The Harcourt inhaler.

Contributors

Buxton, Dudley Wilmot, 1855-1931.
Royal College of Surgeons of England

Publication/Creation

London : John J. Griffin, [1904?]

Persistent URL

https://wellcomecollection.org/works/rzzdjft5

Provider

Royal College of Surgeons

License and attribution

Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
https://wellcomecollection.org

3

Chloroform in Surgical Anæsthesia:

THE HARCOURT INHALER AND EXACT PERCENTAGE VAPOURS.[1]

By Dudley W. Buxton, M.D., B.S., M.R.C.P.,
Anæsthetist and Lecturer on Anæsthetics in University College Hospital.

The apparatus which I have been asked to explain to you this evening owes its origin to the ingenuity of Mr. A. Vernon Harcourt, F.R.S., sometime Reader in Chemistry at Christ Church, Oxford. The British Medical Association in 1901 appointed a Committee, of which I was a member, to carry out certain investigations with regard to chloroform, and Mr. Vernon Harcourt was co-opted a member of that Committee. In the course of our investigations, it became apparent that we must obtain some method of exactitude by which we could ensure a definite amount of chloroform being delivered, in other words, a definite dosage by a known percentage of chloroform vapour in air. Now, in 1899 Mr. Vernon Harcourt published, in the "Transactions of the Chemical Society," a description of a method whereby a current of air could be mixed with any desired proportion of chloroform vapour. This method was, however, only applicable to small animals, and was supplemented in June, 1902, by a communication by Mr. Harcourt to the Royal Society. In the paper in question reference is made to two methods, both of which were demonstrated before the Committee of the British Medical Association, and the second was adopted by them, after various experiments and trials, as being applicable to human beings.[2] The apparatus shown to-night is the outcome of these experiments, and is a remarkably ingenious application of chemico-physics to the service of suffering humanity.

While the Committee of the British Medical Association were studying the various methods and apparatus for giving chloroform, I was requested to report upon various inhalers, and among them upon Mr. Vernon Harcourt's Chloroform Regulator. Let me, before going into detail, explain that the principle of this apparatus is that air passes over the surface of chloroform by the aspiration of the patient's respiration, and that by its construction the apparatus delivers a maximum strength of 2 per cent. I was first uncertain whether this 2 per cent. strength would satisfy the requirements of surgery, although possibly adequate for physiological work. Probably those of you who have not used or seen the apparatus used will be inclined to take this view. I mention my own mental attitude at the commencement of my research:

[1] Read at a Meeting of the British Gynæcological Society, March 10, 1904.
[2] Mr. Harcourt formulated a Report on these methods, which the Committee duly presented to the British Medical Association. See *Brit. Med. Journ.*, July 18, 1903, cxlii.

however, experience has convinced me that, like theories based on *a priori* reasoning, this one was entirely wrong.

The great bugbear of this chloroform question has always been *a priori* reasoning, coupled with a confiding faith that chloroform as an anæsthetic obeyed no laws like other drugs. Like the blessed word "Mesopotamia," the much-abused word "idiosyncrasy" has consoled many an aching heart and ministered to the *amour propre* of not a few chloroformists.

But, if you will bear with me, I hope to convince you that there is overwhelming evidence in favour of the statement that chloroform is not only a most law-abiding body, but is impeccable in the matter of idiosyncrasy, while no evidence exists in support of the contrary view save various *ipse dixits*, which are inadmissible as against definite experimental and clinical observations.

Snow, who in 1858 was the voice of one crying in the wilderness of inexact experimentation, conducted researches on chloroform, which succeeding workers have elaborated and confirmed, but have not disproved. His conclusions were that 12 minims of chloroform in the body produces the 2nd degree of narcosis, 18 minims the 3rd degree, 24 minims the 4th degree, and 36 minims the 5th degree. Thus 18 minims is 2 per cent., 36 minims equals 4 per cent. (Fluids of body: 30 lb. equals 15 litres, or 300 litres of vapour in 15,000. The figures are given by Waller, *Brit. Med. Journ.*, April 23, 1898, p. 1,059.)

Paul Bert, although working on somewhat different lines, and without any knowledge of Snow's views, arrived at the same figures, i.e. 2 per cent. vapour will produce anæsthesia. It is true that Snow speaks of a safe 5 per cent. vapour, but his methods of giving chloroform were so inexact that the actual vapour inhaled was never anything like the dangerous 5 per cent. spoken of.

When Clover adopted a dosage method of giving chloroform, he fixed his maximum at 4·5 per cent., which was too dangerous for operations lasting any time, and even in his skilled hands actually proved fatal. His, like other methods based upon the principle of mixing large quantities of air and chloroform vapour, was fallacious. In the first place, the gases do not remain equally intermingled, and the heavy chloroform vapour sinks, so that the first portion inhaled possesses a lower tension than the last.

An apparatus I have seen used in France, invented by Dr. Dubois, and which was described in the press recently by Dr. Waller, who showed it in London and at Hereford, gives a 2 per cent. vapour, and produces anæsthesia.

Thus we see that experiment shows 2 per cent. of chloroform vapour is safe, and clinical experience reveals that it is effectual certainly in some cases.

Further, we may dismiss most of the methods suggested, such as are inapplicable for general use on account either of their inaccuracy or, in the case of Dubois' machine, as being too cumbersome and costly.

The next question is—What are the requirements of the surgeons of to-day, and how far can these requirements be met by low-tensioned chloroform vapours? All admit it is a very different matter to undertake the conduct of the anæsthetic for the more serious operations in vogue at the present time than it was in the case of such surgical proceedings as were performed a generation or so back. The anæsthetist is expected not only to make and keep his patient unconscious, but he is asked to ensure muscular relaxation, and the abeyance of as many of the reflexes as is consistent with his patient's ultimate recovery. Indeed, in many instances, the inability of the chloro-

formist to accomplish this must result in the failure of the operation and jeopardise the patient's chances of after-recovery.

You ask, then, Can 2 per cent. of chloroform vapour effect this? And I am bound to say that, with Mr. Harcourt's inhaler I must answer, It will do so. But before I tell you in a few words what I have done with it, I am anxious to point out what will explain the apparent discrepancy between myself and others with regard to "light" and "deep" narcosis.

In the teaching and in many of the books of trustworthy men you will find that they emphatically caution against "light anæsthesia," and point out the many reflex dangers liable to accrue if their directions are unheeded. I am convinced, however, that a common, if not general, misapprehension exists with regard to so-called "light anæsthesia." It is this. The patients who reveal these reflex troubles are not anæsthetized at all. There are two conditions: one is *incomplete* or *irregular narcosis* or *anæsthesia*, and the other is *light anæsthesia*; and these are absolutely different things. In practically all cases the patient must pass definitely into the third degree of narcosis before the anæsthesia is complete. Then, and not until then, if in the view of the anæsthetist a light phase of anæsthesia is best for the patient, and is sufficient for the requirements of the surgeon, the anæsthetist can, by lessening the dosage of the anæsthetic, diminish the depth of the narcosis without running any risk of reflex dangers. He will, of course, have to expect the phenomena characteristic of the particular phase of narcosis, but of none other. The incomplete anæsthesia is the type one commonly hears of, and sometimes sees, in the hospitals among learners. The patient is hurried often with a too strong vapour of chloroform into a drugged state, the mixture of chloroform in the blood stream is irregular, some tissues are over-dosed, others are under-dosed. The operation is commenced and the patient moves or vomits; then the anæsthetic is pushed, and disaster may, and commonly does, occur.

Will you forgive me if I pursue this matter a little further and compare the physiology of "incomplete" with "light" narcosis?

We have to deal with the vasomotor system, the lungs, their nerve mechanism, the pulmonary circulation, the heart, and the vagus control. To insure safety, all these must work in harmony. What may occur, however, and I am afraid often does occur, is that in this irregular anæsthetisation first one strength, then another, the machinery is put out of gear.

The work of McWilliam has recently been extended by Miss Sowton and Professor Sherrington, and we now know by their research on the isolated mammalian heart that not only does the heart undergo acute dilatation when chloroform perfuses the coronary vessels, but that even 1 in 100,000 circulating fluid produces a weakening of both the auricular and ventricular beats by 30 per cent. and 49 per cent. When more concentrated solutions were perfused the effects were even more marked, and were ultimately destructive to the structure of the muscle. But equally important researches in this connection are those of Rudolph and Embley, who have independently worked out the part played by the vagus control in chloroform narcosis. The first point is that the vagal centre becomes unduly irritable under chloroform, and the more so when the vapour is strong. In early narcosis Embley, working with over 2 per cent. vapour, repeatedly obtained complete and fatal vagal inhibition of the heart.

With lower dilutions the inhibitory action was not fatal. The point I desire to emphasise is, that the dilatation of the heart and the vagal inhibition are

not fatal when a lower tension of chloroform is uniformly acting upon the tissues of the body, but are unavoidably fatal when the uniform tension is high or an irregularly distributed amount of chloroform finds its way to vital points. Then, as regards vasomotor action. All observers agree that under chloroform the blood pressure falls. This fall is proportional to the actual tension of the chloroform, and always makes for danger both by depriving the nerve centres and heart of their necessary blood supply, and by draining the blood generally from the arteries into the veins, more particularly into the large abdominal veins, felicitously called by Leonard Hill " the abdominal pool." One sees in abdominal sections, especially under chloroform, that as soon as the abdominal walls are opened there is some shock, which steadily increases, and is most marked in deep narcosis. This is easily explained. The vessels are no longer protected by the parietes, and the thin-walled vessels dilate and receive more blood. The reverse is seen when the abdomen is closed. The shock lessens, the patient gradually rallies, because the hæmodynamics of the abdomen have again resumed their normal condition. Now, with a low percentage of chloroform these dangers are lessened or even annulled. To put it in another way, if dangers arise when the chloroform in the body is uniformly distributed and is of low tension, remedial measures result in the safety of the patient ; if the tension is high, the patient dies. It would be worth much discomfort to the operator to ensure this maintenance of safety ; but I think that my cases will show that no discomfort to the surgeon need arise when a low tension of chloroform is employed.

With high-tensioned vapours, my past experience goes to show that it is extremely difficult to ensure a uniform distribution of chloroform ; and it often happens that a patient seemingly narcotised, is, in fact, incompletely anæsthetised, and even if he safely emerges from the stage of induction, is in greater peril of reflex shock, respiratory failure and death. It must never be forgotten that, unlike other anæsthetics, chloroform is a protoplasm poison and that at a certain strength it not only paralyses nerve and muscle, but absolutely kills them. This destructive power actually increases with the strength of chloroform which is carried through the tissues by the blood stream.

Now if we admit that a 2 per cent. vapour of inhaled chloroform, even taken for a prolonged period, is not destructive to nerve and other tissues, that it does not render the dilated heart unable to contract sufficiently to maintain the circulation, that it does not involve risk of fatal vagal inhibition, that it does not cause a dangerous fall of blood pressure, we have at least got to know what haven of safety we should seek. For the present we are, I submit, warranted in believing that ; possibly as our methods improve and our knowledge increases we may recognize that 2 per cent. is too high a concentration. I will not attempt here to suggest what 2 per cent. inhaled chloroform represents in the residual air of the lungs or in the blood or tissues : the data at present is wanting. I propose rather to explain how, by means of Mr. Harcourt's simple apparatus, we can obtain this 2 per cent., and lessen it as the necessities of the case require. The apparatus consists of a two-necked bottle, which is filled with chloroform to near the top of the conical part, and two coloured glass beads are dropped into the liquid to indicate when the temperature is within the range 13°–15°C. (=55·4° – 59°F.). If the temperature of the chloroform is below 13°, both the coloured beads will float ; if it is above 15°, both will sink ; in the former case the proportion of chloroform inhaled will

be less than the pointer of the stop-cock indicates; in the latter case it will be greater. During inhalation the chloroform is cooled by evaporation; its temperature may be kept between 13° and 15° by now and then holding the bottle in the hand till the blue bead has sunk and the red bead is beginning to sink.

The stopcock is so made that when the pointer is at the end of the arc nearest the bottle of chloroform the maximum quantity is being administered —namely 2 per cent. When the pointer is at the opposite end only air will be inhaled; and when it is midway dilution of the 2 per cent. mixture with an equal volume of air will make the proportion 1 per cent. The shorter lines on either side indicate intermediate quantities, namely 0·8, 0·6, 0·4, 0·2, and towards the chloroform bottle, 1·2, 1·4, 1·6, 1·8.

The valves on the two branches prevent the entrance into the apparatus of expired air, and also serve to show whether the stopcock is working rightly. Only one valve opens when the pointer is at either end of the scale, both equally when the pointer is midway, and for all other positions one valve opens more and the other less, in the degree indicated by the position of the pointer on the scale. The movement of these valves shows also how full and regular the breathing is.

It is generally found that beginning with the pointer at 0·2, and moving it on towards the chloroform bottle at the rate of one division about every half-minute up to 1·6 or 1·8, produces narcosis as quickly as is desirable.

For the maintenance of narcosis it is believed that 1 per cent. or even less will be found sufficient. The stopcock can be moved by a touch of the finger so as at once to increase or diminish the dose.

The face-piece, which is provided with an expiratory valve, and can be fixed in any position, is either attached directly to the inhaler, which in this case is held in the hand, and should be kept as nearly vertical and as steady as possible, or can be connected by about 20 in. of half-inch rubber tubing, the inhaler in this case being supported on a stand or hung on to the back of the bed.

The mask is made of solid toughened rubber, fitted with a rubber air-cushion. It can be washed, or boiled, and as it becomes plastic in hot water the shape can easily be modified, if required, so as better to fit the patient's face.

Now any apparatus must differ in the hands of various men, for, happily, none can ever invent a "penny-in-the-slot chloroform machine." There must be the controlling mind behind the mechanism; in the first place the hand must acquire the dexterity necessary to get the full use of the contrivance, and, secondly, as the user has the power of altering the strength of vapour his knowledge must guide him in selecting the requisite strength of vapour for each patient.

It would be tedious to read lists of cases to you, so I will only mention a few, and in passing say I have now used this inhaler for some hundreds of cases, including the graver abdominal operations involved in partial resection of the stomach, pylorectomies, enterectomies, gastro-enterostomies, hysterectomies, colectomies, appendicotomies, with cholecystectomies, and other very complex operations involving the liver and intestines. I must add to my list removal of cerebral growths, Hartley-Krause's resection of the Gasserian ganglion, the dissection of the nerves in the suboccipital triangle for torticollis, and a number of other operations more severe to perform in some cases than their mere names might indicate. In most of these,

although employing a 2 per cent. for induction, I have worked with a 1 per cent., or, in some cases, a ·5 per cent. vapour. Now I think these operations require two things from the anæsthetic ; they call for a complete and absolute narcosis, and a freedom from reflex movements. These cases tax the skill of the surgeon, and induce him to look for and demand from his chloroformist that such *desiderata* are given him, and when I say that in only one case have I supplemented the Harcourt Inhaler, and then only for a minute at a critical moment in a gall-bladder case, when there was some rigidity, I think I may say that I have some reason to believe that the narcosis offered was satisfactory from the point of view of the surgeon. In none of these cases have I been caused any alarm by conditions arising from the anæsthetic.

But there are other cases in which the operation is not so much to be dreaded as the actual condition of the patient. Into this category come bad empyemas and liver abscesses communicating with a bronchus, extensive goitres with tachycardia, and fat, feeble people with an addiction to alcohol.

I have used the inhaler now for several goitres and several empyemas, and with these have found the greatest comfort from being able to diminish my percentage of chloroform. You may say that a skilled man with a Skinner's mask and a drop bottle can do this. Possibly, but how many can ? And if you try even your skilled men and test them by accurate methods I venture to say that their percentages will be wildly wide of the wished-for amount.

I wish, if I may, to mention a few cases.

A lady of extreme obesity, over 60, puffy, had cancer of the body of the uterus, and as abdominal section through many inches of fat was thought impossible, it was decided to perform a vaginal hysterectomy. Her condition was so unsuitable for any anæsthetic that I had to warn the friends that her life was in danger. As a matter of fact, she not only gave me no trouble, but she was not sick, had no headache, and told me subsequently she had no idea that she had taken an anæsthetic.

A lady of over 40, a chronic asthmatic, with grave aortic lesions, kidney trouble, and bronchial catarrh, was another case so bad that I was seriously anxious about her. The result of the chloroformisation was absolutely perfect. There was no trouble during the narcosis or afterwards.

But an even worse case was that of a gentleman whom I was asked to see to determine whether he could take an anæsthetic. I am allowed to mention this case by the courtesy of one of the Fellows of this Society. This patient, æt. 60, about five feet high, and weighing over seventeen stone, had rolls of fat all over him. He suffered from bronchitis and emphysema, with a feeble fatty heart with dilated aortic and mitral orifices, and albuminuria. I expressed the opinion that unless the operation were imperative with a view to saving life, he ought to be spared what I regarded as a grave risk, especially as previously he had taken an anæsthetic with, I was told, extreme difficulty, and was placed in some danger. However, as the operation had to be done, I used the Harcourt Inhaler, and had no difficulty in maintaining anæsthesia, after obtaining full narcosis, by a 1 per cent. vapour.

Another class of cases is that of intestinal obstruction with vomiting. With some grave cases of this sort I have used the inhaler successfully because I was able to limit my doses so accurately. In the same way patients with a cerebellar tumour, since there is commonly pressure in the region of the medullary centres, are among the most dangerous with which chloro-

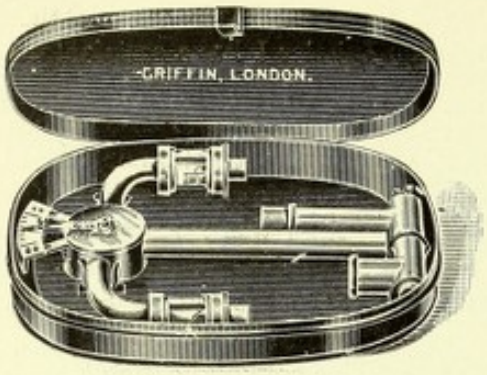
formists have to deal. When we employ a low percentage vapour these dangers are lessened, and with Mr. Harcourt's Inhaler I have satisfactorily dealt with several of these cases.

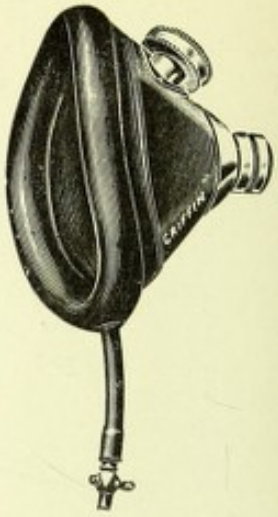
The dangers met with in using this Inhaler have been in no case serious; I have never had to employ artificial respiration or tongue traction or, indeed, any heroic treatment whatever. As to after effects, vomiting has often been absent, and I believe generally less severe than when other methods are adopted. In many instances delayed vomiting follows chloroform in cases where morphine has been given, and it is, I believe, often the combination of these two drugs which occasions the troublesome vomiting.

In conclusion, I would say that the gist of this communication is to be found in the statement that a vapour of chloroform not exceeding 2 per cent. is quite adequate for surgical anæsthesia, and its use avoids most of the grave dangers of this anæsthetic; that such a percentage can be obtained by the proper use of Mr. Harcourt's Inhaler, and this, with experience, will be found sufficient for all requirements. Like all apparatus, its technique must be mastered, and it must be used with intelligence and a knowledge of the powers and limitations of chloroform in order that the most satisfactory results may be obtained.

A Reprint from "The Medical Press and Circular" of an original communication which appeared in the issue of Wednesday, March 23, 1904.

PRICES.





	£	s.	d.
APPARATUS COMPLETE with face-piece, plain bottle and beads	5	5	0
JAPANNED TIN CASE to take the inhaler less face-piece and bottle		6	0
BOTTLES, plain . . . . . *each*		2	0
,, graduated in drachms . . . . . ,,		4	0
FACE-PIECES, in three sizes, complete with fittings; large, medium, small . . . . . *each*	1	5	0
INCREASE TUBE for raising the possible maximum dose to 2·5 and 3 per cent. [See p. 6]		2	6
BEADS, red or blue . . . . . *each*		1	0
EXPIRATORY VALVE CHAMBER		3	6
GLASS CHAMBERS FOR INSPIRATORY VALVES, cemented in metal frame ready for attachment		3	0
MICA VALVE-FLAPS . . . . . *per doz.*		0	9
INDIA-RUBBER valve-flaps, of specially prepared material ,,		3	0

Both the mica and rubber flaps require to be renewed at intervals. The former are apt to fracture, and the latter become hard and non-pliant in course of time.

Cases to hold the complete apparatus are made to order according to given specification.

Letters patent have been granted in the following countries :—
Great Britain, Belgium, France, United States.
Patents in Austria and Germany pending.

To be obtained through any dealer in Surgical Instruments, or direct from the PATENTEES and SOLE MAKERS:

JOHN J. GRIFFIN & SONS, LTD.,

MAKERS OF SCIENTIFIC APPARATUS,

20–26, Sardinia Street,
Lincoln's Inn Fields, London, W.C.

REGISTERED

TRADE MARK.