental operations.

Extraction of Teeth. It is the custom in the medical journals and medical societies, to object occasionally to the use of chloroform in tooth-drawing, as if the operation were not sufficiently severe to require it. I will say nothing of the wives and daughters of medical men in connexion with this subject, but will only allude to the case of an elderly lady, who had for thirty years been the private friend, as well as the patient, of one of the Council of the College of Surgeons. After she had had ten necrosed teeth extracted, and had awakened from the effects of the chloroform, her friend and surgeon, who had been looking on, discoursed eloquently on her case, explaining how the state of her mouth was ruining her health; how impossible it would have been for her to go through the operation without chloroform, and what a great advantage it was.

Dr. Watson says in his Lectures:* "I am not at all sure that the increased longevity of modern generations is not, in some degree, attributable to the capability of chewing their food which the skill of the dentist prolongs to persons far advanced in life." I have seen at least fifty cases in which the dentist has been able to exert his skill in enabling his patient to masticate only by the aid of chloroform; cases of feeble, aged, or debilitated persons, whose mouths contained between twenty and thirty stumps of teeth or necrosed teeth; and who were able to get rid of them all at two or three operations a few days apart; but without the opportunity of being made insensible, would undoubtedly have continued with the mouth in a tender and painful state.

It was in consequence of the relief afforded by nitrous oxide gas, in pain caused by a tooth, that Sir Humphrey Davy suggested its application in surgical operations; it was for the extraction of a tooth that Mr. Horace Wells first carried out the suggestion of Davy; and it was in the

* Fourth edit., vol. ii, p. 467.

extraction of teeth that Dr. Morton first employed sulphuric ether as a substitute for nitrous oxide gas. These circumstances seem to point to a demand for anæsthetics in operations on the teeth; and when the great frequency of these operations is considered, it is probable that more pain may be prevented during their performance than in any other class of operations.

I have notes of 867 cases in which I have administered chloroform during the extraction of teeth, chiefly by dentists living in this neighbourhood: amongst whom are Mr. Saunders, Mr. Cartwright, Mr. Samuel Cartwright, Mr. Arnold Rogers, Mr. Thomas A. Rogers, Mr. Tomes, Mr. Bigg, Mr. Crampten, Mr. F. W. Rogers, Mr. Alfred Canton, Mr. Woodhouse, Mr. Lintott, Mr. Rahn, Mr. Vasey, Mr. Sercombe, Mr. Fletcher, and several others; and there is one dentist in the City, Mr. West of Broad Street, whom I have frequently assisted. The number of teeth, or stumps of teeth, extracted in these 867 operations, has been about 3021. In some cases in which several teeth have been removed, I have not been sure of the exact number, but have put down about the number.

The number of teeth extracted at an operation has varied from one to nineteen. The latter number was extracted by Mr. Canton on one occasion, and on two or three occasions, Mr. Arnold Rogers and Mr. Samuel Cartwright extracted seventeen at one sitting; but these gentlemen and others, as well as myself, have thought it better, as a general rule, to make more than one operation, when the number of teeth to be drawn exceeded ten, in order that the mouth might not contain too many wounds at one time, and that the loss of blood might not be very great. A great number of the operations have been for the extraction of the four first permanent molars, in children about thirteen, as these teeth are very apt to decay at an early period.

I have on 181 occasions, of which I have memoranda, given chloroform for the extraction of a single tooth. I exhibited it lately to a lady, aged eighty-six, whilst Mr. Bigg extracted an abortive wisdom tooth, which had recently come through the gum, and was giving pain. She awoke in about two minutes after the operation, and was quite cheerful and well.

The patients have been seated in an easy chair in all the operations on the teeth, except in a very few cases where a female patient was too ill to sit up. In many cases, and always if there was any feeling of faintness, the patient has been placed on a sofa, after the operation, for twenty minutes or half an hour. I am not aware of any inconvenience from the chloroform, in any of the cases of tooth-drawing, excepting sickness and vomiting, which in a very few of the cases have been troublesome for some time.

It is necessary in tooth-drawing to make the patient unconscious, and to continue the chloroform a little while after unconsciousness is induced, till the sensibility of the edge of the eyelid is very much diminished, or almost altogether suspended, otherwise the patient will probably make a resistance that will interfere with the operation, or scream out and alarm his or her friends. I nearly always take about four minutes in the inhalation. It is not desirable to take longer than five or six minutes, as the patient would be slower than is desirable in recovering completely from the effects of the vapour.

The patient is usually in the third degree of narcotism when the operation is performed, and, in this degree, as was previously stated, there is not unfrequently a contracted and rigid state of the muscles. This state often affects the muscles of the jaws, and interferes with the opening of the mouth, if it be closed. I generally tell the patient to keep his mouth open whilst inhaling, and by that

means it often remains open when he is insensible. Not unfrequently, however, he closes it on becoming insensible. One can generally open it by pressing on the chin; but as the chin does not afford a very favourable hold, there are a very few cases in which the mouth cannot be opened easily in this way, at least not unless the effects of the chloroform are carried further than is desirable for these operations. I therefore carry with me a little instrument of two blades, made to open by means of a screw. The ends of the blades are covered with leather, and, if introduced between the teeth, at the corner of the mouth on the side opposite to that on which the dentist is about to operate, the mouth can easily be opened.* The power of the instrument is only such that I can scarcely open it with one hand, when I hold the blades with the other. It would not enable one to open the mouth of an adult if he were closing it by voluntary power; but the spasm caused by chloroform is very much less powerful than the action of the muscles when influenced by the will. I never use the instrument for opening the mouth when the patient is closing it voluntarily under the influence of a disordered consciousness, but always wait till consciousness and volition are entirely suspended. When the mouth is once opened, it can generally be kept open with the fingers, and the instrument may be withdrawn.

The bleeding during tooth-drawing is never so free as to interfere with the breathing; but when more than two or three teeth are extracted, and especially if they be in the back part of the mouth, some of the blood which escapes nearly always flows into the stomach; it flows down the fauces and œsophagus usually without any act of deglutition; but the evidence of its having gone into the stomach is obtained in those cases where the patient vomits. In

* It was made by Mr. Matthews, Portugal Street. It was not contrived by me.

consequence of the blood flowing into the stomach, vomiting cannot so generally be prevented by the precaution of not taking a meal before the operation in tooth-drawing as in other operations; but the sickness usually subsides as soon as the patient has emptied his stomach.

The chloroform has occasionally to be repeated in tooth-drawing before the operation is completed, especially in cases where several teeth require to be extracted. When this is the case, I always reapply it as soon as the patient begins to show signs of feeling the operation, without waiting till he recovers his consciousness. In many cases, however, a number of teeth are extracted without any repetition of the chloroform; and in the instances in which as many as fifteen, seventeen, or nineteen teeth were extracted at one operation, it was chiefly because the first application of the vapour enabled the dentist to take out such a number, otherwise, in most of these cases, a number of the teeth would have been left for a succeeding operation. It has occasionally happened, however, that the chloroform has required to be repeated, once or twice even, for the extraction of a single stump. When the chloroform is repeated once or twice, it is generally a longer time before the patient is able to leave the dentist's house. I always request the patients who are operated on at the dentist's, to drive home, as it is not advisable to walk, or use any exertion for an hour or two after the action of chloroform. Indeed, the patient is usually disinclined for any exertion for twenty minutes or half an hour after the influence of this agent, and sometimes for much longer; although I have seen a patient mount the box of a sort of dog-cart, and drive himself away, within five minutes after having several teeth extracted whilst he was in a state of complete insensibility from chloroform.

I have administered chloroform in a great number of

cases for the destruction of the nerves of the teeth. The patient requires to be made as insensible in this operation as in tooth-drawing.

Secondary Hæmorrhage after Operations. The hæmorrhage which occasionally comes on several days after an operation, from sloughing, ulceration, or the non-formation of a coagulum in an artery, is probably as liable to occur now as formerly; but I believe that hæmorrhage, a few hours after an operation, is much less frequent since the practice of narcotism by inhalation. Before this practice, it was extremely common for the patient to faint during an operation, when the bleeding of the smaller arteries stopped, and they escaped the ligature, to break out in hæmorrhage occasionally afterwards; but under the influence of narcotic vapours it is unusual for the patient to faint, and consequently every vessel which is capable of bleeding is tied during the operation.

CHLOROFORM IN PARTURITION.

When the practice of inhalation in midwifery was first introduced by Dr. Simpson, he very naturally adopted the plan which is usually followed in surgical operations, making the patient unconscious at once, and keeping her so to the end of the labour. It was soon found, however, by other practitioners, that this is not necessary; and, indeed, it would not be safe in protracted cases. Drs. Murphy and Rigby were, I believe, amongst the first to state, that relief from pain may often be afforded in obstetric cases, without removing the consciousness of the patient; and I soon observed the same circumstance.* Some persons, indeed, have alleged that the pain of labour can always be prevented, without making the patient unconscious of surrounding objects; whilst others have asserted that no relief can be

* London Journal of Medicine, vol. i, pp. 54, 976.

afforded unless unconsciousness be induced. But both these opinions are directly opposed to experience. There are comparatively few cases in which the suffering can be prevented throughout the labour without interfering with consciousness, although there are very many cases in which it can be in this way prevented in the early part of the labour. This difference depends, in some measure, on the constitution of the patient, but chiefly on the severity of the pain to be prevented. It is in accordance with what is observed in medical and surgical cases, that the pain should be removed, in some instances, without abolishing consciousness, and that in other instances it should not; for, in certain cases of neuralgia, the pain is so severe, that no material relief can be obtained by chloroform as long as consciousness is retained; and in surgical operations, although it now and then happens that the minor and concluding parts of an operation, such as tying vessels and introducing sutures, can be performed without pain, whilst the patient is consciously looking on, a free incision in the skin can hardly ever be made, under similar circumstances, without pain.

With regard to the cases of labour in which chloroform may be employed, it will be readily conceded that, in cases where the pain is not greater than the patient is willing to bear cheerfully, there is no occasion to use chloroform; but when the patient is anxious to be spared the pain, I can see no valid objection to the use of this agent, even in the most favourable cases. The benefits arising from chloroform in severe cases of labour are experienced in a lesser degree in favourable cases; and the patient may be fairly allowed to have a voice in this, as in other matters of detail which do not involve the chief results of the case. The determination of the kind of labours in which chloroform should be used, or withheld, is really a matter of not much importance, because, as we pass from cases that are severe and

protracted to those which are short and easy, the quantity of chloroform that is used, and the amount of diminution of the common sensibility, and of interference with the mental functions, become so trifling, that very little remains about which to hold a discussion. Indeed, from what I have observed of the continued use of this agent in medical cases, and its use by healthy persons for experiment, I believe that the quantity which is inhaled in a short and easy labour might be continued daily for an indefinite period, without appreciable effect on the health.

The above remarks apply also, in some measure, to the question as to the period of the labour when the exhibition of chloroform should commence; for, in proportion as the pains are feeble, it must be more sparingly administered. The most usual time when the accoucheur and I have determined that the inhalation should be commenced, has been when the os uteri was nearly dilated to its full extent, and the pains were taking on an expulsive character. In many of the cases which I have attended, it has, however, been commenced much earlier; for the suffering caused by the dilating pains in the first stage of labour is often very great, and the chloroform is consequently of the utmost service when employed at this time.

As regards the manner of giving chloroform, I shall first allude to cases not requiring manual or instrumental assistance. In such cases, when it has been determined to resort to inhalation, the moment to begin is at the commencement of a pain; and the chloroform should be intermitted when the uterine contraction subsides, or sooner, if the patient is relieved of her suffering. It is desirable to give the chloroform very gently at first, increasing the quantity a little with each pain, if the patient is not relieved. The practitioner easily finds, with a little attention, the quantity of vapour which it is desirable to give at

any stage of the labour, and in each particular case; his object being to relieve the patient without diminishing the strength of the uterine contractions and the auxiliary action of the respiratory muscles, or with diminishing it as little as possible. At first, it is generally necessary to repeat the chloroform at the beginning of each "pain"; but, after a little time, it commonly happens that sufficient effect has been produced to get the patient over one or two uterine contractions without suffering, before it is resumed.

The external evidences of the uterine contractions continue as before, when the patient is rendered unconscious by chloroform; and the muscles of respiration are called freely into play, to assist the action of the uterus in the second stage of labour. The aspect of the patient under these circumstances, is generally that of one who is suppressing the expression of her sufferings; and any relative or friend who comes in, without knowing that chloroform has been given, begins to praise the unconscious patient for her fortitude. On some occasions, indeed, there are groans and cries, as of suffering; but the mind being unconscious of pain, it can hardly be said to exist.

It may be remarked, that complete anæsthesia is never induced in midwifery, unless in some cases of operative delivery. The diminution of common sensibility to a certain extent, together with the diminution or removal of consciousness, suffice to prevent the suffering of the patient during labour; and she never requires to be rendered so insensible as in a surgical operation, when the knife may be used without causing a flinch or a cry. The nerves of common sensation must be allowed to retain their functions to a certain extent during labour; otherwise the assistance of the respiratory muscles, which consists of reflex action, or "motion arising from sensation, without the aid of voli-

tion", would not take place, even if the contractions of the uterus should still continue.

The effects of chloroform on the brain should not be carried during labour beyond what I denominate the second degree of narcotism, or that condition in which the mental functions are diminished, but not altogether suspended, except when the effect of the vapour is associated with natural sleep. The patient under the influence of chloroform to this extent, has no longer a correct consciousness of where she is, and what is occurring around her, but is capable of being aroused to give incoherent answers, if injudiciously questioned. In this state, the patient will sometimes assist the labour by bearing down voluntarily, if requested to do so, and be otherwise obedient to what is said; and by withholding the chloroform for a few minutes, she at any time becomes quite conscious. As a general rule, it is desirable not to hold any conversation whilst the patient is taking chloroform, in order that her mind may not be excited. The plan mentioned above, of giving the chloroform very gently at first, also has a tendency to prevent its causing mental excitement, the patient coming gradually under its effects. In surgical operations, excitement of the mind can nearly always be avoided by carrying the patient pretty rapidly into a state of insensibility, in which the mental functions are necessarily suspended. But in the practice of midwifery, it is not allowable to cause a state of coma or insensibility, except in certain cases of operative delivery, hereafter to be mentioned.

I nearly always employ, in obstetric cases, the inhaler that I use in surgical operations. There is not the same necessity for an accurate means of regulating the proportion of vapour in the air which the patient is breathing during labour, where but a trifling amount of narcotism requires to be induced, as in surgical operations, where a deeper

effect is necessary; still I find the inhaler much more convenient of application than a handkerchief, and it contains a supply of chloroform which lasts for some time, thereby saving the trouble of constantly pouring out more. When I do administer chloroform on a handkerchief during parturition, I follow the plan of putting only ten or fifteen minims of chloroform on the handkerchief at one time.

The quantity of chloroform administered during any one pain, never exceeds a very few minims; but the quantity used in the course of a protracted labour is often considerable. I have several times used from four to six ounces; and in one case, at which I was present the greater part of the time, seventeen fluid ounces of chloroform were used with the inhaler, which would produce as much effect as three or four pounds used on a handkerchief. The inhalation was continued with intermissions over a period of thirty-one hours. The patient was unconscious during the greater part of the last five or six hours, but previously to this, her constant complaint was that she had not enough chloroform. She was the wife of a physician, was thirty-seven years of age, and in her first confinement. The membranes ruptured early. The labour was natural, but there was excessive sensibility. The first twenty-six hours of intermitted inhalation were during the first stage of labour.

Chloroform can be best applied when there is an additional medical man, who has not to attend to the ordinary duties of the accoucheur; but it can be given very well by the accoucheur himself, so as to save the greater part of the suffering of labour; although he perhaps cannot always administer it in the perfect way in which he could, if he had no other duties to divide his attention.

It is probable that the use of chloroform has no particular influence over the duration of labour, in the whole number of cases in which it is employed; but individual

labours are occasionally either retarded or quickened by it, according to circumstances. In some cases, the chloroform, even when very moderately employed, diminishes both the strength and the duration of the uterine contractions, and prolongs the interval between them, thereby making the labour somewhat longer—a matter of no consequence, however, as the patient is not suffering in any way. In other cases, the inhalation causes the uterine action to become stronger and more regular, by removing the excess of sensibility by which it has been interfered with. This occurs more particularly in the first stage of labour. In some cases, also, the chloroform seems to act as a direct stimulant to the uterine contractions, increasing their force and frequency—a circumstance at which we need not be surprised, when we remember that both opium and brandy, in moderate quantity, often act in the same manner. Chloroform has also the effect of promoting the dilatation of the os uteri in many cases, even when no rigidity exists; and when there is rigidity of the os uteri, the inhalation is of the utmost service, and shortens labour very much. This is the case, also, when there is rigidity of the perineum.

When the forceps have to be applied, it is desirable to make the patient insensible, as if for a surgical operation just before they are applied; and to leave off the chloroform as soon as they are introduced, in order to allow of the uterine action to return, and assist in the delivery. I have always found the action of the uterus return immediately after the forceps were introduced; and where the child was not delivered at once, I have continued the chloroform in sufficient quantity to keep the patient unconscious, whilst allowing the uterine contractions to continue.

I have administered chloroform on nine occasions in which the forceps were applied; in four of the cases, I was sent for in consequence of the operation being required;

and in the other five cases, I was in attendance from an early part of the labour, and had administered chloroform more or less for some hours before the forceps were applied. They were applied in three instances by Dr. Murphy, twice by Dr. Ramsbotham, and in the other cases by Drs. Farre, Frere, and Thudichum, and Mr. Peter Marshall.

I have administered chloroform in two cases of craniotomy, both of which were performed by Dr. Murphy, on account of deformity of the pelvis. The amount of chloroform scarcely requires to be increased during this operation beyond what would be given according to the strength of the pains which may be present at the time.

In the operation of turning the child, the mother requires to be made quite insensible, in order that the uterine contraction may be entirely suspended till the legs of the child are brought down, when the inhalation should be discontinued to allow the contraction of the uterus to return. I have notes of six cases of turning the child, in which I have administered chloroform. The first case, which occurred in 1848, was one of natural presentation, in which turning was performed by Dr. Murphy, on account of narrowness of the pelvis, and the impossibility of applying the forceps; the introduction of the hand was difficult on account of want of space, but the uterus offered no resistance. Dr. Murphy has related the case. Three of the other instances of turning were performed by Mr. French, in cases which had been attended by midwives, and the membranes had been ruptured for several hours. The shoulder and part of the chest were in each case pressed down into the pelvis, and the pains were very strong; yet under a full chirurgical dose of chloroform, the child was turned as easily as if the membranes had not been ruptured. In the first of these three cases, the child was dead before the operation commenced. In the other two, it was born alive. In the

last case, the membranes had been ruptured for ten hours before the operation was performed. After the child was delivered, there was found to be a second child presenting naturally, but I did not stay to give any more chloroform. The fifth case of turning was performed in a case of elbow presentation by Mr. Peter Marshall. The membranes had been previously ruptured. I administered chloroform, also for Mr. Marshall, in a case where the hand was presenting below the head; he raised it above the head, and as it did not come down again when the pains returned, the labour was allowed to pursue its natural course, and terminated favourably in two or three hours, the child being alive. The chloroform was not continued after the operation was performed. The remaining case of turning was performed by Mr. Tegart, of Jermyn Street. I was in attendance with him from an early stage in the labour, and the operation was performed before the membranes were ruptured.

I administered chloroform, in 1849, in a case in which Dr. Murphy had to make an artificial os uteri. The patient was, of course, made quite insensible as for any other surgical operation; and the vapour was continued afterwards in a modified degree till the labour was completed.

On December 26th, 1850, I was requested by Mr. Cooper, of Moor Street, Soho, to assist him in a case of retention of the placenta. The patient had given birth to a child two hours before, and Mr. Cooper had introduced his hand, but had been unable to bring away the placenta, on account of firm contraction of the uterus in a sort of hour-glass form. On the chloroform being administered, the hand was easily introduced, and the placenta detached, and extracted. There was very little hæmorrhage.

In some of the many cases at which I have met Dr. Cape, premature labour was induced about the eighth month of utero-gestation, by rupturing the membranes, on account of deformity of the pelvis.

In a case attended by Mr. Cantis, the patient was suffering from osteo-sarcoma of the bones about the shoulder. Dr. Ferguson was present during the latter part of the labour. The lady lived a few weeks after her confinement.

A patient, attended in her confinement by Mr. Colambell of Lambeth, in 1853, to whom I gave chloroform, had been long under the care of Dr. Williams with cavities in the lungs. I heard very lately that she was still living.

A patient of Mr. Robert Dunn, to whom I gave chloroform in her confinement, was at the time in a state of insanity.

In one of the patients whom I have attended with Dr. Arthur Farre, there was separation of the recti muscles of the abdomen; which there is no doubt must have taken place gradually during pregnancy. The patient was but twenty years of age, and in her first labour. Quite early in the labour, before the pains were at all strong, Dr. Farre and I observed that the abdomen was of a peculiar form, the uterus projecting very much forwards, whilst there was a slackness in the flanks. The abdominal muscles did not assist the pains at all; and it was probably from this cause that the labour progressed slowly and was terminated at last with the forceps. The recti muscles recovered their position by careful bandaging.

The chloroform has always been left off as soon as the child was born, but a little has been administered again on several occasions during the expulsion of the placenta. The placenta has generally been expelled very soon in the labours in which I have given chloroform; usually in about five minutes. There has hardly ever been uterine hæmorrhage of any amount, except in patients who had suffered from it in previous labours. In a case attended by Mr. Nathaniel Ward, however, there was a slight hæmorrhage before the birth of the child, and about an hour afterwards

there was a considerable hæmorrhage which made the patient feel rather faint for some hours. She afterwards went on favourably, however. She was a young woman who had had several children.

A patient, to whom I was recommended by Sir John Forbes, inhaled chloroform in three confinements. She recovered favourably from the two first; but on the third occasion, after going on favourably till the fifth day, she was attacked with puerperal fever, and died on the seventh day from her confinement.

I am not aware that more than one death has been recorded as having occurred from chloroform during labour; and this took place in England, in 1855, when no medical man was present.* The patient had inhaled chloroform in America in a previous labour; but her medical man, on the last occasion, who was her particular friend, forbad that agent, and said that if she was determined to have it, he would not attend her. She procured chloroform unknown to him, and a number of scents to put on her handkerchief and hide the odour of it from him. He went to bed in the house, and was not called up till his patient had been dead about an hour. The monthly nurse, who had procured the chloroform for the patient, said that she snored very loudly for an hour after she fell asleep. About five drachms of chloroform were used from the bottle, and the handkerchief from which it was inhaled remained close to the patient's face till she died. The death seemed to have taken place very slowly, and the monthly nurse was extremely stupid to allow the patient to die. It may also be remarked that the accident would not have taken place except for the medical man's extreme objection to the use of chloroform.

The chloroform has been occasionally blamed by the

* See Medical Times and Gaz., 1855, vol. i, p. 361.

friends of patients, or medical men opposed to its use, in cases where patients have died from puerperal convulsions or other causes, so long after the vapour had been left off that it could not be the cause of death. The following case shows how easy it would be to make a mistake with respect to the effects of chloroform. Soon after its introduction, I was requested to administer it to the wife of a medical man who had a great desire for it in her confinement. Mr. Propert was to attend the lady. I was sent for late one evening, but as there were no pains at the time when I arrived, I was requested to go to bed in the house. After a time, I was called by a servant, who told me that the baby was born, and that Mr. Propert was sent for. I found that the birth had been so sudden that the husband, who was in the room, could not get to the bed side before the child was born. Mr. Propert arrived, and I went home, leaving the patient very well. Mr. Propert informed me, that after I left the patient went into such a state of syncope as to make him think she was going to die, and continued so for some time. She ultimately recovered. There was no hæmorrhage or any other cause to account for the faintness, and I understood Mr. Propert to say, that if the patient had inhaled chloroform, he should have blamed it for the condition into which she lapsed.

THE INHALATION OF CHLOROFORM IN MEDICAL CASES.

Neuralgia. When the pain of neuralgia is not extremely severe, it may be removed by the inhalation of chloroform without causing unconsciousness; but when it is very severe, it is necessary to make the patient unconscious before the pain is suspended. In some cases of neuralgia of the face, the pain is so severe that the signs of it remain after the patient is rendered unconscious, and only disappear when he is quite insensible; and then, as the insensibility

passes off, the hand is raised to the face, and the contortions of the features return before the patient awakes to be aware of his suffering. When the mental branch of the fifth nerve is affected, the paroxysms of pain are accompanied by a motion and smacking of the lips. In a hospital patient I have seen this when he was awake, but in a gentleman only when his consciousness was removed by the chloroform, and before complete insensibility was induced; when awake, he restrained the impulse to this kind of motion of the lips.

In administering chloroform it is desirable to continue it steadily and gradually till the pain is relieved; and if the patient is rendered unconscious before the pain is removed, to continue it till all signs of suffering disappear. After the first inhalation of the vapour, the pain will generally return in a few minutes, but when again subdued, it will not return so quickly; and after it has been suspended a few times by the repetition of the chloroform during the space of an hour or so, the pain is usually removed either permanently or for two or three hours. In some cases I have had to repeat the chloroform occasionally throughout the day, and, on one or two occasions, for two or three days in succession. The chloroform can, in general, only be considered a temporary remedy, and therefore such other medicines should be applied as may be thought advisable.

When I have prescribed chloroform in a liniment, to be applied to the face, the patient has often found out that he obtained more relief by smelling at the liniment than by applying it. Chloroform generally gives great relief, however, when applied locally in neuralgia, either alone or mixed with camphorated spirit; it is advisable to apply it on a piece of lint or blotting paper, which should be covered over with tinfoil, or some other impermeable substance, to prevent the evaporation. It causes about as much heat and

uneasiness as a mustard poultice, before it relieves the pain.

Spasmodic Asthma. On November 12th, 1850, I administered chloroform in the Hospital for Consumption, at Brompton, to a married woman, aged thirty-five, a patient of Dr. Cursham. She was in a fit of spasmodic asthma, but was the subject also of chronic bronchitis. Twenty minims of chloroform were inhaled from an inhaler. It gave immediate relief, producing a momentary state of unconsciousness, or a state bordering on it. In a few minutes the difficulty of breathing gradually returned, but not to the same extent, and the inhalation was repeated with a like effect. The difficulty of breathing returned less quickly and severely; and after a third inhalation of twenty minims she was completely relieved, and could lie down. The patient had a good night, and was better next day. On the 14th, she had another fit of spasmodic asthma, which was relieved completely by the chloroform in the same manner as the previous one. This patient inhaled extract of stramonium every evening, by a method which will be described further on.

Other cases of spasmodic asthma have been relieved as readily and completely; but in one or two cases, in which the difficulty of breathing seemed to depend on disease of the heart, the relief was not so great; the patient went to sleep, but the breathing remained embarrassed.

Spasmodic Croup. I have administered chloroform in seven cases of this complaint. It was recommended in every instance by Dr. Ferguson, and all the cases ended in recovery. The children were from eight months to two years of age; the majority being about a year. I always gave enough chloroform to cause a state of unconsciousness, for which a few minims suffices in a young child, and when the effect passed off, or nearly so, I repeated the dose. I

generally gave five or six doses in the course of about half an hour, after which the child would often sleep for two or three hours. In the milder cases it was repeated once a day; but in the more severe cases it was continued, in the above manner, twice a day. I administered it to a patient of Dr. Van Oven, respecting whom Dr. Ferguson had been consulted, for fifteen days, twice every day, excepting the last three days. This child was very ill when the treatment was first commenced, having a severe fit of spasmodic breathing every five minutes. When the chloroform is given during the spasm, it is desirable to give it very cautiously.

Mr. W. J. H. Cox read a paper on the treatment of laryngismus stridulus, with chloroform, at the London Medical Society, in 1850. He had entrusted the administration of it to the mother or nurse, and directed it to be given whenever the spasmodic breathing should come on. I am inclined to think that this would be the best way of giving it, if one could be quite sure of the intelligence of the party to whom it was intrusted.

Hooping Cough. I have only administered chloroform in two cases of this complaint. It was recommended in both cases by Dr. Ferguson. One of the children was extremely ill of bronchitis, and it died. The other child recovered, but the chloroform was not continued. I am not aware that chloroform has had any fair trial in hooping-cough. It should be given whenever a fit of coughing comes on.

Infantile Convulsions. I have administered chloroform in two cases of this disease, with the effect of relieving the convulsions, but the children died. They were both extremely ill before the chloroform was administered. One was the patient of Mr. Walter Bryant, and Dr. Seth Thompson was consulted about it. A case has been related by Dr. Simpson of Edinburgh, in which the chloroform was

continued for a day or two, and in which the infant recovered.

*Delirium cum Tremore.** Some cases have been related in the medical journals, in which this complaint was treated successfully by chloroform alone; but I prefer to use this agent only as an adjunct to the treatment by opium. Sometimes the patient is so violent and suspicious that he cannot be made to take opium; but it is much easier to make a person breathe a medicine, than swallow one. It is only necessary to hold a patient, and to apply the chloroform near his face, and he is obliged to breathe it, and as the effect of it subsides, he recovers the power of swallowing before his delirium returns; for whilst he is still unconscious, he will swallow whatever is poured into his throat. Opium can be administered, and the chloroform can be repeated occasionally so as to keep him asleep for an hour or two till the opium takes effect and prolongs the sleep. It is a great advantage of chloroform that the delirium may be subdued in a few minutes by it, and can be kept away till opium takes effect.

In certain cases of delirium cum tremore, such a quantity of opium is taken without procuring sleep, that the medical attendant has, what I believe to be, a well-grounded fear of giving more. A patient whom I saw with Mr. Peter Marshall, in April 1850, had taken ten fluid drachms of laudanum and two grains of acetate of morphia, within twenty-four hours of my seeing him, without any sleep being

* Dr. Watson defends the original name of this complaint, delirium tremens. He says:—"But they who object to *delirium tremens* appear to see no harm in delirium ferox: whereas it is just as incorrect to say *delirium* is fierce, as to say that it trembles: it is the patient who is furious, even as it is the patient who trembles." Now, in speaking of a patient, we may speak either of his mind or his body: we may say that a person is learned, or that he is fat. A patient may be fierce on account of the kind of delirium with which his mind is affected, and the term ferox applies both to him and the complaint; but the act of trembling affects only his body.

procured. He was put to sleep immediately by chloroform, which was repeated on the following day. The patient got quite well in a few days.

In December 1851, I saw a patient who had had no sleep for four days, except three intervals of a quarter of an hour each, although a great deal of opium had been given. He was very violent; and for the last twelve hours had spat out all the medicine that was given to him; his pulse was small and very rapid. He was made insensible in a few minutes, and the chloroform was repeated, at intervals, for half an hour, so as to keep him unconscious. Fifty minims of tincture of opium were given in one of the intervals. I waited an hour and a quarter after the chloroform was discontinued; the patient was still sleeping, and his pulse was less frequent. I learnt that when he awoke he was quite free from delirium, and he was well in a few days.

Delirium in Fever. In November 1857, I administered chloroform to a youth of seventeen, who had been ill of typhoid fever for sixteen days. He had been in a state of constant delirium for upwards of forty-eight hours without having the least sleep, although he had had tincture of opium in divided doses to the extent of forty-five minims, and had taken a tablespoonful of wine every four hours. The chloroform was continued gently for half an hour; he slept for an hour afterwards, and at intervals during the night. He was a little better in the morning; and the delirium was not again so violent as it had been. He died on the nineteenth day of the fever, from a recurrence of diarrhœa.

Dr. Fairbrother, of Bristol, gave small doses of chloroform by inhalation, with the best effects, in a case of typhus fever, in the Bristol Infirmary. The patient was delirious and worn out for want of sleep, her life being in fact de-

spaired of. She inhaled the chloroform occasionally for several days, sleep being always procured when it was applied, and she recovered without any other medicine.*

Hydrocephalus. I administered chloroform on two occasions, for half an hour at a time, to a child, seven years old, when delirious and screaming violently, in this complaint. The child was much relieved by the inhalation, but it died on the fourteenth day of the disease.

Tetanus. I have notes of three cases of tetanus in which I have administered chloroform. The first was a patient of the late Mr. Keate, in St. George's Hospital, in February 1849. It was a girl, fourteen years old, who had received some severe burns in the face and various parts of the body, a fortnight previously. Four days before inhaling the chloroform, she was attacked with symptoms resembling those of chorea, but for the last two days the complaint was recognised to be tetanus. There was rigidity of the spine and jaws, and of one arm, which was flexed. Spasms came on every minute or two, affecting, more particularly, the head and the arm. I commenced to give chloroform very gently at four in the afternoon. It prevented the spasm before consciousness was quite removed. Whenever the spasm offered to return, the inhalation was repeated with the effect of stopping it. The chloroform was continued till half-past five, with the effect of keeping the spasm away; and the patient took some drink during this time, better than she had done previously. I saw the child again at eight o'clock in the evening, and found that the spasms had returned soon after I left, and had continued as before. The chloroform was given again at intervals for an hour and a half, with the effect of keeping away the spasms, and inducing sleep; but I found that the child was getting

* Med. Gaz., vol. xli, 1848, p. 102.

weaker, and would die even if the spasm was entirely prevented. She died at a quarter past eight the following morning. There was no inspection of the body.

The next case was a patient of Mr. Propert, a boy, ten years of age, who had suffered from sloughing of the skin of the inferior extremities. The tetanus came on during the healing process, whilst the greater part of both extremities was in a state of ulceration, and covered with healthy granulations. The patient was in a very irritable and feeble state, and his pulse was 150 in the minute. He was made insensible, and the chloroform was repeated twice in the space of half an hour. No relaxation of the muscles of the jaws was produced, although the effect of the chloroform was carried as far as seemed safe in such a subject. He died twelve hours afterwards.

I administered chloroform lately to a patient of Mr. Salmon in St. Mark's Hospital. He underwent an operation by ligature for prolapsus ani and hæmorrhoids on March 1st; on March 5th tetanus commenced, and on March 7th chloroform was administered whilst Mr. Salmon removed some sloughs from the anus; and it was repeated occasionally afterwards. The patient was a man, fifty-two years of age; he was the subject of kidney disease, and the tetanus was extremely severe. He had had four doses, each containing a fluid drachm of laudanum, between the time when the tetanus commenced and his inhaling the chloroform. His pupils were contracted, and he was made insensible by an extremely small quantity of chloroform. He was, in fact, very much under the influence of opium, although the spasm of the tetanus prevented his sleeping.

Chloroform affords great relief to the patient affected with tetanus, and it probably increases the prospect of recovery in cases which are not too severe and acute.

Epilepsy. Dr. Todd at one time had chloroform admi-

nistered by inhalation, in King's College Hospital, to the extent of causing insensibility, at stated intervals, in cases of epilepsy, and he thought with advantage. I have frequently administered chloroform for surgical operations to patients who were subject to epilepsy, and have very rarely found it produce any approach to a fit.

In July 1850, I administered chloroform to a boy, seven years old, in an epileptic fit, which had lasted about an hour when the inhalation was commenced. He had had fits previously, the last of which had occurred a year before, but none of them had lasted so long as the existing one. He had eaten nine new potatoes for his dinner, at one o'clock, and the fit came on about eight. I found the abdomen swollen and very tympanitic. There was constant convulsive motion of the right arm, and of the neck; the latter drawing the head to the right side. The mouth was also drawn to the right at each convulsive motion. The chloroform was given by putting a few minims at a time on a handkerchief, and holding it to the mouth and nostrils. It caused immediate cessation of the convulsions every time it was applied. The convulsions, however, returned again in a minute or two. In the intervals that he was partially under the influence of the vapour, he breathed easily without stertor. The convulsions became gradually less severe, and ceased entirely ten or fifteen minutes after the commencement of the inhalation.

Puerperal Convulsions. I have not been called to any case of this complaint since chloroform has been in use; but some cases have been related in the medical journals in which the inhalation of chloroform has been employed with a favourable result. One case is related by Mr. Henry Rudge, of Leominster.* When the chloroform was admi-

* Association Med. Journ., 1853, p. 706.

nistered, the patient was in violent convulsions which came on in frequently succeeding fits. The os uteri was dilated, and the head presenting. The pains were entirely arrested. The chloroform was administered by twenty minims, at intervals, on a folded handkerchief. The convulsions, after a few inhalations, entirely ceased, and Mr. Rudge extracted the child without difficulty. There was another child with the head presenting: it was delivered with the forceps. The placenta was delivered with the hand on account of smart hæmorrhage. There was only one attack of convulsions after delivery, and the patient recovered favourably. It was her first labour, and her age was twenty-three years.

A case of puerperal convulsions was related by Mr. Andrew Bolton to the Newcastle and Gateshead Pathological Society.* His patient, aged twenty-two, was at the full period of her first pregnancy. The os uteri was high, slightly dilated, and extremely rigid. She was treated at first by bloodletting, and full doses of morphia. Mr. Bolton says: "As her condition appeared hopeless should the paroxysms continue, chloroform was administered on a piece of linen, in half-drachm doses, and its full effects kept up for three hours. At two P.M., there was a slight return of convulsion; skin warm and perspiring; the os uteri was found steadily dilating; and from her uneasy movements, it was apparent that uterine action had begun.

"Half-past three. The membranes were ruptured; and brisk uterine action ensuing, a dead child was expelled, immediately followed by the placenta. She regained her senses during the expulsive efforts, but appeared entirely ignorant of her previous condition. Recovery followed without any bad symptom.

"In conclusion, I would remark, that the convulsions were in no measure mitigated by the depletion, which was

* See Med. Times and Gaz., 1853, vol. ii, p. 412.

carried to the utmost; nor was there any yielding of the os uteri until the chloroform was inhaled."

The urine was not examined in either of the above cases, and it is not stated that œdema was present.

Hysterical Paralysis and Contractions. In December 1851, I administered chloroform in Charing Cross Hospital to a young woman about twenty-five, a patient of Dr. Chowne. She kept her left knee in a semiflexed position, and would not allow it to be moved. She had been in bed in the hospital for two months. She inhaled the chloroform reluctantly, and, after becoming unconscious, she breathed and sobbed in a hysterical manner. When insensible, the limb went down flat on the bed, the knee being quite movable. A straight splint was applied, and the limb was secured to it with bandages. I was informed that in a few days she contrived to get her leg bent again. She was the domestic servant of a nobleman. It was evident that there was nothing the matter with her limb, and that it was only influenced by her volition, which was perverted by the hysteria under which she was labouring.

In November, in the same year, I administered chloroform in the same hospital to another patient of Dr. Chowne, whose case was more obscure and complicated. The patient was a woman, aged thirty-three, who represented that for several months she had been unable to open her mouth, or to speak, and that she had, for the same length of time, been paralyzed in the left arm and leg. The affection, it was said, came on suddenly, in a kind of fit, which was followed by unconsciousness for three or four weeks. It was also said, that she had one or two fits the previous year, after which she was unconscious for a long time. The patient was quite conscious before inhaling the chloroform, and replied to questions by nodding or shaking the head, or by writing on a slate. She was unmarried, and had not

menstruated for some months past. The chloroform was administered with a view to ascertain whether or not she was feigning. On first becoming unconscious, the patient breathed in a sobbing and hysterical manner. The chloroform was given very gradually; and as she became more affected, there were some struggling and rigidity, when the right arm and leg were moved about a good deal. The left arm and leg were also distinctly moved, but not above a tenth part as much as the extremities of the opposite side. When the patient was quite insensible, the limbs being relaxed, the pupils turned upwards, and the conjunctiva insensible, attention was turned to the jaws, which were still firmly closed, but they were opened by using a moderate degree of force with the fingers. The effect of the chloroform having been allowed in a great measure to subside, it was again administered, when the movements of the limbs recurred, and there was the same difference between the motion of the right side and that of the left, as before. When I left the patient, more than half an hour after the chloroform was discontinued, she had not opened her eyes or answered questions; and she did not do either for six days. I saw her five days after the chloroform. The pulse was very rapid on my first going to the bedside, but its frequency subsided in a few minutes. On my raising the eyelid, she turned her eye about, as if endeavouring to hide the pupil under the lid. On the following day she answered questions by nodding and writing on a slate, and was, in other respects, the same as before inhaling the chloroform.

The great difference in the amount of motion in the limbs of this patient, under the influence of chloroform, showed that the paralysis of the left side was not a mere pretence. It is, indeed, possible that the absence of motion in the limbs of the left side, for several months, would cause them

to move less than the opposite ones during the action of chloroform; but it is not to be supposed that the patient would keep these limbs in one posture during the night, and when no one was present, without ever moving them, unless she herself believed that they were paralyzed. I looked on the woman as a sick person, and not a mere impostor; for although she appeared to exaggerate her symptoms, and to have a good deal of pretence and affectation, this circumstance arose, no doubt, from her complaint.

In April 1853, I administered chloroform four times to a patient of Dr. Arthur Farre, a girl of fifteen years of age, who was affected with a contraction of the flexor muscles of the left thigh and leg, of the muscles which bend the body to the left side, and those which bend and turn the head to the same side, in consequence of which the leg was drawn up, and the body and head were curved greatly to the left side. The contraction of the muscles had lasted for several weeks, but she had been ill for a much longer period, her illness having commenced with a fever. She took an extremely small quantity of nourishment, and was very thin. Her bowels were moved with difficulty. The pulse was very feeble and small, and there was a tendency to coldness of the surface. An eminent surgeon in the provinces had expressed his opinion that the distortion of the limbs and trunk was a feigned disorder; but the action of the chloroform proved that he was altogether in error. The muscles became completely relaxed when the patient was quite insensible, and the limbs and trunk and head could be readily moved into any position; but as the effects of the chloroform subsided, the deformity returned on each occasion before the patient recovered her consciousness. Neither the chloroform nor any other measures were of any service, and Dr. Farre informed me that the patient died a few weeks after I saw her.

Mania. I have been informed of several cases in which chloroform has been administered in acute mania, with the effect of calming the patient and procuring sleep. I have administered it in two cases with the same temporary advantage. In one of the cases, the patient was persuaded to inhale it; in the other, he had to be held by three keepers till he was unconscious. An eminent and well-known scientific man, who became insane some years ago, refused to take food. It was found that after being made unconscious by chloroform, he would take a meal just as he recovered from its effects, and the chloroform was given before every meal for a long time.

Spasmodic Pain. In August 1851, I administered chloroform to a woman who was labouring under a severe paroxysm of spasmodic pain in the abdomen. The pain was completely removed, without altogether causing unconsciousness. An opiate was given to prevent the pain from returning.

I have not had the opportunity of administering chloroform during the passage of calculi down the ureters, or of gall-stones; but there can be no doubt that it would be of the greatest service in such cases. If Dr. Griffin had been provided with chloroform when he attended the late Mr. Augustus Stafford with an attack of gall-stones,* he would have been able to relieve his patient in five minutes, instead of taking two or three hours to produce relief by opium. There would have been no occasion for the venesection, which was carried to thirty ounces. And at the end of the attack, on Dr. Griffin leaving his patient for the night, if chloroform had been employed, he would have left him without any appreciable amount of the narcotic in his system. As it was, however, he left him with a quantity of opium unabsorbed from the alimentary canal. The bandage

* Med. Times and Gaz., 1857, vol. ii, p. 553, and 600.

got displaced from the arm; there was an additional hæmorrhage, the opium became absorbed more quickly, and a dangerous state of narcotism was induced.

Frequent and long-continued Use of Chloroform. Many patients have inhaled this agent hundreds of times, and it continued to produce insensibility as readily as at first. The dose does not require to be increased on account of its long use. I was informed of the case of a lady who was affected with a painful cancer, and was attended by the late Mr. Keate and Mr. Henry Charles Johnson. She inhaled chloroform at frequent intervals, by day and night, for a very long time, consuming three or four ounces in the twenty-four hours.

In November 1851, a surgeon in the north of England wrote to me respecting one of his patients, a lady, who had inhaled a great deal of chloroform, on account of neuralgia of the uterus. He said that, during that year, and principally within the last six months, she had inhaled at least two hundred ounces; that she often inhaled as much as three ounces in a day; and that it seemed to have produced very little effect on her general health, except that she seemed to be more susceptible of pain. He said that he had reluctantly yielded to the entreaties of his patient to administer it so often, and he wished for my opinion respecting the propriety of continuing its use, and what effect it would be likely to produce.

I advised that the chloroform should be continued as long as the severity of the pain rendered it necessary; and expressed my opinion, that it would produce as little ultimate effect as any other narcotic which might be used to relieve the pain. I saw the surgeon in September of the following year. He informed me that the chloroform was continued for some time after he had written to me; but

that his patient had recovered from her complaint, and had left off the chloroform, and was in good health.

Mr. Garner, of Stoke-upon-Trent, has related the case of a lady, affected with neuralgia, who inhaled sixty-two ounces of chloroform from her handkerchief, in twelve days.*

* Med. Times and Gaz., 1856, vol. ii, p. 528.

SULPHURIC ETHER, OR ETHER.

History and Composition. "This liquid is first described by Valerius Cordus, in 1540, under the name of *oleum vitrioli dulce*. The term *ether* was applied to it a hundred and ninety years afterwards by Frobenius, who, in a paper in the *Philosophical Transactions*, described its singular properties; at the end of this paper is a note by Godfrey Hankwitz, Mr. Boyle's operator, mentioning the experiments that had been made upon it by Boyle and by Newton."*

The present chemical name of ether, or sulphuric ether, is oxide of ethyle. It consists of four atoms carbon, five atoms hydrogen, and one atom oxygen. Its atomic number is consequently 37.

The usual way of making ether, is to distil common alcohol (the hydrated oxide of ethyle) with sulphuric acid.

Chemical and physical Properties. Ether is a clear, colourless liquid, of the specific gravity of 0·715 at 68°. It boils at 96° Fahr.; and the specific gravity of its vapour is 2·565. It is soluble, in all proportions, in alcohol, and it is soluble in nine parts, by measure, of water. Water is also soluble in nine parts, by measure, of ether, so that after ether has been agitated with water, it retains one-tenth of its volume of that fluid. Ether is very inflammable, and, as it yields its vapour very freely, great care is required in pouring it out by artificial light. Its vapour is also very explosive when mixed, in certain proportions, with atmospheric air.

* Brande's Chemistry, 5th ed., p. 1274.

The ordinary ether of the shops contains a portion of alcohol which has distilled over with it; the alcohol should be removed by agitating the ether with twice its volume of water, before it is used for inhalation. The ether which has been treated in this way is called washed ether. The water which it takes up during the washing can be removed by distilling it from lime, or dry carbonate of potassa; but this is unnecessary, as the water does not interfere with the action of the ether when inhaled; and part of the water evaporates and is inhaled with the ether, when the atmospheric air is not already saturated with moisture.

Ether has a peculiar and very strong odour; in this respect it differs extremely from chloroform. The odour of a single drop of ether can be distinctly perceived all over a large operating theatre, whilst a pint of chloroform may be spilt without its odour being much noticed. The strong odour of ether is, indeed, one of the greatest objections to its use, since another agent has been discovered which is free from this objection. As was previously stated, the odour of chloroform cannot be perceived in the breath, after the lungs are emptied by one or two expirations of the vapour just taken in; whilst the smell of ether can be perceived in the breath for twenty-four, and sometimes for forty-eight, hours after the patient has inhaled it. The surgeon, and others who have been about the patient, also smell of the ether to a less degree. When a rabbit has been killed by the inhalation of ether, a starving cat will not eat its flesh even after it has been boiled; whereas the odour of chloroform cannot be perceived in the bodies of animals that have been killed by it.

If ether is exposed to atmospheric air by being kept a long time in a bottle but partly filled, it is apt to be decomposed into acetic acid and water.

The following Table shows the result of experiments which I made to ascertain the quantity of vapour of ether that 100 cubic inches of air will take up, when saturated with it, at various temperatures, the barometric pressure being 30 inches of mercury. The ether I employed in the experiments was washed, but not dried. It was, therefore, saturated with water, of which it contained one-tenth of its volume. It had a specific gravity of 0·735 at 60° Fahr., and it boiled at 98°.

Temp. Fah.	Cubic inches of vapour.	Minims of ether.
50°	52	64
51	54	66
52	56	69
53	59	72
54	62	76
55	65	80
56	68	84
57	72	88
58	76	93
59	80	98
60	84	102
61	88	107
62	92	112
63	97	117
64	102	122
65	107	128
66	112	134
67	117	140
68	123	147
69	130	156
70	138	165

In the above Table the air is a constant quantity of 100 cubic inches, which becomes expanded to 152, and so on; but the following Table shows the quantity of vapour in 100 cubic inches of the saturated mixture of vapour and air at different temperatures:—

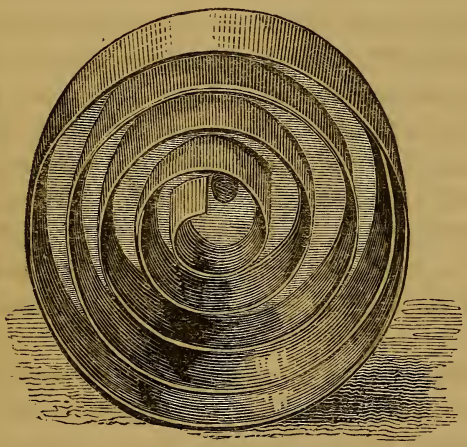
Temp. Fah.	Air.	Vapour.
40°	73	27
42	72	28
44	70	30
46	69	31

Temp. Fah.	Air.	Vapour.
48°	67	33
50	66	34
52	64	36
54	62	38
56	60	40
58	57	43
60	54	46
62	52	48
64	49	51
66	47	53
68	45	55
70	42	58
72	40	60
74	37	63
76	34	66
78	32	68
80	29	71

The absorption of caloric during the evaporation of ether is much greater than during that of chloroform, owing both to the greater quantity of vapour it yields on account of its lower boiling point, and to the lower specific gravity of the vapour. The evaporation of ether from the bulb of a thermometer usually lowers the temperature nearly to zero of Fahrenheit. When the inhalation of ether was first commenced, the inhalers employed consisted generally of glass vases containing sponge, to afford a surface for the evaporation of the ether. Both glass and sponge being very indifferent conductors of caloric, the interior of the inhalers became much reduced in temperature, the evaporation of ether was very much checked, and the patient breathed air much colder than the freezing point of water, and containing very little of the vapour of ether. On this account, and through other defects in the inhalers, the patient was often very long in becoming insensible, and, in not a few cases, he did not become affected beyond a degree of excitement and inebriety.

To ensure the ether taking effect in a short time in every case, I made use of the conducting power of the metals, and the great capacity of water for caloric. The inhaler

which I employed was made of plated copper, and was placed in two or three pints of water, of the ordinary temperature. The form of the inhaler was that of one which had been contrived by Mr. Julius Jeffries for the inhalation of aqueous vapour.* No sponge or bibulous paper, or other material, was used; and the air, before being inhaled, was made to pass over a considerable surface of ether by means of a spiral volute, soldered to the top of the inhaler, and reaching nearly to the bottom. The accompanying engraving shows the interior of the inhaler, on a scale of half the dimensions, the bottom being removed.



The Physiological Effects of Ether are essentially the same as those of chloroform. The various degrees of narcotism which I described in the earlier part of this work, when treating of chloroform, were first described by me when treating of ether in 1847, before chloroform was in use.† All the remarks which I made with respect to the

* Lond. Med. Gaz., Feb. 1842.

† On the Inhalation of the Vapour of Ether in Surgical Operations. London, 1847.

manner in which age, strength or debility, and other circumstances, influence the action of chloroform, apply also in an equal degree to ether.

I performed some experiments in 1848,† for ascertaining the proportions of vapour of ether present in the blood in the different degrees of narcotism. They were conducted on the same principles as those previously related, which were performed for the purpose of determining the same point in regard to chloroform.

Experiment 31. Two grains of ether were put into a jar holding 200 cubic inches, and the vapour diffused equally, when a tame mouse was introduced, and allowed to remain a quarter of an hour, but it was not appreciably affected.

Experiment 32. Another mouse was placed in the same jar, with three grains of ether, being a grain and a half to each 100 cubic inches. In a minute and a half, it was unable to stand, but continued to move its limbs occasionally. It remained eight minutes without becoming further affected. When taken out, it was sensible to pinching, but fell over on its side in attempting to walk. In a minute and a half, the effect of the ether appeared to have gone off entirely.

Experiment 33. A white mouse in the same jar, with four grains of ether, was unable to stand at the end of a minute, and at the end of another minute ceased to move, but continued to breathe naturally, and was taken out at the end of five minutes. It moved on being pinched, began to attempt to walk at the end of a minute, and in two minutes more seemed quite recovered.

Experiment 34. Five grains of ether, being two and a half grains to each 100 cubic inches, were diffused throughout the same jar, and a mouse put in. It became rather more quickly insensible than the one in the last experiment.

* Papers on Narcotism by Inhalation. Lond. Med. Gaz., vol. xli-ii.

It was allowed to remain eight minutes. It moved its foot a very little when pinched, and recovered in the course of four minutes.

Experiment 35. A white mouse was placed in the same jar with six grains of ether. In a minute and a half, it was lying insensible. At the end of three minutes, the breathing became laborious, and accompanied by a kind of stertor. It continued in this state till taken out, at the end of seven minutes, when it was found to be totally insensible to pinching. The breathing improved at the end of a minute; it began to move at the end of three minutes; and five minutes after its removal, it had recovered.

Experiment 36. The same mouse was put into this jar on the following day, with seven grains of ether, being 3·5 grains to the 100 cubic inches. Stertorous breathing came on sooner than before; it seemed at the point of death when four minutes had elapsed; and being then taken out, was longer in recovering than after the last experiment.

Experiment 37. Two or three days afterwards, the same mouse was placed in the jar, with eight grains of ether, being four grains for each 100 cubic inches. It became insensible in half a minute. In two minutes and a half, the breathing became difficult; and at a little more than three minutes, it appeared that the breathing was about to cease, and the mouse was taken out. In a minute or two, the breathing improved; and in the course of five minutes from its removal, it had recovered.

The temperature of the mice employed in the above experiments was about 100°. That of the birds in the following experiments was higher, as is stated; and they differ widely from the mice in the strength of vapour required to produce a given effect, although I found but little difference between the mice and birds, in this respect, in the former experiments on chloroform. And one of the linnets was

employed in both sets of experiments. Having seen MM. Dumeril and Demarquay's statement of the diminution of animal temperature from inhalation of ether and chloroform, before the following experiments were performed, the thermometer was applied at the beginning and conclusion of some of them. I have selected every fourth experiment from a larger series on birds.

Experiment 38. 18·4 Grains of ether were diffused through a jar holding 920 cubic inches, being two grains to each 100 cubic inches, and a green linnet was introduced. After two or three minutes it staggered somewhat, and in a few minutes more appeared so drowsy, that it had a difficulty in holding up its head. It was taken out at the end of a quarter of an hour, quite sensible, and in a minute or two, was able to get on its perch. The temperature under the wing was 110° before the experiment began, and the same at the conclusion.

Experiment 39. Another linnet was placed in the same jar, with four grains of ether to each 100 cubic inches of air. In two minutes it was unable to stand, and in a minute more, voluntary motion had ceased. It lay breathing quietly till taken out, at the end of a quarter of an hour. It moved its foot slightly when it was pinched. In three minutes it began to recover voluntary motion, and was soon well. The temperature was 110° under the wing, when put into the jar, and 105° when taken out.

Experiment 40. A green linnet was put into the same jar with 55·2 grains of ether, being six grains to 100 cubic inches. It was insensible in a minute and a half, and lay motionless, breathing naturally, till taken out at the end of a quarter of an hour. It moved its toes very slightly when they were pinched with the forceps, and it began to recover voluntary motion in two or three minutes. Temperature 110° before the experiment, and 102° at the end.

Experiment 41. A linnet was placed in the same jar, containing eight grains of ether to each 100 cubic inches. Voluntary motion ceased at the end of a minute. The breathing was natural for some time, but afterwards became feeble, and at the end of four minutes appeared to have ceased; and the bird was taken out, when it was found to be breathing very gently. It was totally insensible to pinching. The breathing improved, and it recovered in four minutes.

Experiment 42. 9·2 grains of ether, being one grain to each 100 cubic inches of air, were diffused through the jar, holding 920 cubic inches of air, and a frog was introduced. At the end of a quarter of an hour, it had ceased to move spontaneously, but could be made to move its limbs, by inclining the jar so as to turn it over. At the end of half an hour, voluntary motion could no longer be excited, and the breathing was slow. It was removed, at the end of three-quarters of an hour, quite insensible, and the respiratory movements being performed only at long intervals, but the heart beating naturally; and it recovered in the course of half an hour. The temperature of the room was 55° at the time of this experiment.

We find from the 32nd experiment, that a grain and a half of ether for each 100 cubic inches of air, is sufficient to induce the second degree of narcotism in the mouse; and a grain and a half of ether make 1·9 cubic inch of vapour, of specific gravity 2·586. Now the ether I employed boiled at 96°. At this temperature, consequently, its vapour would exclude the air entirely; and ether vapour, in contact with the liquid giving it off, could only be raised to 100° by such a pressure as would cause the boiling point of the ether to rise to that temperature. That pressure would be equal to 32·4 inches of mercury, or 2·4 inches above the usual barometrical pressure; and the vapour

would be condensed somewhat, so that the space of 100 cubic inches would contain what would be equivalent to 108 cubic inches at the usual pressure. This is the quantity, then, with which we have to compare 1·9 cubic inch, in order to ascertain the degree of saturation of the space in the air-cells of the lungs, and also of the blood; and by calculation, as when treating of chloroform,

1·9 is to 108 as 0·0175 is to 1.

So that we find 0·0175, or 1-57th to be the amount of saturation of the blood by ether necessary to produce the second degree of narcotism; and as by Experiment 35, three grains in 100 cubic inches produced the fourth degree of narcotism, we get 0·035, or 1-28th, as the amount of saturation of the blood in this degree. Now this is within the smallest fraction of what was found to be the extent of saturation of the blood by chloroform, requisite to produce narcotism to the same degrees. But the respective amount of the two medicines in the blood differs widely; for whilst chloroform required about 288 parts of serum to dissolve it, I find that 100 parts of serum dissolve five parts of ether at 100°; consequently $0{\cdot}05 \times 0{\cdot}0175$ gives 0·000875, or one part in 1142, as the proportion in the blood in the second degree of narcotism; and $0{\cdot}05 \times 0{\cdot}035$ gives 0·00175, or one part in 572, as the proportion in the fourth degree.

In Experiment 42 the frog was rendered completely insensible by vapour of a strength which was not sufficient to produce any appreciable effect on the mouse in Experiment 31. This is in accordance with what was met with in the experiments with chloroform. Air, when saturated with ether at 55°, contains 32 grains in each 100 cubic inches; so that the blood of the frog might contain 1-32nd part as much as it would dissolve, which, although not quite so great a proportion as was considered the average for the fourth degree of narcotism in the mice, yet was more

than sufficient to render insensible the mouse in Experiment 34.

There is a remarkable difference between the birds and the mice, in respect to the proportions of ether and air required to render them insensible, a difference that was not observed with respect to chloroform. In some experiments with ether on guinea-pigs, which are not adduced, they were found to agree with mice in the effects of various quantities.

The birds were found to require nearly twice as much; five grains to 100 cubic inches, the quantity used in an experiment between the thirty-ninth and fortieth, which is not related, may be taken as the average for the fourth degree of narcotism in these birds, with a temperature of 110°. By the kind of calculation made before, we should get a higher amount of saturation of the blood than for the same degree in mice. But as serum at 110° dissolves much less ether than at 100°, the quantity of this medicine in the blood of birds is not greater than in that of other animals; and, considered in relation to what the blood would dissolve at 100°, the degree of saturation is the same.

By Experiments 36, 37, and 41, we find that with ether, as with chloroform, a quantity of vapour in the air, somewhat greater than suffices to induce complete narcotism, has the effect of arresting the respiratory movements.

In treating of chloroform (page 74), the average quantity of serum in the adult human subject was estimated at 410 fluidounces. In order to find the quantity of ether in the system, we may multiply 410 by 0·000875 for the second degree of narcotism, and by 0·00175 for the fourth degree, when we shall obtain 0·358 and 0·71 of an ounce, *i. e.* f. ℥ii. ℥l in the first instance, and f. ℥v. ℥xl in the second. In the third degree of narcotism, in which surgical operations are usually performed, the quantity is intermediate, or a little over four drachms.

On the Administration of Ether. About a fluid ounce of ether is usually inhaled by an adult patient in becoming insensible; fully one-half of this is, however, thrown back from the lungs, windpipe, nostrils, and face-piece, without being absorbed. I usually put two fluid ounces of ether into the inhaler above described, at the beginning of the inhalation, and this quantity often lasts to the end of the operation, if it is not a protracted one. The inhaler is connected, by means of a wide elastic tube, with a face-piece similar to that described and delineated in treating of chloroform. It is necessary that the inhalation should commence, as in the case of chloroform, with the expiratory valve of the face-piece turned on one side, for the admission of air which is not charged with ether, and that the vapour should be admitted to the air-passages by degrees, to avoid the irritation that would arise from suddenly inspiring any considerable quantity of the vapour. The vapour of ether is very much less pungent than an equal quantity of the vapour of chloroform; but as the patient requires to breathe about six times as much of it in the inspired air, it feels quite as pungent as that of chloroform, and, perhaps, a little more so. Whilst the patient never requires to take in more than four or five per cent. of vapour of chloroform in the inspired air, he requires to inhale about thirty per cent. of vapour of ether, in order to be rendered insensible in a convenient time. The air-passages, however, soon get accustomed to the presence of the vapour of ether, and in a minute and a half or two minutes after the patient begins to inhale, he can usually bear the valve to be closed so far as to charge the air with as much vapour as is necessary speedily to cause insensibility. The inhaler yields quite sufficient vapour when the water-bath is at 50° Fahr.; and at the seasons of the year when the temperature of the water is higher, the expiratory valve of the face-piece can be left more or less open to ad-

mit a portion of air which has not passed through the inhaler.

I prefer the flavour of ether vapour to that of chloroform; and the sensations I experience from the inhalation of ether are more pleasurable than those from chloroform. Many persons agree with me on both those points; but some prefer chloroform. The quantity of ether expended in causing insensibility is eight or ten times as great as that of chloroform, but the quantity used in a protracted operation is not so disproportionate; for, owing to the great solubility of ether and the large quantity of it which is absorbed, it is much longer in exhaling by the breath, and when the patient is once fairly insensible, it does not require to be repeated so frequently as chloroform.

In administering ether, I usually rendered adult patients insensible in four or five minutes, and children in two or three minutes. A somewhat longer time was occasionally occupied in cases in which the air passages were irritable, or where there was much rigidity and struggling. I never failed to make the patient insensible in any one instance in which I administered ether. I have notes of 152 cases in which I administered ether, before chloroform was introduced, and twelve cases in which I have exhibited it since.

Nearly all the great operations of surgery were included several times amongst the cases in which I administered ether. Amputation of the thigh was performed in nineteen cases; fifteen of the patients recovered, and four died. Amputation of the leg was performed eleven times; eight of the patients recovered, and three died. The arm was amputated three times; one of the patients died, and two recovered. There were thus thirty-three of the larger amputations with eight deaths, being a mortality of twenty-four per cent. There were two amputations of the forearm, and both patients recovered. There were nine operations of

lithotomy; seven of the patients recovered, and two died. Five of the patients were children, who all recovered; the two deaths occurring amongst the four adult patients. Eighteen female patients had the breast removed for tumour, and they all recovered except one.

On July 1st, 1847, Mr. Cutler amputated the leg of a man, aged forty-four, in St. George's Hospital, who had suffered from disease of the tibia and ankle, which had existed thirty years, and was caused by an accident. This patient died on the seventh day, of sloughing phagedena, which was present in the hospital. It was then found that he had disease of the heart. Its structure was soft and easily lacerable; much fat was mixed up with the muscular structure. The aortic valves were much thickened, and almost cartilaginous in structure. Two of them were so much contracted that they were together about the size of a healthy one. The left ventricle was dilated, and the right ventricle still more so; its walls being extremely thin. The ether had acted quite favourably on this man.

I administered ether repeatedly in infants and old people. Some of the infants were operated on by Mr. George Pollock, in 1847, for congenital cataract by drilling; and two of them were operated on, in 1857, for hare-lip, by Mr. Fergusson and Mr. Bowman. A gentleman, one of whose toes the late Mr. Liston amputated in 1847, was said to be subject to apoplectic attacks. The ether acted very favourably. Amongst the operations which Mr. Liston performed on patients to whom I administered ether, was the tying of the external iliac artery in a man, aged forty, for an aneurism of the groin, situated partly above Poupart's ligament. The patient lay perfectly still in this, as in all the other important operations in which I administered ether. He recovered.

On June 18th, 1847, I exhibited, in University College

Hospital, ether to a man, aged forty-two, with stricture of the urethra, caused by an accident. He passed his urine only in drops, and the attempts to pass a catheter had all failed. It was Mr. Liston's intention to divide the urethra in the perinæum, but when the patient was placed fully under the influence of ether to the fourth degree of narcotism, a catheter (No. 1) passed into the bladder, and the operation was not required. Larger catheters were introduced in a few days, and on July 27th, the patient was discharged, being able to pass his urine in a good stream.

Ether was administered in many cases of midwifery by Dr. Simpson, who had first applied it in obstetric cases, and by a number of other practitioners. I only exhibited it in one case, and then only for a short time. Mr. Lansdown of Bristol used it in thirty cases.* In one case, it was continued for eleven hours and a half, and fourteen fluid ounces of ether were used. He said that he invariably found the perinæum relaxed before the head came to bear on it, thereby not requiring the pressure of the head to force it open, in cases where ether was used. He says: "I find the uterus sending out the placenta immediately after the expulsion of the child, and there has been scarcely any hæmorrhage following." Mr. Lansdown said that he had found the action of the uterus to be induced by ether, when in a sluggish state, but he had not found this effect from chloroform, in the cases in which he had used it.

Ether was used with great advantage in most of the kinds of medical cases in which chloroform was afterwards applied. In the summer of 1847, an infant, nine months old, was brought to me in a convulsive fit, which had lasted twenty minutes. I poured twenty minims of ether on a sponge, and applied it to its mouth and nostrils; in two or three minutes, the quantity was repeated. The spasm sub-

* Lancet, Jan. 1, 1848.

sided, and the child fell asleep. It had no return of the fit. It was labouring under hooping-cough at the time, which had existed a week.

The inhalation of ether was employed in the treatment of asthma, hooping-cough, and tetanus, before it was employed in surgical operations. It has been already stated (page 14) that Dr. Richard Pearson administered the vapour of ether in consumption in 1795. Dr. Robert Willis sent an article to the *Medical Gazette* on February 2nd, 1847,* in which the following passages occur.

"Ether, given by the mouth, has long been familiarly employed in the treatment of asthma. I have for many years been aware of the fact that it is vastly more efficacious administered directly in vapour by the breath. My plan of using it is extremely simple. I have had recourse to no kind of apparatus for this purpose, but have been content to pour two, three, or four drachms of the fluid upon a clean handkerchief, and to direct this to be held closely to the mouth and nostrils: a single short and difficult inspiration is hardly made before the effect is experienced; and I have occasionally seen the paroxysm ended in six or eight minutes, the respiration having in that brief interval become almost natural.

"It is not otherwise with hooping-cough: the paroxysms of coughing are positively cut short by having the ether and the handkerchief in readiness, and using them when the fit is perceived to be coming on."

I have been informed of a case of tetanus which was treated successfully by inhalation of ether more than twenty years before this medicine was used to prevent the pain of operations, but I am not able at present to give a reference to the case. Mr. C. A. Hawkesworth, surgeon, of Burton-on-Trent, wrote me an account of a case of tetanus, which

* Vol. xxxix, p. 271.

had recovered under the inhalation of ether in 1847. The patient was a healthy-looking butcher's boy, about twelve years old, who had received a slight scalp wound, which was followed by general tetanus. Mr. Hawkesworth administered the vapour of ether to him during the greater part of one day. The spasm relaxed most completely whilst the influence of the ether continued, but returned in great degree when the inhalation was intermitted. He took no other medicine except calomel and jalap, with a view to purgation; the calomel, however, acted on his mouth. He recovered speedily and completely. Some other cases of recovery from tetanus under the inhalation of ether have been recorded in the medical journals.

In February, 1847, Dr. Sibson related several cases of facial neuralgia that had been greatly benefited by the inhalation of ether;* and it has been used in many cases since.

The inhalation of ether causes an increased flow of saliva in many cases; quite as frequently, in fact, as chloroform. Vomiting also follows the use of ether quite as often as that of chloroform. The insensibility from ether lasts longer than that from chloroform without repeating the inhalation when the narcotism is carried to the same degree. When the narcotism from ether is carried to the fourth degree there is generally a complete absence of pain for three minutes, and a state of unconsciousness for five minutes longer, a period during which any pain there might be would not be remembered afterwards. On account of this longer duration of the effects of ether, it is better adapted than chloroform for certain operations on the face, as removal of tumours of the jaws, the operation for hare-lip, and making a new nose. The relaxation of the muscular system from the effects of ether seems greater in general than from chloroform, and ether therefore seems to be the better agent to employ in the reduction of old dislocations, and strangulated hernia.

* Medical Gazette, vol. xxxix, p. 358.

Great safety of Ether. I believe that ether is altogether incapable of causing the sudden death by paralysis of the heart, which has caused the accidents which have happened during the administration of chloroform. I have not been able to kill an animal in that manner with ether, even when I have made it boil, and administered the vapour almost pure. The heart has continued to beat after the natural breathing has ceased, even when the vapour has been exhibited without air; and in all cases in which animals have been made to breathe air saturated with ether vapour, at the ordinary temperatures of this country, they have always recovered if they were withdrawn from the vapour before the breathing ceased. Even in cases where the natural breathing had ceased, if the animal made a gasping inspiration after its removal from the ether it recovered.

I hold it, therefore, to be almost impossible that a death from this agent can occur in the hands of a medical man who is applying it with ordinary intelligence and attention.

I am only aware of two deaths which have been recorded as occurring during the administration of ether, and it is not probable that the death in either case was due to the ether. The first of these cases occurred in France, at the Hotel Dieu d'Auxerre, on July 10th, 1847.* The patient was a man fifty-five years of age, who had a cancerous tumour of the left breast of seven months duration. He was robust, and had no general lesion resulting from the cancerous disease. The ether was exhibited with the apparatus of Charrière. The patient had hardly inhaled two or three minutes when he became strongly excited. The trunk and limbs were agitated with violent starts and shocks. The breathing became frequent, and the face injected. He endeavoured to push away the inhaler, and

* Gaz. Médicale, Mars 4, 1848, p. 170.

babbled as if drunk. This state lasted for five minutes, and the prick of a pin showed that sensibility still remained. The apparatus was still applied, but in opening to the ether vapour an issue as large as the instrument permitted; for the tap which gave passage to it had hitherto been but half turned, and that progressively. At the end of ten minutes from the beginning of inhalation, the relaxation and immobility of the limbs was complete, the insensibility was not doubtful, the respiration was deep, gentle, but free from râle. The muscles of the face had ceased to be agitated, and it was of a violet red colour, as was also the skin in front of the chest; the pupils were turned upwards, dilated and immoveable.

The apparatus was taken away, and the operation was commenced; but the incision had only given issue to a small quantity of black blood, when it was perceived that the features were altered and become entirely violet, and that the respiration was extremely feeble. The pulse, touched on this moment for the first time, was soft, full, and very slow. All at once it ceased to beat.

Twenty-four hours after death, all parts of the body yielded a strong odour of ether. The blood was deep black, fluid, and rather viscous. The blood which gorged the back part of the lungs had a consistence and colour somewhat like treacle. The mucous membrane of the bronchi, trachea, and larynx was very much congested. The spleen was so softened in its interior as to resemble the lees of wine.

This patient appears to have died rather from the want of admission of sufficient air to the lungs than from the effects of ether. The apparatus was applied without intermission, long after the face became injected, and was kept applied till it became of a violet colour. The pulse was not felt till the patient was dying. Artificial respiration

was not attempted, although it would most likely have restored the patient.

The other death which happened whilst the patient was under the influence of ether took place at the Hotel Dieu de Lyons, on September 11th, 1852.* The patient was a woman, aged fifty-five, but looking much older. She was affected with a tumour of the superior maxillary bone, and was weak and in a bad state of general health. M. Barrier was reluctant to remove the tumour, but yielded to the entreaties of the patient. The ether was administered from a sponge placed in a bladder, and the patient was quickly put to sleep. M. Barrier had made the incisions in the face, and had just divided the ascending process of the jaw, when the breathing stopped. There was no pulse at the wrist, and it was doubtful whether there was any at the precordial region. The patient was placed horizontally, and artificial respiration and other measures were applied, but without success.

This patient evidently died of hæmorrhage; the mode of death which M. Barrier must have been dreading, as we perceive from his reluctance to perform the operation. According to the result of my experiments on animals, ether is not capable of causing the kind of death which this patient died.

There were three or four cases in which ether was blamed by the operating surgeons for causing the death of patients, who recovered from its effects, and died some days, or at least hours, afterwards. The nature and circumstances of the operation were sufficient to account for the fatal result in each of these cases, whilst the extended use of ether has confirmed the opinion that it cannot be the cause of deaths which occur days, or even hours, after its use.

* Gaz. des Hôpitaux, Juin 18, 1853.

On Friday, the 12th of February, 1847, Mr. Roger Nunn performed lithotomy, in the Colchester Hospital, on a man who, as it was found after his death, had disease of the kidneys. The ether seemed to act favourably. Mr. Nunn says: "There was neither difficulty nor loss of time in cutting into the bladder; but having done so, some little delay occurred in grasping the stone, which was small, very flat, and lying in the posterior part of the bladder; the delay was also increased by the extremely relaxed state of the bladder itself, which seemed to fall in folds on the forceps, and to cover the stone."* This delay in grasping the stone is attributed by Mr. Nunn to a collapsed state of the bladder caused by the ether, but it can only have arisen from the fact of the urine having escaped from the bladder, before the stone was seized. The small vessels divided in making the first incision showed much inclination to bleed, and Mr. Nunn secured them immediately after the patient was put to bed.

Speaking of his patient and the ether, Mr. Nunn says: "He recovered from its effects after a short time, and continued in a quiet passive state, but without decided reaction for twenty-four hours. At this period he had a chill, which lasted for nearly twenty minutes." Stimulants were given, but without much effect. The patient seemed incoherent from eight o'clock P.M. of Saturday till nine A.M. of the following day. From this time he gradually sank, and died at five o'clock P.M. of that day, Sunday, being sensible to the last.

On March 9th, 1847, Mr. Wm. Robbs, of Grantham, removed an osteo-sarcomatous tumour from the back part of the left thigh of Ann Parkinson, a married woman, aged twenty-one, the mother of one child.† Mr. Robbs tried to make his patient insensible with ether, but did not succeed.

* Medical Gazette, vol. xxxix, p. 414. † Ibid., vol. xxxix, p. 585.

He says, indeed, that in about ten minutes its usual effects were produced; but these could not have been its full and proper effects; for he says, "she appeared quite sensible to the pain during the whole of the operation." It is reported that she appeared to feel the first cut. Mr. Robbs says that during the early part of the operation, the patient "cried out much, complained, and writhed in great agony of pain." The operation was begun by an incision commencing midway between the tuberosity of the ischium and the trochanter major, and extending about six inches down the thigh. The fascia was next divided, and the muscles were next separated with the handle of the scalpel, so as to expose the upper surface of the tumour. After this had been done, the inhaler was replaced to the mouth of the patient whilst the operation proceeded, but the ether appeared to take no effect. The tumour was "very adherent to the long head of the biceps flexor cruris, which nearly covered it anteriorly, while posteriorly it rested on the sheath of the great sciatic nerve. It took its origin from the common tendon of the flexor muscles, close to the tuber ischii, and was inserted into the short head of the same muscle just below its origin." Mr. Robbs says: "The dissection was protracted longer than I expected, from the violent contractions of the muscles, and the struggles of the patient." He estimated the time occupied in the operation at twenty-five or thirty minutes; and the sister-in-law of the patient, who gave her evidence at the inquest, expressed her opinion that the operation lasted an hour all but five minutes. At the end of the operation, the patient appeared very faint, and the pulse was very rapid and feeble. The patient remained much depressed, with a pulse of 140 in the minute, small, and without much power, having her intellect perfect; she died forty hours after the operation.

A coroner's inquest was held, but neither the coroner nor

any of the jury appeared to have any knowledge or suspicion that a surgical operation on the thigh could possibly be the cause of death. A surgeon who gave evidence stated, that "the shock from the operation was not simply the cause of death, as the seat of the disease was not essential to life." The verdict was, that the death of deceased was caused by the inhalation of ether; and that no blame was attached to the surgeon, as ether had been used and recommended by eminent medical men.

I cannot tell whether Mr. Robbs would have undertaken the operation if ether had not been about to be used, but if he had undertaken it without ether, one may presume that he would have done what every surgeon does who undertakes a great operation, that he would have informed the patient and her friends that it would be attended with some amount of danger. In his communication to the *Medical Gazette*, Mr. Robbs complains of the friends of his patient having thought it necessary to obtain a coroner's inquest; but he has himself to blame for that. After he had attributed the death entirely to a new agent, which had been given with a view to prevent the pain, and had entirely failed even in that, it was very natural that they should seek for a legal investigation of the affair.

Mr. Robbs makes no admission that the pain his patient suffered could be due to any defect in the administration of the ether. He states, that he "was quite unprepared for that perfect state of prostration of the brain and nervous system which it appears in this case to have induced". The fact of the patient crying much, and complaining, and writhing in great agony of pain, and the contraction of the muscles, and the struggles which protracted the operation, do not look like a prostration of the brain and nervous system. At the end of the operation she was, to be sure, prostrated by its long duration, and the great loss of blood

which must have occurred ; but her brain and nervous system were not so much affected as the vascular and muscular system. She spoke of the operation as having been very severe, and she retained her mental faculties perfectly to her death. Ever since 1818 many of the students at lectures on chemistry had inhaled the vapour of ether to quite as great an extent as Mr. Robbs' patient.

As a proof how far the feelings will suspend both reason and common sense, it may be mentioned that some of the medical men, who were strongly opposing the use of ether in 1847, did not hesitate to allude to the inquest in this case, as showing that ether had caused the death of a patient.

Mr. Eastment, of Wincanton, Somersetshire, related a case* in which he attributed the death of the patient to ether. It was apparently the first time he had seen ether employed on the human subject; and with a larger experience of its effects, he would no doubt alter his opinion respecting the cause of death in the case he related.

A boy, aged eleven years, became entangled in the machinery of a mill, about eight A.M., on February 23rd, 1847, in consequence of which he sustained a very severe compound fracture of the left thigh, with great laceration of the soft parts, and a simple fracture of the right thigh. The surgeons in attendance waited till four P.M. for the boy to recover from the shock of the injury, and then performed amputation of the left thigh. Ether was given, but so badly, that the patient's sufferings were so severe on the circular incision being made, that it appeared to be a complete failure. The inhalation was repeated, however, and the pain of the latter part of the operation was prevented. The patient died three hours after the operation, being in a state of great exhaustion, with occasional mental excitement, during the three hours.

* Medical Gazette, vol. xxxix, p. 631.

This patient's chance of life would probably have been improved if the ether had been more effectually given, so as to prevent all the pain of the operation; but I believe that his chance of recovery would have been most improved by administering the ether soon after the accident in the morning, which would most likely have removed the collapse, and enabled the surgeon to perform amputation at once, and thus have prevented the eight hours suffering and depressing effects of the great laceration of the thigh.

M. Bouisson* has mentioned a case in which death was attributed to ether by a surgeon named Roël, of Madrid. Dolorès Lopes, aged fifty, of very feeble constitution, and addicted to drunkenness, had long suffered from a cancerous tumour of the breast. It was removed after the patient had inhaled ether for half an hour, and it weighed three pounds and a quarter. The patient died seven hours after the operation. But the operation itself was sufficient to account for the death of such a patient; and she could not die from ether at the end of seven hours after inhaling it.

On account of its great safety, ether is extremely well adapted for medical cases, in which it is necessary that a narcotic vapour should be administered by the patient's nurse.

The Combination of Chloroform and Ether. Some practitioners have recommended the inhalation of the vapour from a mixture of chloroform and ether; but the result is a combination of the undesirable qualities of both agents, without any compensating advantage. Ether is about six times as volatile as chloroform—that is to say, if equal measures of each be placed in two evaporating dishes kept side by side, at the same temperature, the ether evaporates in about one-sixth the time of the chloroform; and when the two liquids are mixed, although they then evaporate

* Méthode Anesthésique, p. 394.

together, the ether is converted into vapour much more rapidly; and, in whatever proportions they are combined, before the whole is evaporated the last portion of the liquid is nearly all chloroform: the consequence is that at the commencement of the inhalation the vapour inspired is chiefly ether, and towards the end nearly all chloroform: the patient experiencing the stronger pungency of ether when it is most objectionable, and inhaling the more powerful vapour at the conclusion, when there is the most need to proceed cautiously.

A death which occurred during a surgical operation in America, has been attributed to the mixture of chloroform and ether which was employed;* but there is no doubt that the patient died of hæmorrhage. Dr. R. Crockett, of Wytheville, Virginia, removed a fatty tumour from the back of a boy, aged five years. Four parts of washed ether by measure were mixed with one part by measure of chloroform, and a drachm of this mixture was poured on a funnel-shaped sponge which was applied near the mouth and nostrils. The tumour was very large, and required two incisions of nine inches in length for its removal. Six arteries required to be tied; and just as the last one was secured, the child began to vomit. He was found to be pulseless, and he died three or four minutes from the commencement of vomiting. Dr. Kincannon, who was present, and watching the patient, said that up to the time he began to vomit, there was nothing in the circulation or respiration to produce the least apprehension.

The operator said that the patient probably lost four ounces of blood, certainly not six. It must be observed that as the blood during an operation is carried away by the sponges, it is impossible to estimate the amount. It could be ascertained only by an analysis of the water in

* American Journal of Med. Science, July 1857, p. 284.

which the sponges are washed. But even admitting that in the present case the loss of blood did not exceed six ounces, it is probable that this amount, flowing suddenly from a child of five years of age, might cause death. Vomiting does not take place when a patient is deeply under the influence of ether or chloroform, and the fact of no signs of over narcotism having appeared, confirms the view that death was occasioned by the loss of blood.

AMYLENE.

This substance was discovered and described in 1844 by M. Balard, Professor of Chemistry to the Faculty of Sciences of Paris.* M. Auguste Cahours had given this name five years previously to a product which is isomeric with amylene, and is produced at the same time, but is now termed paramylene.

Amylene is made by distilling amylic alcohol with chloride of zinc. The amylic alcohol is obtained from crude fusel oil, otherwise called oil of grain, or oil of potatoe spirit. The fusel oil must be submitted to a careful distillation, with a thermometer in the retort. It begins to boil at a comparatively low temperature, but that portion only is to be retained which comes over from 266° to 284° Fah. Caustic potash is added, to decompose the œnanthic ether which the distilled liquid contains, and it is then redistilled, and that portion which boils steadily at 270° Fah. is collected as pure amylic alcohol. Amylene can be obtained from amylic alcohol in the same manner that olefiant gas, or ethylene, can be made from common alcohol, namely, by heating it with dishydrating agents, as sulphuric, phosphoric, fluoboric and fluosilic acids, and chloride of zinc; but most conveniently with the last substance, which is the one that M. Balard employed. The product which is obtained when amylic alcohol and chloride of zinc are distilled together, contains at least three distinct hydro-carbons, amylene, paramylene, and metamylene; and the amylene

* Annales de Chimie et de Physique, 3ème série, tom. xii, p. 320.

which is the most volatile is separated from the others by successive distillations.

Amylene is a colourless and very mobile liquid, of extremely low specific gravity; being one of the lightest liquids known. The amylene made for me by Mr. Bullock* had a specific gravity of 0·659 at 56°. It is very volatile, boiling at 102° Fah. according to M. Balard, and at 95° according to Frankland, and the specific gravity of its vapour is 2·45. It is composed of ten atoms carbon and ten atoms hydrogen, and bears the same relation to amylic alcohol that olefiant gas, or ethylene, bears to common alcohol.

It is inflammable, burning with a brilliant white flame; and in pouring it out by candle light, the same care is required as in dealing with sulphuric ether. A slight explosion may be obtained by applying a light to a mixture of a small amount of its vapour with a large quantity of air.

It is soluble in alcohol and ether in all proportions, but is very sparingly soluble in water, being in fact a hundred times less soluble than many substances which are ordinarily spoken of as insoluble. From a number of careful experiments which I made, I found that water dissolves 2·35 per cent. of its volume of the vapour of amylene. It follows therefore, from the specific gravity of amylene and of its vapour stated above, that amylene requires 9319 parts of water for its solution. The water which has dissolved this small quantity of amylene tastes as distinctly of it as amylene itself.

Amylene has more odour than chloroform, but much less than sulphuric ether, and the odour does not remain long in the patient's breath. The smell of amylene somewhat resembles that of wood spirit. The first specimens which Mr. Bullock made were slightly offensive, but the odour improved and diminished in strength, as he obtained the sub-

* 15, Hanover Street, Hanover Square.

stance in a state more nearly approaching to purity. Many persons, who thought the odour disagreeable at first, began to like it after they had been exposed to it three or four times. It is almost without taste, and it produces no irritation, or effect of any kind on the sound skin, even when confined, and prevented from evaporating. The vapour is almost entirely without pungency, furnishing in this respect a remarkable contrast to both ether and chloroform. Its presence can be perceived on first beginning to inhale it, but after two or three inspirations, one cannot tell whether the air one is breathing contains any of the vapour or not. It does not cause any cough unless there is great irritability of the air-passages, or the vapour is breathed of great strength in the very first inspirations.

Amylene produces about as much cold during its evaporation as sulphuric ether does. If a sponge or piece of blotting-paper wetted with amylene is exposed to the air, a portion of the moisture of the air becomes condensed on its surface, by the cold caused during the evaporation of the amylene; and by the further effect of the cold the condensed moisture is frozen, and the sponge or paper is covered with hoar frost.

The boiling point of pure amylene would probably be that which I have quoted above from Frankland, viz., 35° cent. or 95° Fah.; but the amylene which has been obtained for inhalation contains other hydrocarbons of an analogous composition, and its boiling point is not steady: 95° Fah. was indeed about the average boiling point of the greater part of the amylene furnished to me by Mr. Bullock, for it usually commenced to boil at 86°, and as it evaporated, the boiling point gradually rose to 109°, or higher.

No method is at present known of separating amylene from the products which come over with it, except a number of distillations; and although these may be carried so far as

to obtain a small quantity almost pure, the price of it would be too great to admit of its employment for inhalation. For this purpose, one must be content with a product approaching to purity. Dr. Debout, in an article on amylene,* says that the boiling point commences at 28° (82° Fah.), and rises gradually to 40° or 45° (104° or 113°) in the best products which have been obtained by Mr. Bullock of London, M. Hepp of Strasbourg, and the house of Ménier at Paris.

M. Duroy published an elaborate paper on amylene, on April 9th, 1857.† In this paper, he gives the result of an examination of four specimens of amylene: the first, which he calls A, was amylene made by Mr. Bullock; the second (B) was the amylene of M. Ménier; the third (C) was some that he had prepared according to the process of M. Hepp; the fourth (D) was amylene which he had obtained by a process which he described. In this process, he employed dry chloride of zinc and amylic alcohol. M. Balard recommended a solution of chloride of zinc of a certain strength to be used. I may state, however, that Mr. Bullock had from the first used dry chloride of zinc.

The following table shows the temperature at which the different specimens began to boil, and the temperature to which they rose before being boiled entirely away.

A	30° cent.	=	86° Fah.	to	46° cent.	=	115° Fah.
B	29 „	=	84 „	to	75 „	=	167 „
C	30 „	=	86 „	to	62 „	=	143 „
D	31 „	=	88 „	to	57 „	=	134 „

Mr. Bullock's amylene went through the smallest range of temperature whilst boiling away.

M. Duroy found that potassium was oxidized to a certain extent in all these specimens of amylene, and a small quan-

* Bulletin Général de Thérapeutique, t. lii, p. 312.
† L'Union Médicale, p. 175.

tity of hydrogen gas was produced, showing that they did not consist entirely of hydrocarbons, but that there distilled over with them a small quantity, either of amylic alcohol, or amylic ether.

The following table shows the cubic centimetres of hydrogen gas which were disengaged from three grammes of each of the different kinds of amylene.

A	-	-	-	64
B	-	-	-	91
C	-	-	-	75
D	-	-	-	69

Examined in this way, Mr. Bullock's amylene showed the smallest quantity of impurity; and, next to that, the amylene made by M. Duroy.

M. Duroy found that amylene can be purified from the substances containing oxygen by distilling it again with dry chloride of zinc. He was able to obtain pure amylene, boiling steadily at 35° cent., but to get at this result he made so many distillations that he had only forty grammes of amylene from five litres of amylic alcohol.

He states that the following are the characters of absolute amylene.

To boil steadily at 35° cent.

To be without action on potassium, and to preserve that metal like naphtha.

Not to be coloured, even by prolonged contact with caustic potassa.

Not to give rise to valerianic acid under the action of hydrated potassa.

The following table shows the amount of vapour of amylene in air which is saturated with it at various temperatures. The specimen of amylene with which I made the experiments began to boil at 95° Fah.

Temp. Fah.	Vapour.	Air.
24°	20·3	79·7
26	20·9	79·1
28	21·6	78·4
30	22·3	77·7
32	23·2	76·8
34	24·3	75·7
36	25·5	74·5
38	26·8	73·2
40	28·2	71·8
42	29·6	70·4
44	31·1	68·9
46	32·7	67·3
48	34·3	65·7
50	36·0	64·0
51	36·9	63·1
53	38·6	61·4
55	40·0	60·0
57	42·5	57·5
58	43·7	56·3
59	45·0	55·0
60	46·5	53·5
61	47·7	52·3
63	50·4	49·6
65	53·1	46·9
67	55·9	44·1
69	58·8	41·2
71	61·9	38·1
73	65·1	34·9
75	68·6	31·4

I was not aware of the existence of amylene till 1856, or I should have tried it sooner; for I made inquiry in 1848 for a substance named eupion by Reichenbach, its discoverer, but was unable to obtain it. Eupion is a carbohydrogen, described as having all the physical characters which belong to amylene, though obtained in a different way; and I believe it is the same substance, or the hydride of amyle. Reichenbach obtained it from coal tar, but other chemists have not been able to make it.

Judging from experiments which I had made on analogous substances, there could be no doubt of amylene causing insensibility when inhaled; but I could not tell, without actual trial, whether it might not be unpleasant in its action.

I believe that amylene had but rarely been made, and only in very small quantity, until I requested Mr. Bullock to make it for me. For some time afterwards, soon after my first paper had appeared on the subject, M. Berthé, of Paris, made some amylene and submitted it to M. Balard, its discoverer, who acknowleged its purity, and was astonished at the great quantity M. Berthé had obtained. This quantity, however, appears to have only been forty grammes, or about ten fluid drachms.

As soon as Mr. Bullock succeeded in making some amylene for me, I proceeded to perform some experiments with it on small animals. I found that it was necessary that an animal should breathe air containing about 10 per cent. of the vapour in order to lose its consciousness, and that 20 per cent. caused a deep state of insensibility, whilst 25 per cent. could be breathed with perfect safety.

The following are a few of the experiments.

Experiment 43. A guinea pig was placed in a glass jar holding four hundred and twenty-eight cubic inches. Fifteen grains of amylene were dropped through a small tube in the air-tight cover of the jar, fell upon blotting paper suspended within, and quickly evaporated and became mixed with the air. In three or four minutes the guinea pig staggered and became altered in its manner. It did not become further affected, although it was allowed to remain for ten minutes. When taken out its sensibility did not seem impaired. Each grain of amylene produces 1·315 cubic inch of vapour, and consequently the air in this experiment contained 4·6 per cent. of vapour.

Experiment 44. The same guinea pig was placed in the same jar three days afterwards, and twenty-five grains of amylene were introduced in the same manner. At the end of two or three minutes the guinea pig seemed estranged in its manner, and turned its head from side to side. In a

little time it seemed getting drowsy, but at the end of twelve minutes it was still on its legs and moving voluntarily. Eleven grains more of amylene were now introduced. In a little time it sank down unable to stand, and on being turned over by inclining the jar it made efforts to right itself, which became more and more feeble. It was taken out at the end of fifteen minutes, *i.e.*, three minutes after the introduction of the additional amylene. It gave a slight squeak, and moved its feet and eyelids on being lifted. On being pricked it gave decided evidence of sensation. It recovered in a few minutes. There were 7·7 cubic inches of vapour in each one hundred cubic inches of air in the first part of the experiment, and eleven cubic inches in the latter part.

Experiment 45. Six fluid drachms of amylene in a little bottle were put into a glass jar of the capacity of one thousand six hundred cubic inches, and the mouth of the jar was tied over with a large piece of oiled silk. The bottle was emptied by inclining the jar, and the amylene was made to run about the sides of the jar till it had all evaporated. A guinea pig was then folded in the superabundant oiled silk beyond the string which tied it, the string was then opened, and the animal introduced into the jar without allowing any communication with the external air. The guinea pig began to be affected within half a minute, and in a minute it was lying insensible, but moved its limbs when it was rolled about in the jar. In two minutes it was flaccid, and could be rolled about without causing any resistance or muscular action. It lay relaxed and motionless till taken out at the end of four minutes, although by an occasional motion of the eyelids it seemed not altogether insensible. It was quickly taken out, but the moment it was removed it began to kick, and being pricked it flinched. It was not able to stand for two minutes, but after this it

quickly recovered. Six fluid drachms of amylene weigh 240 grains, and produce 315 cubic inches of vapour; consequently there was nearly 20 per cent. of vapour in the air in this experiment.

Experiment 46. A guinea pig, a fortnight old, was placed in the jar holding 428 cubic inches, and eighty-two grains of amylene were introduced on blotting paper. It was six minutes in evaporating. The guinea pig became gradually affected, and, a minute or two before the amylene had all evaporated, it was lying unable to walk. It was allowed to remain till ten minutes had elapsed, that is, four minutes after the amylene was all converted into vapour; but it did not, apparently, become quite insensible. The limbs were never quite relaxed, and when turned over in the jar there was a little motion of the limbs and head. There was also a little quivering motion of the limbs occasionally when not disturbed, and at one time it opened and shut its mouth. On its removal, pricking the soft parts of its toes caused sometimes a slight groan. It recovered slowly and gradually. In ten minutes it was quite conscious, but not as brisk as before the experiment. There was 25 per cent. of vapour in the air the guinea pig breathed in this experiment.

Guinea pigs have a great tendency to flinch when pricked whilst they are under the influence of amylene. I did not find this to be the case with other animals.

Experiment 47. A lean, starved cat was placed in a glass jar holding 1,600 cubic inches, and 120 grains of amylene were introduced upon blotting paper. The cat became inebriated whilst the amylene was evaporating; and by the time it had all evaporated—which was four and a half minutes—the cat had sunk down in a state of insensibility. The eyes were turned downwards, so as to expose the white; but its limbs were not relaxed. In a minute or two after-

wards it made no effort when rolled about in the jar. It was taken out at the end of nine minutes from the commencement of introducing the amylene. It was breathing noisily; its limbs were not relaxed; it was totally insensible to pricking of the ears and paws. It began to recover in about a minute: in two or three minutes it flinched on being pricked; it staggered for two or three minutes longer, and in ten minutes it was pretty well recovered. The amylene would produce 158 cubic inches of vapour, or very nearly ten per cent. in this experiment.

Experiment 48. A linnet was placed in a jar holding 428 cubic inches, and forty grains of amylene were introduced on blotting paper. In two minutes it had evaporated. Until it had nearly evaporated, the bird was hardly affected, only evincing a desire to escape. As soon as the amylene had evaporated, the linnet lay unable to move, but evincing consciousness and sensibility by the motion of its eyelids and eyes, and by moving its legs when it was turned over by inclining the jar. It remained in this state for three minutes, when eight grains more of amylene were introduced into the jar. The bird almost immediately closed its eyes; and it opened its bill a little, from which a little liquid flowed. The motion of its legs also ceased, and its breathing was slower. It was taken out half a minute after the last portion of amylene was introduced. It seemed quite insensible when removed, but began to recover in a few seconds. When its foot was pricked, twenty or thirty seconds after its removal, it flinched. In two or three minutes it was quite recovered. There were 12·3 per cent. of vapour in the air in the first part of this experiment; and 14·7 per cent. in the latter part.

Experiment 49. Another linnet was placed in the same jar, and forty-eight grains of amylene were introduced in the same manner. It took nearly three minutes to evapo-

rate, hoar frost being produced on the blotting paper. The bird began to stagger when the amylene was about half evaporated; and by the time it was all evaporated, the bird was lying apparently insensible, with its eyes closed, and breathing quickly. It was allowed to remain two and a half minutes, during which it did not alter. It was often rolled about by moving the jar; and during the last minute and a half it made no effort, except once or twice a slight motion of the wings. It was taken out two and a half minutes after the amylene had all evaporated. It was quite passive, and insensible to pricking of the toes, for half a minute or so after its removal, when it began to recover, went through a stage of staggering, and was well in three or four minutes. The amount of vapour in the air, in this experiment, amounted to 14·7 per cent.

Experiment 50. Fifty grains of amylene were diffused in a glass jar holding 330 cubic inches, and a linnet was introduced by momentarily moving the lid a little to one side. It was quickly affected, and in about a quarter of a minute was lying quite insensible. It remained so, breathing quickly and naturally, and made no effort whatever when rolled about in the jar. It was allowed to remain three minutes, and there was a slight fluttering motion of the wings just before its removal. It was quite passive when removed, and insensible to pricking of the soft part of the foot. It began to recover its sensibility in three quarters of a minute. In two minutes it was able to stand, and in six minutes it got on the perch. There was twenty per cent. of vapour in the air in this experiment.

As amylene boils nearly at the temperature of the blood, that fluid would be able to absorb about one-fifth as much as it would be able to dissolve, when an atmosphere is breathed containing twenty per cent. of the vapour, which produces a complete state of insensibility, or the fourth

degree of narcotism. When ten per cent. is breathed, which has been shown to cause the second degree of narcotism, about one-tenth as much vapour as the blood would dissolve must be absorbed. In treating of chloroform and ether, it was previously shewn that the fourth degree of narcotism was caused by one twenty-eighth part as much of these agents as the blood would absorb; and the second degree by one fifty-sixth part. And these were the proportions absorbed of several other agents which are made from ordinary alcohol, and will afterwards be mentioned.

Although the proportion of amylene absorbed is large in relation to the whole quantity which the blood would dissolve, it is a very small amount on account of the extremely slight solubility of the agent. If we estimate the average amount of serum of the blood in the human adult at 410 fluid ounces, as before, then, as amylene requires 9,319 parts of watery fluids for its solution (as nearly as I could ascertain), the quantity of this agent in the system must be rather less than three grains in the fourth degree of narcotism; rather less than a grain and a half in the second degree; and a very little over two grains in the third degree of narcotism, the condition in which surgical operations are usually performed. Amylene is therefore, when absorbed, about as powerful in its medicinal properties as the alkaloids.

The following fact also proves that but a very small quantity of amylene is absorbed. In breathing this agent backwards and forwards from a small bladder containing 200 cubic inches of air, fourteen minims was the largest quantity I could put into the bladder without being rendered unconscious; but in employing a large bladder holding 670 cubic inches, I could put in forty-five minims, and breathe it backwards and forwards for some time without being rendered unconscious. With fifty minims of amylene I

immediately forgot where I was; but awoke in a minute or two, seated in the same position, and with the bladder in my hand. Fifty minims of amylene would produce between six and seven per cent. of vapour in the bladder; and after the air in the lungs became mixed with that in the bladder, there would be rather more than five per cent. of vapour in it.

Viewed in the light of the small quantity which requires to be absorbed into the system to cause insensibilty, amylene is a very powerful agent; but when considered in relation to the quantity which is consumed during inhalation in the ordinary way, it is very far from being powerful. This arises from the great tension and the small solubility of the vapour, in consequence of which it is, with the exception of a small fraction, expelled from the lungs again without being absorbed. In this respect it resembles, to a great extent, the nitrogen gas of the atmosphere, with which the lungs are always four-fifths filled, while the blood contains but a few cubic inches. It takes from three to four fluid drachms of amylene to cause insensibility in the adult.

I found, by my experiments on animals, that amylene is, like chloroform and some other agents, capable of causing sudden death by over-narcotism of the heart, and paralysis of that organ; but that it is more difficult to cause this kind of sudden death with amylene than with chloroform.

Experiment 51. One hundred and twenty grains of amylene were made to evaporate in a jar holding 330 cubic inches, and a full grown guinea pig was suddenly introduced, the cover being partly removed for a moment. It was allowed to remain for about a minute, when the breathing became of a gasping character. Being taken out, and the stethoscope applied immediately to the chest, the heart could not be heard to beat; and its action did not return, although the gasping continued for about a minute. There

was nearly 48 per cent. of vapour in the air in this experiment, except that a small quantity might escape as the guinea pig was introduced. I had tried guinea pigs with smaller proportions of vapour in the air, but had not succeeded in arresting the action of the heart.

The lungs were rather congested, and the right cavities of the heart were filled, and somewhat distended with coagulated blood.

Experiment 52. A kitten, six weeks old, was placed in a jar holding 330 cubic inches, after ninety-five grains of amylene had been made to evaporate and diffuse itself. The kitten remained three quarters of a minute in the jar, and was suddenly taken out. It was scarcely insensible on its removal, but soon became so. The stethoscope was applied, and the heart was found to be beating rapidly. The kitten quickly recovered.

One hundred and six grains of amylene were made to evaporate in the same jar, and the kitten was quickly introduced, as before, by moving the cover for a moment. It was allowed to remain for half a minute, and removed with the same symptoms and result as before.

The same quantity of amylene was employed, and the kitten was introduced again, and allowed to remain for fifty seconds. On its first removal the heart was not beating, but the kitten was gasping; and just afterwards the heart was heard to be beating rapidly. The kitten quickly recovered.

One hundred and twenty grains of amylene were allowed to evaporate in the jar, and the kitten was introduced again. It was allowed to remain a minute, and was taken out as the breathing appeared to be on the point of ceasing. The heart was beating when the stethoscope was employed, and the kitten quickly recovered. It seemed impossible to kill it with amylene, except by allowing it to remain and inhale

the vapour, by those gasping inspirations which took place when the action of the heart was arrested, and which restored the action of this organ, when the kitten was withdrawn from the vapour. In the different parts of this experiment there were 37, 42, and 47 per cent. of amylene in the air.

When mice are placed in air containing 30 per cent. and upwards of vapour of amylene, they usually recover, as in the following experiment, if the breathing has not entirely ceased on their removal; whilst if they are placed for a quarter of a minute in air containing 8 or 10 per cent. of vapour of chloroform, they generally die, although they may be breathing well, and hardly insensible, when they are removed.

Experiment 53. Eighty grains of amylene were introduced into a jar holding 330 cubic inches, and when it had evaporated, a white mouse was introduced. In about five seconds it was quite insensible, and in about a quarter of a minute the breathing appeared to have ceased. The mouse was quickly withdrawn, and immediately began to gasp. After a few gasps the quick breathing returned. In half a minute after its removal the mouse was recovering, and it was soon quite well. There was 32 per cent. of vapour of amylene in the air in this experiment.

I administered amylene with the inhaler which I had used for several years in exhibiting chloroform, and which I have described in treating of that agent. In administering chloroform it is desirable that the patient should breathe 4 or 5 per cent. of the vapour in the air he inspires; and the air, when saturated with vapour of chloroform at 60°, contains 12 per cent., or nearly three times as much as the patient ever requires. In administering amylene for surgical operations, it is desirable that the patient should take in 15 per cent. of the vapour with the air he breathes; and

air, when saturated with this vapour at 60°, contains 465. per cent., or fully three times as much as the patient ever requires. It therefore seemed reasonable that the inhaler which had answered so well with the former agent, might be employed in the same manner, and used successfully with the latter agent. Vapour of chloroform, when inhaled of twice the proper strength, *i.e.*, of 8 or 10 per cent., is capable of causing sudden death by over-narcotism of the heart; but amylene is required to be of nearly 40 per cent., or more than twice the proper strength, before it could produce this result: and it seemed, therefore, reasonable to expect that the inhaler which had been employed for so many years with chloroform, might be employed in exhibiting amylene with an equally satisfactory result. And if the amylene furnished for inhalation had been a constant and uniform product, boiling steadily at the same temperature, like chloroform, there is no doubt that these expectations would have been fulfilled.

I first administered amylene, in King's College Hospital, on the 10th of November 1856, to two boys, about fourteen years old, previous to Mr. Samuel Cartwright extracting some teeth. I had but a few drachms, and being very sparing of its use, it did not entirely remove consciousness in either case, and the pain was not altogether prevented: the effects, however, as far as they extended, were so favourable as to encourage a further trial, which was made in the same institution, on December 4.

On this occasion I exhibited the amylene to four patients —two men, a young woman, and a girl of ten years old: it occasioned complete unconsciousness and absence of pain in each case. The first man was about thirty-five years of age. Half a fluid ounce of amylene was put into the inhaler, and he inhaled for three minutes. At first the valve of the face-piece was about one-third open, but it was gradually moved

till it was almost closed. The man breathed readily, without coughing, and in a very little time seemed to be unconscious. The pulse became quick and slightly irregular; the skin became flushed; and in about two minutes there was a rather free sweating of the forehead; the eyes did not turn upwards; the conjunctivæ did not become insensible; there was no relaxation of the limbs, and, on the contrary, no struggling. The patient sat well, supporting himself, without any tendency to slide out of the chair; the mouth was partly open, and there was a tendency to laugh, just as the amylene was discontinued. The tooth was extracted by Mr. S. Cartwright, without making him flinch or cry in the least. In less than a minute he awoke. He looked a little strange at first, but immediately remembered all the circumstances of his situation, but knew nothing of the operation; and, three minutes after the extraction of the tooth, and six minutes after entering the room, he went away feeling, as he said, quite well. The amylene put into the inhaler was nearly used.

A young man, about twenty years old, next inhaled the same quantity, in exactly the same manner, for just three minutes; there was no irregularity of pulse, and no sweating; otherwise the symptoms were exactly the same. The tooth was extracted without his knowledge, and without causing a cry or flinch. He awoke, and was able to go in three minutes.

A young woman in bad health, an out-patient of one of the physicians of the hospital, next inhaled. She breathed the amylene for four minutes, and about three drachms were used. The effect was carried to the commencement of the third degree of narcotism; and the eyes were inclined to turn up, but did not do so persistently. The edges of the eyelids also remained sensible. There was a little trouble and delay in getting the mouth open, as the muscles of the

jaws were rather rigid; and when the tooth was extracted, she flinched, and cried out a little. She did not remember the operation. She said she had had a very unpleasant dream, and she was dizzy and uncomfortable for about ten minutes, after which she was better.

A little girl ten years old inhaled for four minutes, and between two and three drachms were used. The eyes were turned up for a short time. She did not flinch or cry as the first tooth came out, but did both as two others were afterwards extracted. She did not, however, know anything afterwards of the operation. She recovered her consciousness in a minute or two, and quite recovered from the effects of the vapour in a few more minutes. There was no sickness, and no increased flow of saliva, in any of the cases.

On December 11th, I administered the amylene again in five more cases of tooth-drawing, with very similar results to those obtained in the previous cases; and on December 13th, I exhibited it in some more important cases.

Mr. Fergusson performed an operation for fungus of the testicle; Mr. Bowman removed some diseased glands from the groin; and there were two cases of tenotomy, in one of which forcible extension of the knee was made.

From November 1856 to July 1857, I exhibited amylene in 238 cases. There were seven cases of lithotomy; six of the patients were children, and the seventh a young man of seventeen. They all recovered. Five of the operations were performed by Mr. Fergusson, in King's College Hospital; and two were performed in St. George's Hospital, by Mr. H. C. Johnson and Mr. George Pollock.

There were five cases of resection of the knee; three of the patients got well, and two died. These operations were performed in King's College Hospital, one of them by Mr. Partridge, and the other four by Mr. Fergusson. Of the seventeen cases of resection of the knee, mentioned at page

280, in which chloroform was administered, I know the result only in thirteen of the cases. Of these, eight recovered, one of them after undergoing subsequent amputation at the thigh; and five died.

Some statistics of this operation have been gathered by collecting the cases which happen to be reported in the medical journals, but such statistics are likely to be extremely erroneous. The cases that are reported are probably far more favourable than those that are not reported. A surgeon undertakes an operation of this kind with no other view than the benefit of his patient, and without thinking of the medical journals; and, if his first or second case is unsuccessful, he is probably not inclined to repeat the operation. If the cases should be successful, however, he is inclined to repeat the operation when opportunity occurs, and may ultimately give the result of his experience to the profession.

Mr. Bowman removed the head of the femur in two little boys to whom I administered amylene; they both recovered, as did a girl who inhaled amylene whilst Mr. Fergusson performed resection of the elbow. I administered amylene in four cases of amputation of the thigh: one of these operations was performed by Mr. Henry Lee, on January 7th, 1857, on a girl aged twelve or thirteen, who underwent resection of the knee on the 1st of November previously. That operation was performed by Mr. Bowman, and the girl inhaled chloroform. At the time of the amputation, she was suffering from pyæmia, was extremely weak, and had a pulse of 150 in the minute. The vapour was exhibited to the patient in bed, before her removal to the operating table. There was an examination of the knee before the operation; and the anæsthesia was kept up till the dressings were applied, which was twenty-five minutes from its commencement, and nearly three fluid ounces of

amylene were used. She went through the operation extremely well. There was no sign of pain, and the pulse remained the same throughout the operation, and there was no depression. The patient recovered.

There was one operation of amputation below the knee by Mr. Fergusson, in which I administered amylene. The patient was a woman of twenty. The operation was performed on account of paralysis of the muscles of the leg and foot. She recovered. There was an amputation of the forearm; two amputations of the great toe, with its metatarsal bone; and two or three of toes and fingers: four cases of operation for stricture of the urethra by perinæal section—three of them by Mr. Fergusson, and one by Mr Curling. There were three operations of lithotrity, two for hæmorrhoids and prolapsus ani, and four for fistula *in ano*. There were nine operations for the removal of tumours of the female breast; there were seventeen operations for necrosis of the tibia, femur, lower jaw, and other bones.

I administered amylene in several operations on the eye. There were two operations for cataract by extraction, and one by drilling, performed by Mr. Bowman; eight cases of excision of the eye by that surgeon, as well as some operations for artificial pupil, for the removal of foreign bodies from the eye, for staphyloma, and one for the separation of the eyelids from the globe. There were also twelve operations for strabismus, eleven of them by Mr. Bowman, and one by Mr. Fergusson.

I exhibited amylene in forty-eight operations of tenotomy. Several of them were performed by Mr. Fergusson, but the greater number were performed by Mr. W. Adams and the late Mr. Lonsdale, in the Orthopædic Hospital. The narcotism was scarcely carried beyond the second degree in any of these cases. The eyes were open, and the features generally had an expression as if the mind was

active on some subject or other. The muscles were nearly always in a state of tension, at least they were not relaxed in any case. Many of the patients were children, and a number of them only inhaled between one and two minutes. There were five operations for the forcible extension of stiff joints, and two for dislocation of the humerus: the latter were treated in the St. James's Parochial Infirmary. The first case was a dislocation downwards in a woman aged sixty-eight. She inhaled for three minutes, when, extension being made, the bone slipped into its place with the utmost ease, although Mr. French had found a good deal of resistance in an attempt he made just before sending to me—not any serious resistance or pain, but so much of both as led him to think it would be a good opportunity for trying the amylene. In two minutes after the reduction of the dislocation, and five minutes after beginning to inhale, the patlent was quite awake again, and said that she had felt nothing. The other case was a dislocation forwards in a man aged seventy-two. No attempt to reduce it was made till the amylene was administered. The case was under the care of Mr. Buzzard. After inhaling two or three minutes, the old man got into a state of muscular rigidity, and did not get beyond this state, although I continued the inhalation nearly ten minutes, until about two ounces of amylene were used. He was quite insensible, but the rigidity prevented the reduction of the dislocation. So I discontinued it, and sent for some chloroform, which I administered a few minutes afterwards. It produced muscular rigidity rather stronger that that which the amylene had caused; but, by continuing the inhalation steadily for about two minutes, the limbs became relaxed, and the humerus slipped easily into its place. This is the only case in which the amylene has not effected the purpose for which I have exhibited it; and I have no doubt that I

could have produced relaxation of the voluntary muscles by increasing the strength of the vapour the patient was breathing; for I have always been able to produce relaxation of the muscular system of animals with it; but there were one or two circumstances which at the moment stood in the way of this. The patient's face was so hollow from his loss of teeth that the face-piece fitted badly; and, as it was early in a frosty morning, the water-bath of the inhaler was colder than usual. These defects could have been remedied if necessary, but I thought it as well to use chloroform; and I am inclined to think that chloroform and ether are better agents to employ in those instances where relaxation of the voluntary muscular system is required.

Sixteen tumours of different kinds were removed from different parts of the body, in addition to the tumours of the breast previously mentioned, in cases in which I administered amylene; and there was also a number of miscellaneous operations which I have not mentioned.

One of the patients of the late Mr. Lonsdale at the Orthopædic Hospital was a girl of seventeen, who had the scapula drawn up in an extraordinary manner by the action of the muscles. When she became unconscious from the amylene the shoulder came into its right position, with hardly any pressure, although her muscular system was not in the least relaxed from the action of the vapour; and the deformity remained absent for three days. The amylene was repeated three or four times with the same temporary benefit, and chloroform was given on one occasion when I was not present with a similar result. I have not heard of the subsequent progress of the case. I cannot suppose that the direct effect of amylene would remain three days on the nervous system, and I conclude that the result was brought about by some change in the emotions of the patient.

I gave amylene in twenty-four cases of tooth-drawing,

including those which were previously mentioned. One of the cases was that of a lady under the care of Dr. Oldham. She was suffering from a large ovarian tumour, and was unable to rise from the sofa. Mr. Bell extracted four teeth whilst she was under the influence of the amylene. She became insensible without the least excitement, was perfectly quiet during the operation, and recovered in a minute or two, feeling quite cheerful and well.

I have administered amylene in seven cases of labour. The first patient was under the care of Mr. Buzzard in St. James's Infirmary, on January 20th, 1857. It was the patient's second labour, and was a lingering one, having lasted thirty-five hours. I administered the amylene only during the last twenty minutes preceding the birth of the child, the head being advanced so as to rest on the perinæum. The vapour was given, well diluted, at the beginning of each pain. The patient breathed very deeply, and got relief very quickly from each pain ; the mind was quite clear between the pains, and I could not tell whether or not the consciousness was removed for half a minute or so during each pain. Half a fluid ounce of amylene was used. The next case occurred in an out-patient of King's College Hospital, under the care of Mr. Meadows, Dr. Farre's assistant. It was the patient's third confinement. I arrived three hours after the commencement of labour, and two hours before the birth of the child. The os uteri was almost dilated on my arrival, and the pains were very strong, recurring every three minutes or so. They continued to increase in strength to the last. The patient was probably unconscious for a brief period during the uterine contractions, while the amylene was administered, but between the pains she was quite conscious. Under the use of chloroform, in a labour with brisk and frequently recurring pains, as in this case, the patient usually sleeps on from one

pain to another. The amount of amylene inhaled in this case was three fluid ounces. The quantity used in each of these cases must have been about half a fluid drachm in each pain, and this is the quantity I had previously recommended Dr. Tyler Smith to employ, when he did me the honour to ask me some questions about amylene before he employed it in a case of labour. The results arrived at by Dr. Tyler Smith, in a case in which he employed amylene, were similar to my own, viz. relief of suffering during the uterine contraction, consciousness between the pains, and no interference with the progress of the labour.

On April 28, 1857, I administered amylene in Brownlow Street, Drury Lane, to a woman in her sixth labour, attended by Mr. Ponsonby R. Adair, one of Dr. Farre's assistants. She had been in labour since three P.M. the previous day. The os uteri was fully dilated, and the amylene was commenced at 5·25 A.M., and continued till 5·50, when the child was born. The placenta was expelled in a few minutes with very little bleeding. The amylene was exhibited with the inhaler at the beginning of each pain, which it soon relieved, although the patient did not become unconscious. The pains came on every two minutes or so, and kept increasing in force till the birth. About six drachms of amylene were used.

On May 1st., I administered amylene to another woman in her sixth labour, also attended by Mr. Adair. The vapour was commenced at 9·30 P.M., the patient having been in labour a few hours. The os uteri was not fully dilated. The pains came on regularly every three minutes, but were not very strong; they, however, gradually increased, and the child was born at half-past eleven. The cord was round the neck, and the child was nearly asphyxiated in the birth, but it was restored readily by Dr. Marshall Hall's method. The placenta was expelled a few minutes after the child

with very little hæmorrhage. The patient inhaled with every pain, which was very quickly relieved. The last quarter of an hour, she seemed to be altogether unconscious. About three fluid ounces of amylene were used.

On May 14th, I exhibited amylene for about an hour to a woman in her third labour, attended by Mr. Adair. The os uteri was nearly dilated when I arrived, and the patient had been in labour about ten hours. The pains occurred every three or four minutes, but were not strong. Amylene was inhaled with each pain for about an hour, when the pains almost ceased, just as the os uteri was fully dilated. I waited for half an hour without giving amylene, and then left to attend to another engagement. Mr. Adair informed me that the pains returned soon after I left, and that the child was born in about half an hour. The patient was hardly rendered unconscious by the amylene. Between two and three fluid ounces were used.

I exhibited amylene for an hour and ten minutes, on May 25th, to a woman aged 20, in her first labour. She was attended by Mr. Adair. She had been in labour since three P.M. the previous day, and the os uteri was not fully dilated. The amylene was commenced at 9·30 A.M., and inhaled with each pain, which it relieved in a very manifest way. The pains recurred every two minutes and a half. I left off giving the amylene at 10·40 to attend to other business. Mr. Adair informed me that the labour was concluded at one P.M.

On July 1st, I exhibited amylene to a woman in labour with her third or fourth child. Labour commenced at midnight of June 27th, and continued during the following day till the os uteri was dilated to the size of a crown piece, when the pains subsided on the evening of that day, and did not return to be effectual till the evening of July 1st. The amylene was commenced at 10·25, the os uteri being

almost dilated, and the pains recurring every three or four minutes. The uterine contractions increased in force and frequency, and the child was born at 11·45. There was a gush of blood two or three minutes after the birth of the child, and Mr. Adair introduced his hand and removed the placenta, which was only partially detached. The hæmorrage immediately ceased. The patient was feeble and emaciated, and had suffered repeated beatings by her drunken husband. She recovered favourably, as did the other patients.

The action of the amylene was very favourable in these obstetric casess. The pains were relieved very promptly by it, generally by the time the patient had taken two or three inspirations, and the effect of the vapour passed off in most cases between each pain.

The great ease with which amylene can be breathed, owing to its entire want of pungency, is a decided advantage which it possesses over both ether and chloroform. Insensibility can always be induced with amylene in as short a time as is desirable, namely, in from three to four minutes in the adult, and about two minutes in young children. It is not desirable to cause insensibility in a shorter time than this with any agent. If narcotism is induced too quickly, the symptoms are not uniform or in regular order, owing, no doubt, to the circumstance that the narcotic vapour is not equally distributed through the blood, which must convey it to the nervous centres. Insensibility can, indeed, be generally induced with chloroform in the time above-mentioned, but there are many cases in which there is considerable delay at the commencement of inhalation, owing to the pungency of the vapour, especially in nervous and in sensitive patients, and in persons with irritability of the air-passages from chronic bronchitis, phthisis, or any other cause.

In the use of amylene, absence of pain has been obtained

with less profound coma than usually accompanies the employment of chloroform and ether. There are some cases, indeed, in which the minor parts of an operation, under these latter agents, may be performed without pain while the patient is in a semi-conscious state, or even altogether conscious, but they form an exception; while in the use of amylene, the patient has very often been half-conscious during the operation. In operations under chloroform, the patients usually indicate the necessity of repeating the inhalation by a tendency to flinch or cry, without showing any signs of consciousness; but in the use of amylene, they have more frequently begun to look about and to speak before showing any sign of pain. There are some patients who will not lie still under the surgeon's knife while chloroform is being used, unless its effects are carried so far that the breathing is on the borders of being stertorous, but I have not met with any such case in using amylene.

The greater number of the operations under amylene were performed while the patient was in the second degree of narcotism, being apparently awake, although not really conscious of surrounding objects. This usual absence of coma in the employment of amylene cannot be looked on otherwise than as an advantage. It must conduce to the safety of the agent when the proportion of vapour in the air is properly regulated. The reason why no accident is known to have happened from chloroform, in the practice of midwifery, when superintended by a medical man, is no doubt due to the circumstance that it is only requisite to induce a slight effect, in comparison with the effect required in surgical operations.

The best indication that the patient will quietly bear an operation under chloroform, is the more or less complete absence of sensibility of the ciliary edge of the eyelid; but during the inhalation of amylene the patient is often entirely

regardless of the surgeon's knife, whilst the edges of the eyelids retain their full sensibility, and the slightest touch causes strong winking. In operations on the eye, however, and in all other cases where great steadiness on the part of the patient is required, I have thought it best to continue the amylene till the sensibility of the margin of the eyelids was almost abolished; and to effect this it has usually been requisite to carry the influence of the vapour as far as the beginning of the third degree of narcotism, or that condition in which there is no longer voluntary motion of the eyes, or any other part, and in which the eyelids are usually closed, and the pupils inclined upwards. But even in these cases the patient has usually reverted to the second degree of narcotism before the end of the operation, and has shown signs of ideas by the voluntary motion of the eyes and eyelids, or in some cases by speaking. In several cases, however, the sensibility of the eyelid has been removed in the second degree of narcotism; and important operations have been commenced before the patient was "off", to use an expression familiar on these occasions. One instance of this kind was the operation of lithotomy by Mr. Fergusson, on the 14th of March, 1857, in a young man, aged 17, in King's College Hospital. The sound was first introduced, and the stone being detected, the assistants were requested to tie the patient up; and finding his limbs somewhat rigid, they requested me to give him some more vapour. If I had been using chloroform I should have done so without any request, in order to cause relaxation; but I allowed the effect of the amylene to partially subside, and in less than a minute the bandages could be easily applied. I then proceeded to give a little more amylene, but soon found that the margin of the eyelids was insensible; so the operation was performed whilst he was calmly looking about, as if awake; but he showed no sign of pain, and knew nothing

of the operation. I never saw a capital operation performed on the adult, under the influence of chloroform or ether, whilst the patient was in this condition; but I once administered chloroform in St. George's Hospital to a child of three or four years old, which was cut for stone whilst lying calmly with its eyes open, and holding a toy in its hand, all the time of the operation, without letting it fall.

The pulse is almost always increased in frequency and force during the inhalation of amylene,—especially during the early part of the inhalation, and to a greater extent than happens with chloroform. The respiration is very often accelerated during the inhalation,—about as often, I think, as with ether, and more frequently than with chloroform. In many of the early cases in which I administered amylene, the pupil was dilated for a short time; but I consider that this arose from giving the vapour rather stronger than is desirable. I afterwards gave it more gently, and very seldom observed the pupils to be dilated. They remained, as nearly as I could tell, of the natural size, and also sensible to light, in the cases where I made an observation on that point.

The colour of the countenance is generally heightened more or less during the whole period of the inhalation, and in a few cases there was sweating,—a symptom met with now and then under the influence of chloroform and ether. Amylene does not cause the great increase in the flow of saliva which is so often met with during the inhalation of chloroform, and especially of ether.

There is a tendency to laugh during the inhalation of amylene much more frequently than during the use of chloroform. It occurs just after the patient has lost his consciousness, but is soon subdued by the increasing effect of the vapour. I only met with strong mental excitement in a very few patients, chiefly females. It subsided in half a

minute in one case, on leaving off the vapour, and did not recur when the inhalation was resumed. In the other cases it was subdued by continuing the inhalation.

The expression of the countenance generally remains calm and cheerful during the action of amylene; but in a few instances there is a singular, and even unpleasant, aspect of the face for a short time, arising apparently from a brief spasmodic action of the muscles.

I met with less rigidity and struggling during the administration of amylene than in the use of chloroform; but this probably arose from the circumstance that the effects of amylene were very frequently not carried to that degree in which rigidity and struggling are liable to appear. It is in the third degree of narcotism from narcotic vapours that rigidity is met with in those cases in which it occurs, but the greater number of the operations under amylene were performed in the second degree of narcotism. The rigidity from amylene, when it occurs, is of a somewhat different kind, and takes place in patients in whom we should not expect it from chloroform. In the spasm and rigidity from the latter agent, the head is more commonly bent forwards or turned to one side, although it is occasionally thrown back; but under amylene, the latter is the usual position it assumes when rigidity occurs, constituting a brief opisthotonos. The rigidity under the influence of chloroform is usually accompanied with struggling, while in that caused by amylene the patient is generally quieter. The persons in whom rigidity and struggling are most violent from the effects of chloroform are lean, muscular men, who work at hard labour, or follow athletic sports, such as hunting, and especially boating; while those who lead a sedentary life, or are reduced by illness, seldom exhibit these phenomena. Women and children seldom exhibit any rigidity under chloroform, and fat persons least of all. Old people do

sometimes, especially if thin. Under the use of amylene, on the other hand, I have most frequently met with some amount of rigidity in children and young persons, while many robust men, in whom it would be almost certain to occur under chloroform, have not shown any signs of it. The cause of this probably is, that the operation has generally been performed without carrying the narcotism beyond the second degree, while rigidity does not take place till the third degree is attained. In every case where rigidity and struggling have occurred in the employment of chloroform, however violent these symptoms might be, I have continued the vapour gently and steadily till they were subdued, either by removing the tendency to these symptoms, or by carrying the narcotism to the fourth degree, which is accompanied by relaxation of the voluntary muscular system, and usually with some tendency to stertor. In the use of amylene, on the contrary, I have not attempted to subdue the spasm by continuing the inhalation, but have, with the exception of a case of dislocation previously mentioned, withdrawn the vapour when the rigidity appeared, and the operation has either been performed at once, or else, if it was of a nature that the spasm would interfere with, I have waited a short time, and exhibited a little more vapour very gently, so as to get a state of anæsthesia without the recurrence of the spasm.

Mr. Jones, of Jersey, favoured me with the following account of a case in which amylene acted much more favourably on his patient than chloroform.

John D., æt. 41, stout and of very ruddy complexion, so injured his leg that it was deemed advisable to saw off the fractured ends of the tibia. Chloroform was at first given (March 16, 1857), but the effect it produced, though administered with the utmost caution, was evidently of so dangerous a nature, that it is more than probable that death

would have resulted had it been persevered in longer than five or six minutes (the period it was employed). The patient became quite apoplectic, and had two or three very severe convulsions. Amylene was at once substituted, and with the happiest result. The patient appeared conscious, but was not so, and the operation, which was a tedious one, was commenced and finished without his experiencing the least pain, indeed without his having the slightest knowledge that operative measures had been resorted to.

Amylene differs widely from chloroform, and still more from sulphuric ether, in the promptitude with which patients generally recover from its effects. This is a character of amylene which might have been predicted from its physical properties. I have many times observed how quickly, and, indeed, almost instantaneously, small animals recover from the stupor occasioned by certain permanent gases which are sparingly soluble in watery fluids, as olefiant gas, carbonic oxide and carbonic acid gases, nitrous oxide and the gaseous oxide of methyle. Now amylene is so volatile as to approach to a permanent gas ; at a temperature a little above that of the human body it would be a gas, and the vapour is very sparingly soluble in watery fluids, and consequently in the blood. Sulphuric ether is, indeed, as volatile as amylene. I cannot remember any other two bodies whose volatility is so nearly alike ; but sulphuric ether is very soluble in watery fluids, in comparison with amylene. Water dissolves a tenth of its volume of liquid ether, or 23 volumes of the vapour. Consequently a large quantity of ether is absorbed during inhalation, and the blood has to pass many times through the lungs before it is freed from it. The quantity of amylene which is absorbed is, on the contrary, extremely small, as I have explained above, and this, together with its volatility, is no doubt the reason why the patient recovers so promptly from its influence. In about a minute after

the operation is concluded, and the inhalation left off, the patient usually awakes from the influence of amylene, and completely recovers his consciousness. The same quick recovery may take place after chloroform, but more frequently it is a few minutes before the patient is quite conscious. I have seen two or three instances in which a child has slept for twenty minutes or half an hour after amylene, but it must be remembered that children sometimes sleep for hours after chloroform in cases where the operation has not produced a painful wound. The quick recovery of the patient is a decided advantage in all minor operations. In great operations, where the patient is obliged to keep his bed afterwards, it is of less consequence whether he wakes promptly or not, although, even under these circumstances, his friends are generally anxious to see him recover his consciousness. The smarting of the wound after an operation is often prevented longer when chloroform has been employed than after the use of amylene, and this may be considered as a slight advantage which chloroform possesses in certain cases. In some instances, however, in which chloroform has been used, the patient begins to show symptoms of suffering pain in the wound before he has entirely recovered his consciousness, while after amylene I have not seen symptoms of pain in the wound till consciousness had completely returned. In any cases where the pain after an operation, either from a wound or ligatures or caustic, is very great, the inhalation of the agent which has been employed may be gently repeated at times until the pain has a tendency to subside, or till an opiate shall take effect.

The patient generally seems surprised or confused on first recovering from the effects of the amylene, but in a few seconds he becomes, in most cases, completely conscious of his position, and feels that his mind has been wandering. He often says he does not know where he has been in his

dreams, or that he has been a long way. Sometimes he does not remember exactly what he has dreamed about; at other times he does. All this is common enough after chloroform, except that the process of recovery is generally much slower; but there is one condition of mind which is very common after chloroform, which I have rarely met after amylene, I allude to that condition in which the patient asserts that the vapour has not taken effect, and that he has not been asleep at all.

Amylene appears to support the pulse under loss of blood at least as well as chloroform. I have not found the pulse to fail, although there was rather free hæmorrhage in some of the operations.

There has been a little headache in a few of the cases as the effects of this agent were subsiding, but it passed off in a few minutes.

In administering amylene, the vapour must be given of such a strength as will cause insensibility in about three minutes, or it will not succeed at all unless the strength of the vapour be altered. In giving chloroform, the vapour may be of less than half the desirable strength, and by continuing more than twice the usual time, the patient may be rendered insensible; and in using sulphuric ether, the vapour may be breathed of one-seventh the proper strength, and by continuing it constantly for seven times the usual period, *i. e.*, for half an hour, the patient might be rendered insensible; but in using amylene, time will not make up for deficiency in the strength of the vapour. If the vapour be not strong enough to cause insensibility in about three minutes, it might be breathed for an indefinite period without causing insensibility; and the patient is solely affected by what he has inhaled within two or three minutes.

On account of the very rapid subsidence of the effects of amylene, it requires to be very frequently repeated during

the performance of an operation. The patient generally requires to inhale a little of it every half-minute or so to keep up its effect. On this account, it is not well adapted for certain operations on the face. I did, however, administer it with complete success in several operations on the face in King's College Hospital. Amongst these, there were four operations by Mr. Fergusson for making a new nose in which I administered amylene, and succeeded in preventing the pain by holding a hollow sponge, wetted with that agent frequently, near the mouth and nose.

In cases of tooth-drawing, in which a number of teeth or stumps have to be taken out, the effects of the amylene are apt to pass off before the operation is completed, and the inhalation has to be repeated once or twice, but in cases when only one or two teeth require to be extracted, amylene has a great advantage in the promptitude with which the patient recovers from its effects. There is occasionally some difficulty in opening the mouth with amylene, as with chloroform.

The patient has nearly always a very cheerful expression of countenance when he recovers from the amylene, and the state of his mind, as indicated by his conversation, corresponds to his look. Dr. Debout has noticed the same circumstances. Speaking of the patients operated on under amylene in Paris, he says, "A leur réveil et le premier moment de stupeur passé, leur physionomie est épanouie." The same state of countenance and mind is met with after chloroform only now and then, and is by no means the rule.

Hysterical symptoms occurred in a few women after operations under amylene. They were met with about as frequently, I think, as after chloroform. These symptoms generally subsided in a few minutes; but in one or two young women in the hospital, they lasted nearly an hour.

The greatest advantage that amylene possesses over ether

and chloroform, is the great infrequency with which it excites sickness. I only saw vomiting occur in two of the 238 cases in which I administered amylene, although it occurred before I left the patients' room in twenty-two cases out of 100 in which I administered chloroform and kept an account of this symptom, at the time I was using amylene. In the greater number of the cases in which chloroform was exhibited, the patients had been requested not to take a meal; whilst in the cases in which amylene was administered, no directions regarding diet had as a general rule been given.

I made subsequent inquiries respecting most of the patients who inhaled amylene, and I was only able to hear of sickness in eight or ten cases, and it was not distressing or troublesome in any of these. It generally occurred three or four hours after the amylene, and subsequently to the patient taking his first meal after the inhalation. In one of the two cases in which vomiting occurred after amylene before I left the room, there was retching for four hours; but I did not hear of so much sickness after any other case in which I administered this agent; and there was no faintness or depression either in this case or any other in which amylene was employed, although faintness and depression often accompany the sickness which is occasioned by chloroform. Some of the patients who inhaled amylene without being sick, had previously suffered from sickness after inhaling chloroform. I administered amylene, on January 30th, 1857, to a lady, about twenty-five, whilst Mr. Bowman operated for strabismus, and there was no vomiting or sickness, either at the time of the operation or afterwards; but the same patient had undergone a similar operation a week previously, when chloroform was administered, and on that occasion vomiting commenced before the operation was finished, and recurred every quarter of an hour, with violent retching, for twelve hours.

I had the misfortune to lose two patients from the inhalation of amylene. The following are the particulars of these cases.

Mr. Fergusson requested me to assist him on the 7th of April, 1857, in the case of a gentleman on whom he was about to operate for fistula *in ano*. The patient was thirty-three years of age, and was in good health, with the exception of the local complaint, although he had lived somewhat freely. Mr. Fergusson examined the patient's chest the day before the operation, and found the sounds of the heart to be normal. I felt his pulse just before he began to inhale. It was natural, but somewhat accelerated, as usually happens just before an operation. He was lying on his side in bed. About six fluid drachms of amylene were put into the inhaler (I never intentionally used all I put in, but added more before the paper became dry), and he breathed steadily and gently. The valve was gradually advanced over the opening in the face-piece till it about three-quarters covered it, and the patient appeared to become quietly unconscious in about two minutes. He breathed quickly for a few inspirations just as he appeared to become unconscious. Just after this, Mr. Fergusson came and felt the patient's pulse, and he says it was very good. I felt it also. I looked at my watch at this time, and it was two minutes and a half or two and three-quarters from the beginning of the inhalation. Mr. Fergusson commenced to use the probe, and, finding the patient did not flinch, he began to use the bistoury. Mr. P. C. Price assisted at the operation. I held the patient's thigh with one hand, as I often do in such an operation, lest he should flinch. He did not flinch, however, but kept his limbs tense, without moving them. Just at this moment, I observed that the valve of the face-piece, which I had left three-quarters covering the opening, had moved so as to cover it entirely, but I cannot say whether

or not the patient had taken an inspiration a little stronger than I intended, and thought nothing of the matter, as I have frequently had to close the valve completely in giving amylene. It could not, however, have been many seconds in that position, for I paid no attention to the operation, except so much as was requisite to guide me in what I was doing. The inhalation was discontinued at the moment I have mentioned, and on looking round directly after, I found that the operation, which had apparently been but one incision, was finished. I now began to feel for the pulse, more out of constant habit, and from a scientific curiosity, than from any supposed necessity of doing so. Although it had been good only half a minute before, I could not find it in the left wrist, and only a slight flutter in the right one. His breathing was, however, good, indeed quite natural, and he did not seem even to be very insensible, for there was some motion both of his features and limbs, as if he were about to awake. I watched the patient with great anxiety, thinking that surely his good and natural breathing would restore the pulse, and feeling that at all events this superseded any other measures at the moment. In two or three minutes, however, he seemed to be getting more insensible; he did not wink on the edge of the eyelids being touched, and the breathing was getting slower and deeper. I called Mr. Fergusson's attention to the patient, and both he, who was preparing to go away, and Mr. Price, who had all the time been standing by the patient, were surprised to find that anything could be wrong, as they had seen the patient going on apparently so well, not only during the inhalation, but after it was discontinued. They dashed cold water in his face, which did not seem to have any effect. His countenance was now livid, and his breathing of a gasping character. It soon began to leave off, with the exception of deep, distant,

gasping inspirations, and we therefore began to perform artificial respiration, by Dr. Marshall Hall's method, placing him in the prone position, and bringing him partly round, while Mr. Price kept the mouth open. The air could be distinctly heard passing through the larynx during this motion. We also tried pressing on the chest with the head on one side and the mouth open, which answered very well as regarded the ingress and egress of air. Inflation from mouth to mouth was tried, but did not seem to answer so well. Although deep gasping inspirations were made by the patient till fully ten minutes had elapsed from the failure of the pulse, the measures used had no effect; I believe that I heard a feeble motion of the heart even after this period; and, as Mr. Fergusson perceived a slight pulsation at the same time in the right wrist, I was probably not mistaken. There were no further signs of life after this, although the artificial respiration was continued for a long time. I am quite sure as to the length of time respiration continued after the failure of the heart's action. The pulse ceased to be distinctly perceptible at ten minutes before five, and the patient was still breathing at five o'clock. He had not taken food for some hours, but drank a pint bottle of ale a little while before the operation. A good portion of amylene remained in the inhaler after it had been uncovered for an hour and a half.

There was an examination of the body forty-eight hours after death. The body was rigid. There was a good amount of fat beneath the integuments. The cartilages of the ribs were ossified. The lungs were large, and did not collapse; they completely filled the cavity of the chest, and seemed by their texture to be emphysematous, although there were no large cells on the surface. There was a little congestion at the posterior surface of the left one, otherwise they were not very vascular. There was a little clear fluid in the pericar-

dium. There was a good deal of fat on the surface of the heart, which was somewhat larger than natural. It was removed by cutting the great vessels before it was opened, and in removing it three or four ounces of dark-coloured fluid blood escaped. The right ventricle was somewhat dilated, otherwise the heart was healthy; the walls of the left ventricle seemed very thick, but it was contracted, so as almost to obliterate the cavity. The liver was vascular, dark-coloured, and friable. The stomach was healthy, and contained only a little mucus. The other organs were not examined. There was no odour of amylene in the body.

I believe the patient had emphysema of the lungs. There was no such force used in the artificial respiration as could permanently dilate the air-cells, and the dilatation of the right ventricle indicates some chronic obstruction to the pulmonary circulation.

The other death from amylene occurred in St. George's Hospital on July 30th, 1857, in a case in which Mr. Cæsar Hawkins removed a small epithelial tumour from the back. The patient, a short, muscular man, was a tailor, twenty-four years of age, who had been in the Hospital several months, and had had three similar tumours removed, by as many operations, under chloroform; the last of these operations having been performed three weeks previously. He inhaled the amylene without any difficulty; in about two minutes he appeared to be unconscious, and, in another minute, the sensibility of the margin of the eyelids was somewhat diminished, and I told Mr. Hawkins that he might perform the operation. For this purpose the patient, who had been lying on his side on the table, was turned a little more on his face, or at least it was attempted to turn him, when he burst out into a kind of hysterical excitement, laughed loudly, and was with difficulty held on the table. Nothing was done during this excitement, which lasted

about a minute. After it had subsided, I administered a little more amylene, although the patient had not recovered his consciousness; and then Mr. Hawkins performed the operation, which I believe did not last more than two minutes altogether. During the operation, the patient was turned on his face. He rested, I think, chiefly on his knees and elbows. He was muttering in an incoherent manner, and making slight attempts to move, but was easily restrained. I gave him an inspiration or two of amylene now and then during the operation, with the intention of preventing his waking prematurely; for this purpose, I turned the head a little to one side, and raised the face a little from the table.* I had concluded that the patient would not require any more amylene, and was expecting that he would show signs of returning consciousness or sensibility almost as soon as Mr. Hawkins had tied the suture which he was introducing; but, instead of this, the limbs became relaxed, and the breathing, though free enough, took on a noisy, snoring character.

This is a state which is common enough in the use of chloroform, and excites no alarm whatever, but I felt that it ought not to occur in the use of amylene, especially after it was left off. I therefore sought again for the pulse at the wrist, and could perceive it only with difficulty, if at all. I spoke to Mr. Hawkins, and we immediately turned the patient on his back. His face had already become livid, and his breathing was of a gasping character. Mouth to mouth insufflation of the lungs was performed, and between the insufflations there were spontaneous acts of inspiration, during which the air seemed to enter the lungs freely. In a minute or two, the lips became of a proper colour, and the countenance had altogether such a natural aspect that the patient seemed to be recovering. The pulse at the

* Less than an ounce of amylene was poured out, and it was not all used.

wrist, however, could not be felt. No one listened to the chest at this time, for fear of interrupting the process of artificial respiration. After two or three minutes, Dr. Marshall Hall's method of artificial breathing was substituted for the insufflation, and it was continued very perfectly by the house surgeons and others for an hour and a half, with the exception of two short intermissions, which will be mentioned. During three quarters of an hour of this time, there were spontaneous inspirations, during which air entered the lungs, in addition to that which entered during the turning process. Twenty minutes after the accident, the process of artificial respiration was suspended for about a quarter of a minute, to enable me to listen to the chest. I thought I could hear the heart beating regularly, but very feebly, and certainly there was a good vesicular murmur, and the air seemed to enter the lungs by the patient's own breathing, almost as freely as in health. At the end of three quarters of an hour, with the permission of Mr. Hawkins, I introduced two hare-lip pins which had been connected with the electro-magnetic battery, with the intention of performing galvano-puncture of the heart. The needles were introduced to the depth of about an inch and a half between the cartilages of the ribs, just to the left of the sternum, and on a level with the nipple. They were afterwards found to have penetrated the walls of the left ventricle, near the septum, but without reaching the cavity. There was a quivering contraction of the pectoral muscle when the needles were first applied, but no effect on the heart. The needles ought probably to have been coated with some non-conducting substance almost as far as their points. There were no further efforts of inspiration after this time, but this was probably only a coincidence. The electro-magnetic battery had been applied in the early part of the treatment by means of the wet sponges applied to each side of the chest, but it produced no effect.

An examination of the body was made by Mr. Holmes, the Curator of the Hospital Museum, on the following day. A good deal of dark-coloured fluid blood flowed from the right cavities of the heart, and the left cavities contained but little blood. The heart was pale and somewhat friable; but a microscopic examination by Mr. Holmes did not show any fatty degeneration. The lungs were moderately vascular, and contained some small epithelial tumours of the same character as those removed from the back. There was a large cyst in one kidney; but, with these exceptions, the organs were healthy. The vessels of the brain were not distended, and that organ was altogether less vascular than is usual after sudden death. No smell of amylene was perceived in the body.

The continuance of the respiration so long after the heart was paralyzed in these two cases, and especially in the second one, is a remarkably curious event. The respiration continued after the heart had ceased to act in several cases of death from chloroform, but not for so long a time as in these deaths from amylene. It is probable that there must have been some little circulation going on through the brain whilst the respiration lasted, and in fact, the slight fluttering pulse and feeble sounds of the heart, once or twice perceived, indicate that the circulation was not absolutely arrested. Under these circumstances, we may inquire why the action of the heart does not recover. If the circulation were going on in the coronary arteries, it might be expected that the blood from the lungs, which has been aerated by respiration, and freed from the narcotic vapour, would restore the action of the heart. But it is probable, for the reasons stated at page 262, when treating of accidents by chloroform, that the circulation through the coronary arteries is arrested.

The accident clearly commenced at the heart in both these

cases, and I believe that the brain was never more than partially under the influence of the amylene in either of them. In the *Medical Times and Gazette* of July 25th, 1857, M. Devergie is related to have expressed an opinion in the Academy of Medicine of Paris, that the first of the above deaths from amylene was caused, in great part, under the influence of true asphyxia, using that term in its modern acceptation. Now that is altogether an error, arising, probably, from M. Devergie not having seen any original account of the case. There was no cause of asphyxia, either internal or external; the patient breathed well until after his heart had ceased to beat, unless in the most feeble and doubtful manner. The valve which was closed only altered the direction, but not the amount of air. In fact, the patient was throughout supplied with as much air as could enter through a tube twice the size of his windpipe.

I had scarcely any hope of the patient in St. George's Hospital from the very commencement of the accident; for I felt that if he could be recovered by artificial respiration, his own breathing would have remedied the accident, even before it was discovered. From what has been published respecting the pulse sometimes stopping and commencing again, during the inhalation of chloroform, it is probable that many accidents, in which the heart has been nearly paralysed, have happened, and rectified themselves, without attracting much notice.

I have no doubt that in each of these accidents the patient must have taken into his lungs at one moment air containing upwards of thirty per cent. of vapour of amylene. And there is no doubt that the cause of this was the unsteady boiling point of the agent. If the amylene with which I was supplied had boiled steadily at the same temperature, there is no doubt that the means which I was employing, and which had enabled me for ten years, whilst exhibiting

chloroform, to give four per cent. of the vapour, probably without ever allowing the quantity to exceed six per cent., would have enabled me to give fifteen per cent. of vapour of amylene without permitting the quantity to exceed twenty per cent.

The alteration in the boiling point of a specimen of amylene from 86° to 115° Fah. would cause it to give off more than twice as much vapour in the beginning of its evaporation as towards the end; and, moreover, the different specimens of it did not always possess the same amount of volatility.

The temperature of the external air as it influenced that of the water-bath of the inhaler would have some influence over the evaporation of the amylene, but I altered the amount of evaporating surface of paper according to the season of the year for amylene, as I was in the habit of doing for chloroform. The highest temperature of April 7, the day on which the first accident happened, was at Greenwich, according to the Report of the Astronomer Royal, 62°; and on July 30, the day on which the second accident happened, was 78·7°. After the first accident, I had reduced the surface of bibulous paper in the inhaler to one half of what it had previously been.

The first of the above accidents happened in the 144th case in which I administered amylene, and the second in the 238th case. In the ninety cases and upwards in which I administered amylene between these two accidents, I never had occasion to feel a moment's uneasiness about it.

In the future cases in which I employ amylene, it is my intention to administer it from a bag or balloon, putting in so much of the liquid as will make fifteen per cent. of vapour when the bag is filled up with air. In this manner, the variability in the boiling point of the amylene can have no influence whatever on the amount of vapour which the

patient breathes; and if the vapour be breathed over again, within certain limits, in the manner of nitrous oxide gas, there will be a great saving in the amount of amylene consumed.

In my first paper on amylene, which was read on January 10th, 1857, I said: "While I cannot venture to predict for it the absolute safety which seems to attend sulphuric ether under all circumstances, I trust that it will be perfectly safe with careful management."* And I added further on, "It is my opinion that the cold produced during its evaporation would, in all the ordinary methods of inhalation, prevent the air from taking up a quantity of the vapour which would be dangerous."

Although amylene was largely used in Paris, Strasbourg, Montpelier, and Lyons, soon after I published my first account of it, and although I have lately heard that it is still employed in Paris and Berlin, nearly eighteen months after its first use in these places, I am happy that I have not heard of any accident from its use except the two which happened in my own hands.

M. Giraldis, of Paris, who was present at the operating theatre of St. George's Hospital when the accident happened at that institution, had already employed amylene in 100 cases in children, and I believe that he continues to use it. Given on a handkerchief or sponge, I believe that amylene is safer than chloroform, owing to the greater cold produced during its evaporation, and the limit thereby put to the amount of vapour which is given off; but I have seldom given it in this manner, as I do not think it would be certain and regular in its action, and any doubt on these points would, with me, have quite overbalanced its other advantages. In applying amylene on a sponge, M. Rigaud of Strasbourg used 100 grammes (between four and five

* Medical Times and Gazette, 1857, vol. i, p. 84.

fluid ounces) in making an adult patient insensible, although half a fluid ounce suffices with the inhaler I employed.

Mr. Clarke, of Bristol, in a paper which he published on amylene,* says: "It seemed impossible to get too much into the system, and with this I have been greatly impressed; it is this fact that appears to me to promise an immunity from danger. . . . It requires to be given almost unintermittingly, and requires the same amount of attention to keep up its effects as chloroform does to keep the patient safe. The direction of the attention, however, is one less calculated to give anxiety."

Dr. Debout stated, as the result of some experiments on animals, in which he was assisted by M. Duroy, that if it sufficed to double the quantity of chloroform in order to transform the anæsthetic dose of that agent into a poisonous dose, it was necessary to quadruple that of ether, and to quintuple that of amylene, in order to arrive at the same result; and that, therefore, the innocuousness of the new agent was still greater than that of sulphuric ether.†

In a paper which Professor Tourdes, of Strasbourg, read before the Academy of Medicine of Paris, he came also to the conclusion, from a series of experiments and observations, that "amylene was evidently much less dangerous than chloroform, perhaps even than ether."‡

According to my experiments, amylene ought to be placed between chloroform and ether in respect to its comparative safety by the ordinary methods of administration; and by breathing it from a bag, in the manner previously mentioned, it would be absolutely safe, so long as the right quantity were put into the bag.

Papers on amylene were read to the Academy of Medi-

* British Medical Journal, March 28th, 1857.

† Bulletin Général de Thérapeutique, t. lii, p. 223.

‡ Gazette Hebdomadaire, 1857, p. 164.

cine of Paris by Dr. Debout and M. Tourdes, and were reported on favourably. M. Giraldis afterwards presented a paper in which he stated the very favourable result of seventy-nine cases in which he had employed it. The Academy on this occasion recommended the disuse of amylene on account of the accidents which had happened in my hands, apparently overlooking the circumstance that M. Giraldis himself had been much more successful in the use of amylene than in that of chloroform. M. Jobert de Lamballe, the reporter of the Commission, stated that amylene deprived the blood of its red colour and that chloroform does not. But there is no difference between these agents in this respect; the blood retains its proper colour under the use of either of them, unless the effects are carried so far as to interfere with the breathing.

THE MONOCHLORURRETTED

CHLORIDE OF ETHYLE.

This substance was discovered some few years ago by M. M. G. Regnault. It is made by exposing to the sun's rays a mixture of the vapour of chloride of ethyle (muriatic ether) and chlorine gas. One equivalent of the hydrogen of the chloride of ethyle is replaced by an equivalent of chlorine. Its composition is four atoms carbon, four atoms hydrogen, and two atoms chlorine. It has the same composition as Dutch Liquid, which is made by the combination of olefiant gas and chlorine gas; the specific gravity of its vapour, 3·42, is also the same as that of Dutch liquid, which it resembles also in taste and smell. The boiling point is however different, and it differs from Dutch liquid in not being decomposed by an alcoholic solution of potassa.

I tried several times to make the monochlorurretted chloride of ethyle in 1849 and 1850, but did not succeed in procuring more than a drachm or two at once, owing to the constant over-action of the chlorine and the production of other chlorurretted products. In 1851, however, these products which result from the decomposition of muriatic ether by chlorine gas were recommended in Paris as local applications in rheumatism and other painful affections, and Mr. Mason was kind enough to obtain for me from that capital a pint bottle of a liquid consisting chiefly of the monochlorurretted chloride of ethyle. It was mixed with a certain portion of the bichlorurretted and terchlo-

rurretted products, but I was able to separate by distillation as much of the monochlorurretted product as enabled me to administer it to twenty-two patients. Mr. Mason was, however, not able to obtain any more liquid containing any of the monochlorurretted chloride. What he afterwards was able to obtain had a very high boiling point, and consisted chiefly of chloride of carbon; carbon four atoms, chlorine five atoms.

The monochlorurretted chloride of ethyle resembles chloroform very much in taste and smell, and in its physiological properties. Its boiling point is 149°, whilst that of chloroform is 140°; the specific gravity of its vapour is also lower; for these reasons, it is considerably less volatile than chloroform, and it is therefore pretty certain that it would not be liable to cause the sudden deaths which have occasionally been produced by the administration of chloroform, even if it were given freely and with no great care. The difficulty of procuring it in a state of purity is, however, a barrier to its introduction into practice.

I first administered this preparation in King's College Hospital, on June 20th, 1851, to a young woman, whilst Mr. Wm. Hewett, the house surgeon, repeated the operation of paring off venereal warts and applying nitric acid. The patient breathed it very readily without appearing to suffer from the pungency. She was a little longer in becoming unconscious than on former occasions from the chloroform, but soon after becoming unconscious, the sensibility of the conjunctiva diminished, and the operation was commenced. There was some flinching, so that she required to be held, but there were no cries or other signs of sensation. Consciousness returned almost immediately, and she seemed more exhilarated than after chloroform. She had had her dinner just before the operation, and at one time, soon after recovering her consciousness, she said that she felt rather

sick, but this feeling passed off without vomiting, and she did not remember it afterwards. She did not begin to cry out from the smarting till twenty minutes after the operation, when she had been quite conscious, collected, and rational for a quarter of an hour, although on the two former occasions, after chloroform had been inhaled, she began to cry immediately after the operation, and almost before consciousness had returned. Next day she was very well.

On the following day I administered the same preparation to three patients on whom Mr. Fergusson operated in King's College Hospital. The first was a boy seven years old, who had the forefinger removed, together with part of the metacarpal bone, on account of a large enchondroma. The second was an infant three months old, which was operated on for hare-lip; and the third was a woman about thirty-five, who had some venereal warts removed from the pudenda. There was no sickness in either of the cases, although the little boy and the woman had taken their dinners just before the operation.

On June 25th, I administered the preparation with the choloroform inhaler, as in all the other cases, to a muscular young man, about 25, whilst Mr. Henry Lee removed some piles, and applied nitric acid to the raw surface. The patient was six feet three inches in height, and weighed fourteen stone. He became insensible rather slowly, with low muttering and a good deal of rigidity. The operation lasted about ten minutes, during which the inhalation was repeated two or three times. There was no pain. He recovered his consciousness in two or three minutes after the conclusion of the operation; he said that he felt drunk, and he appeared so for a few minutes. He was very cheerful, and had no sickness, although he had had his dinner just before coming to the hospital to have the operation performed. Half a fluid ounce of the monochlorurretted com-

pound was inhaled, being about the same quantity as would have been consumed of chloroform.

The other operations in which I administered this preparation, consisted of the removal of a tumour situated below the angle of the jaw in a young woman, by Mr. Fergusson; an operation on the tibia and fibula of a little boy, for ununited fracture, by Mr. Bowman; trephining the tibia of a young man, and giving exit to a collection of pus, by Mr. Henry Lee; an operation for necrosis of the tibia, by the late Mr. Avery; two operations for hare-lip; two operations for fistula *in ano;* one for nævus on the forehead; one for tenotomy; and one for removal of a fatty tumour, by Mr. Fergusson.*

* In the act of writing this last sentence, Dr. Snow was seized with his fatal illness. The sentence required, however, but the addition of a word or two, to render it complete.—[Editor.]

THE END.

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