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CKWATERS OF LETHE

E ANÆSTHETIC NOTIONS

BY

A. H. BARTON, M.D.

PAUL B. HOEBER

NEW YORK

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(SOME ANÆSTHETIC NOTIONS)

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BY

G. A. H. BARTON, M.D.

ANÆSTHETIST TO THE HAMPSTEAD GENERAL AND ROYAL NATIONAL ORTHOPÆDIC HOSPITALS;
FORMERLY ANÆSTHETIST TO THE THROAT HOSPITAL (GOLDEN SQUARE), THE FEMALE LOCK HOSPITAL, THE NATIONAL DENTAL HOSPITAL, AND TEMPORARILY TO ST. MARY'S, THE FRENCH, AND KING GEORGE'S HOSPITALS

WITH ILLUSTRATIONS

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1920

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FOREWORD

THE following fragmentary essays are the outcome of twenty years' practice and study of anæsthetics in about half as many general and special hospitals. Recent experience in teaching the art has familiarized the author with the pitfalls that beset the path of the neophyte ; many of these are of his own digging, many due to lack of appreciation of simple mechanical details. In so far as they offer hints to beginners these essays crystallize the results of this brief experience. Dealing as they do with small practical matters—too small to take up much space in the textbooks—he hopes they may have some value for commencing and occasional anæsthetists. A further object in publishing these essays is the advocacy of the author's own views and methods, which he trusts will excuse a certain egoism and dogmatism of which he is painfully conscious.

If in form this work is entirely unconventional the author offers no apology. The title should sufficiently indicate this. He hopes that he has not outraged the proprieties of medical literature. Should the pedantic detect in places a tendency to flippancy let them ponder the words of Leonard Williams : " Why should medicine be dull as well as difficult ?"

The author wishes to take this opportunity of expressing his gratitude to the surgeons for long-sufferance and kindly hints in 'prentice days, and later for encouragement in, and opportunities for, the practice of fresh methods as they arose : also to that great master of the craft Dudley Buxton, to whom he is indebted for many opportunities of studying progress made in the field of anæsthesia, and to whose efforts are largely due the improvement in the status of the anæsthetist and the higher plane of the speciality as compared with a quarter of a century ago.

To Dr. R. L. Rawlinson his thanks are due for taking the photographs from which the plates have been reproduced, and to the firms of Messrs. Allen and Hanbury and Messrs. Mayer and Phelps for the loan of blocks for illustrations in the text.

7, Devonshire Street, W. 1,
May, 1920.

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BACKWATERS OF LETHE

ESSAY I

ARMA VIRUMQUE CANO

I.—The Man

"A slave, yea, the very bondsman of a slave," exclaims the cynic. The gibe, like many another, contains a germ of truth. Every surgeon will admit he is the servant of the public, and the anæsthetist is but the assistant of the surgeon. The position has been more euphemistically put by a doyen of the craft—"The science of anæsthetics is ancillary to surgery." It is, if one may say so, one of the minor specialities akin in this respect to radiography and bacteriology. The anæsthetist does not loom largely in the public eye. With few exceptions his very name is unknown to the public, and his services are not carefully selected by the patient and his friends; the choice is left to the surgeon or the practitioner in charge of the case. In many ways a wise procedure. The surgeon will probably choose a man he is accustomed to work with and on whom he can rely to provide the type of anæsthesia he desires; the practitioner will plump for the safe man, in whose

methods he has confidence, the survival of his patient being his only consideration. The patient writes the cheque and promptly forgets the anæsthetist's name ; he probably never considers, and certainly is not in a position to know, what he owes in safety and comfort to his skill. The anæsthetist, then, has three interests to consider—the surgeon's, the practitioner's, and the patient's. These are sometimes conflicting, and it speaks well for the altruism of the craft that the patient's interests are almost invariably the first consideration. The **emoluments** of the anæsthetist are not large. When one considers the amount of time devoted to hospital work they scarcely vie with those of a good class general practice. The work is perhaps more regular, being in the main by appointment ; emergencies are few and night-work rare. The fees in individual cases are generally good enough, but the difficulty of fitting in one's appointments, the rush (occasionally) from case to case, and the long, tedious hours spent in hospital render the anæsthetist's lot a somewhat harassing one. In spite of its drawbacks, however, the speciality has no lack of recruits, many of whom, however, only join the ranks for a time. It appeals largely to two classes. The young man sees in it the short cut to the purlieus of Harley Street and fortune : a few months as resident anæsthetist, then a small appointment as visiting anæsthetist and the patronage of a few surgeons, and he is launched on a career which fortunately entails no heavy preliminary outlay. Unfortunately what appears a comfortable income to a recently qualified man hardly suffices when he gets older and turns

his thoughts to matrimony ; and these incomes will not always expand as fast as one would wish. Many are called but few are chosen. Another type of "short service" man is the one who comes to town and settles in practice in or near middle life. He is not overburdened at first with work and sees in anæsthetics a comfortable little addition to his income. Minor hospital appointments are fairly easy to obtain ; from this source many recruits are drawn. As the years roll on general practice perhaps increases, hospital work grows irksome, and anæsthetics are abandoned. On the other hand, the interests and fascinations of the anæsthetist's craft are great, and given a reasonable amount of financial encouragement, individuals are to be found in both classes who will devote their lives to it to the exclusion of all other avenues of professional advancement, and in the end achieve a competence, perhaps even some measure of fame.

What is the **lure of anæsthetics?** To my mind it lies chiefly in the variety of the work. The problems are almost endless ; they arise from the state of the patient, the nature of the operation, and the special demands of individual surgeons, all of which may be to a certain extent ascertained beforehand. On the top of them all, however, is the patient's idiosyncrasy—an unknown quantity. The resistance offered by one patient to enormous doses and the comparatively small dose that perhaps suffices for another, these things must be discovered for himself by the anæsthetist as he goes on. Much of course may be judged by the patient's physique, habits as regards alcohol, and so forth, but exceptions

are always cropping up. To put it shortly there is a sporting element in the speciality; it is a game of skill in which chance also figures to some degree. The more one plays it the more one grasps the rules and the probabilities which lead to success. In making these remarks I trust I shall not be misunderstood. I am not regarding the administration of anæsthetics as a gamble with death. Risk to life should in these days hardly enter into the game. The anæsthetist's problem is in every individual case to give the best and smoothest anæsthesia with the least discomfort to the patient, using such means and methods as are at present at his disposal and trying new ones that appear to offer good prospects as they arise. In the course of time perfection —and monotony—may come.

There are other charms. Though the responsibilities are great, once the administration is over and the patient has recovered consciousness the anæsthetist's task is as a rule finished. He has nothing further to worry about in that individual case. Again, except for a very short period preliminary to the induction the patient cannot talk, hence in his work the anæsthetist is not worried with endless questions and a futile flow of conversation.

To make a good anæsthetist certain qualities, mental and physical, are desirable, some indeed are essential, and anyone lacking them would be ill-advised to embark on the career. To take the **mental qualities** first: the anæsthetist needs a well-balanced mind capable of forming judgments rapidly; in order to form them his powers of observation should be good, and he should

train them to the highest pitch of perfection. Again he should not be nervous and hasty on the one hand, nor too slow and phlegmatic on the other. Method and orderliness are required. The anæsthetist should "lay his table" with the precision of a well-drilled parlour-maid : everything set to hand so that even in a darkened room it can be found at once. Were I asked the cardinal sin in the anæsthetist, I would almost be disposed to say Clumsiness—by Haste out of Thoughtlessness, in the language of the stud book. What more disturbing than the anæsthetist who upsets his drop bottles in a hurried grab at the tongue forceps, or breaks his patient's teeth in ill-considered efforts at forcing open the mouth? Everything should be done with rapid deliberation and cold despatch, if one may say so. Remember it is better to do nothing well than to do the wrong thing and do it badly. The anæsthetist is sometimes embarrassed in emergencies by his helpers, therefore tact is required. The spectacle of a colleague energetically compressing the lower ribs and abdomen during the *inspiratory* movements of artificial respiration calls for promptness and diplomacy on his part.

In grave emergencies there is a tendency, on occasion, for people to lose their heads. The anæsthetist must always keep cool ; it is up to him to *know* what is the right thing to do and the best and quickest way of doing it. In his early days this will not be easy, therefore the beginner should not be over-arrogant and cocksure, but rather recognize his own limitations and fallibility, and be ready to accept advice from others who may perhaps have more experience. Confidence

in himself should and will come in time. In addition the anæsthetist should be possessed of almost inexhaustible patience ; especially is this needed in dealing with difficult and refractory subjects in an atmosphere charged with impatience.

It seems in these days of modern education to be superfluous to insist on a knowledge of the elementary principles of mechanics and physics. The medical student of the present day should surely be well grounded in such simple matters as the laws of heat, the mechanics of valves and levers, the law of gravitation and effects of specific gravity in mixtures of vapours or fluids. Yet what does one frequently find among students? All these simple things forgotten or ignored. A thorough knowledge of these and kindred matters and its application in practice will avoid many of the minor vexations of the administration.

The **physical endowments** required of the anæsthetist are the perfect use of his hands and feet and a corresponding perfection of at least four of his special senses —sight, hearing, touch, and smell. The hands must be in no way crippled ; let them be as good as they may the anæsthetist will often wish he had an extra pair. He will frequently supplement them with his feet ; these therefore require some attention and acquire a certain delicacy of touch. They should not be encased in uncomfortable, ill-fitting, heavy boots which interfere with this. As regards the sight, errors of refraction which can be corrected by glasses need not trouble one much, otherwise this should be perfect. Hearing is of the greatest importance ; slight alterations in the breathing and in

the working of apparatus are conveyed through the ear, and an early perception of these may make all the difference. These two senses should be receiving impressions during the whole of the administration, on which they should be completely concentrated. The sense of smell is of only occasional use, but it should be highly developed and cultivated to be able to detect the odour of the different anæsthetics either alone or in mixtures, and to gauge roughly the strength of vapours. The sense of touch includes many things, such as the impression of heat and cold, weight, resistance, and so forth. As the aurist knows instinctively by the feel of the catheter between his finger and thumb when the distal end is engaged in the Eustachian orifice, so should the anæsthetist know exactly what his gag or his sponge-holder or any other instrument is doing in the patient's mouth. The difference between chloroform, ether, or a mixture should be as apparent to the sense of touch as to smell. All these senses should be trained to the highest pitch of perfection, impressions should be received from them simultaneously and co-ordinated at once into a mental picture.

Whatever his natural endowments, the anæsthetist is not born, like the poet, but must go through a long and arduous **training.** The many complications that may arise during administration are not of frequent occurrence, hence in an average practice some thousands of administrations must be made before the anæsthetist has seen them sufficiently often to be familiar even with the more common. Books of course are useful; they teach the beginner the rules of the game, but practice

is the only thing that makes his play perfect. Individuals vary, but on an average I should say that it takes quite five years to obtain a thorough mastery of the essentials and another five to acquire all the refinements and the ability to deal with every emergency with cool confidence and promptitude. In conclusion, I would suggest that every anæsthetist is the better for having seen something of general practice. The experience is frequently invaluable. On two occasions it has fallen to my lot to be called to give an anæsthetic to patients suffering from pneumonia. In the first case, the patient had acute mastoid disease; in the second, acute abdominal pains had suggested the advisability of laparotomy; in both, a glance at the patient suggested pulmonary trouble, which I was able to confirm with the stethoscope. Needless to say, no operations were performed. I heard afterwards that the first patient died within twenty-four hours. On many occasions I have been able to diagnose a rash either as, or as not, the eruption of a specific fever. An attack of whooping cough or an epileptic fit in the course of an administration would be slightly embarrassing to one unfamiliar with these phenomena. In addition to medical knowledge, one also acquires in general practice an insight into human nature which is invaluable in dealing with all sorts and conditions during the preliminaries of induction.

II.—Apparatus.

Let us now consider the anæsthetist's ordinary requirements in the way of apparatus. Special methods need special tools, but these will not be discussed here—merely the simple necessaries that will fit conveniently into one bag and serve the purposes of the vast majority of anæsthesias.

The first guiding principle in selecting instruments is quality; the best is always cheapest in the long run, and this applies to both workmanship and material. All rubber parts should be of the best quality; tubing should be stout, avoiding kinks, and seamless—arabesque, or red rubber, is the best. A second guiding principle is general utility; any piece of apparatus that combines in itself the function of two or three instruments means a saving of space and frequently a saving of labour. This principle, of course, has its limitations. A third principle is simplicity in design and construction. The more intricate the apparatus the more likely it is to get out of order, and the less it is in the power of the anæsthetist to discover immediately the cause of any breakdown and effect the necessary minor repairs or readjustments on the spot.

So much for general principles—now for details. In the administration of gas, chloroform, ether, and ethyl chloride, I have found the following list most generally useful:

Gas Cylinders.—Two 25-gallon, mounted on the usual stand with foot-key. Note that the points of the key should be fairly sharp, as if the tap is working stiffly

there may be difficulty in getting them to bite on the sole of the boot. A hand-key, or spanner, is also necessary to screw up the nuts, and sometimes to open the taps if they have been very tightly screwed up. The terminal, on to which fits the rubber tubing, should be bulbous or acorn-shaped at the extremity so as to give the tubing a good hold. It is a frequent trick with nurses and novices to tie the tubing on to the nipple—I have even seen it wired on—the idea being to prevent its blowing off under a sudden increased pressure of gas. No greater mistake could be made. If the tubing blows off, it can be readjusted in a moment; but if it can't blow off, it will probably burst, and bring the administration to an ignominious and disconcerting close. The tubing should be of stout red rubber, fitting the nipple tightly, sufficiently long to have a little slack, but not too redundant in this respect, otherwise the fatuous idiot who may frequently be found haunting the operating theatre will assuredly bring his (or her) foot down on that loose coil on the floor, causing the anæsthetist some temporary embarrassment.

Gas-bags are made in different sizes, from 1½ gallons to 3 gallons capacity. The former is rather too small, as if, as will sometimes happen, gas is running a little unevenly, there is not sufficient margin between depletion and over-distension of the bag. On the other hand, a 3-gallon bag leads to unnecessary waste, as a gallon or two is often left in the bag at the end of the anæsthesia. A 2-gallon capacity is the best. Gas-bags are generally made in black rubber, which, while not so durable as red, has the advantage of being thinner and more

pliable. They are extremely perishable, especially if not in frequent use; they should not be left lying in the bag or a drawer, but always kept partially distended and hanging from a hook when not in use.

A regulating stopcock is supplied which allows of the patient inspiring air or gas from the bag and expiring through an expiratory valve, or re-breathing backwards and forwards into the bag. There are two varieties—Hewitt's and the dental. The former is decidedly cumbersome and furnished with two taps, whereas the latter is simple, and the single tap can easily be adjusted if necessary by the forefinger of the hand which holds the mask, leaving the other hand entirely free for any other purpose.

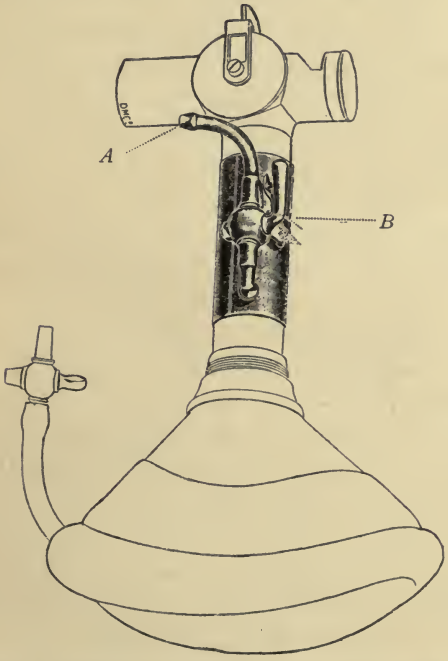
Face-pieces are made in a variety of designs, materials, and sizes. As regards size, the anæsthetist should have one for children and one for adults, and in addition an extra large one with a flat top for use where the mouth has been widely opened with a Wingrave's gag previous to the administration. I like the face-piece and pneumatic pad to be made in one piece. The celluloid masks with removable pads no doubt give an excellent view of the patient's nose—an organ, however, which hardly calls for the concentrated attention of the anæsthetist. On the other hand, the pads invariably work loose after a time, permitting the admission of air through the various resultant chinks.

For the administration of **gas with oxygen**, a supply of the latter, with tubing bag and mixing chamber, are required. Hewitt's apparatus for long held the field. It is cumbersome; the stopcock appears liable to get

out of order, and it demands another complete and heavy separate outfit. Much simpler and better is Weiss's oxygen attachment for gas and oxygen. It consists of a length of tubing for attachment to the gas cylinder, a small, 1-gallon oxygen bag, connected by short, small-bore tubing with the mixing chamber, one end of which fits on to the stopcock of the gas-bag and the other into the face-piece. By means of a handle on a dial the oxygen can be turned on in the desired quantities. A great advantage over Hewitt's apparatus is that it permits of re-breathing, effecting an economy of gas and offering a concession to the views of the "acapnia" school. An apparent and obvious disadvantage is that, the bags being entirely separate, there is no equality of pressure in them. In practice, however, this is of no importance; the whole secret is always to have a plus pressure in the oxygen bag.

The flow of oxygen depends on two things—the pressure in the bag and the size of the orifice through which it passes. With increased pressure in the bag the flow can be reduced by pushing back the tap and reducing the outlet. Pressure in the bag can be maintained, pending refilling, by compressing it between one's chest and the head of the table or chair on which the patient reclines, the bag having been so arranged as to fall into the required position before starting the induction. Oxygen can be obtained from the usual cylinders supplied in operating theatres, or $7\frac{1}{2}$ gallons can be compressed into the ordinary 25-gallon gas cylinder mounted with a separate stand and key. This is very portable and convenient, and, as in my practice

I find 1 gallon of oxygen to 6 or 8 gallons of gas a fair working proportion, it is quite sufficient to take about for ordinary short cases. Where prolonged administra-



Weiss's Oxygen Attachment for Gas and Oxygen.

A, Terminal for connection with oxygen bag; *B*, regulating tap

tions are required, it is advisable to have 100-gallon cylinders sent direct to the venue by the makers.

It must be remembered that the valves of the gas stopcock occasionally get a little out of order, so if it has not been in recent use, it is wise for the anæsthetist

to test it and see that the valves are working properly before proceeding to the administration.

Some apparatus is also required for administration of **gas through the nose.** Here, again, I am convinced that simplicity should be the keynote. Modern complicated apparatus, with numerous valves and accessories, offer no real advantage over the old Patterson's or Coleman's apparatus : this is attached to the ordinary gas-bag after the removal of the stopcock. It is usually furnished with an inspiratory valve concealed in the metal junction between the bag and the tubing. I generally remove even this, thereby allowing in some cases a certain amount of re-breathing.

If it is desired to give oxygen as well, the mixing chamber of the Weiss's apparatus can be fitted in between the tap and the tubing. The tubes connecting the gas-bag to the nose-piece are generally unnecessarily long and not stout enough to obviate kinking—matters which require attention when purchasing. The nose-piece should be made of metal without any pneumatic pad. If two or three different sizes are kept, it will be possible to fit almost any sized or shaped nose. For use during induction a mouth-covering with expiratory valve is necessary ; this, also, is best made of metal. A useful addition is the clip sliding on the tubes and clamping them to the back of the head, thereby fixing the nose-piece in place.

For the administration of chloroform, ether, or mixtures, a **mask** will at times be required, no matter what special methods may be generally preferred. There is no better mask than that known as the St. George's

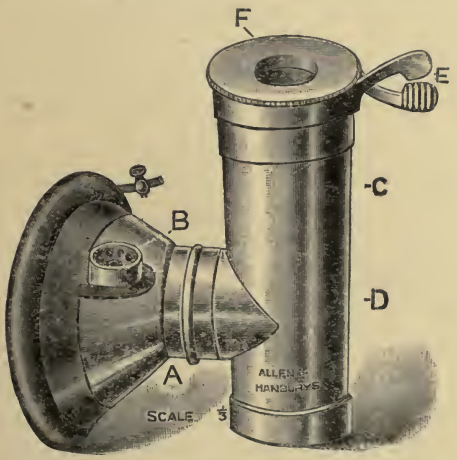
pattern, made by Montague. It is shaped to the surface on which it has to lie, has a guttered rim, and is provided with a nipple for the attachment of the tubing of Junker's apparatus, and equally serviceable for connection if desired with an oxygen cylinder ; the portion of the frame fixing the lint is fastened down by a button, which is a more durable arrangement than a spring catch. Personally, I don't think it much matters what the cover is made of—lint, flannel, or gauze. A point frequently overlooked by nurses is the trimming of the edges ; these are not infrequently left redundant, hanging down on the face, and entirely counteracting the object of the gutter.

The best form of **Junker's Inhaler** is Buxton's modification. It is graduated to two ounces, but not more than one should be put in at a time. A sufficiency of stout tubing should be provided so that on the one hand with the bottle hanging from the table the bellows will reach to the floor, and on the other the delivery tube is of such length that both the anæsthetist and his table can be removed if necessary from the immediate proximity of the operator. The delivery tube is best made in two portions connected by glass tubing ; this enables the last few inches to be taken off, washed, and boiled before operation. In using a Junker that has been put together by someone else let the anæsthetist beware. On two occasions it has happened that I have been tendered a Junker in which the tubing had been transposed, with the result that on compression of the bellows air was forced into the upper part of the bottle and liquid chloroform was driven along the

delivery tube. Therefore, always test a strange Junker before using ; another reason for so doing is to see that it works properly, that there is no escape at the valves, or at the junctions of the various parts, or through breaches in the tubing on the one hand, and that there is no block in any part of the system on the other. Blocks generally occur from kinking or sticking together of the walls of old tubing. An interesting and instructive form of blockage occurred on one occasion in my practice. In a prolonged case ether had been gradually substituted for chloroform ; the Junker was not of the Buxton pattern in which the submersed portion of tube is made of bone, but was provided with one made of metal throughout, which became so chilled by evaporation of ether that the moisture in the air passing through it condensed into little pellets of ice ; these blocked the passage until by the application of warmth to the bottle they were sufficiently melted to allow of their being shot out by the now over-distended bellows. Junker's apparatus is frequently supplied with too small a bellows ; the anæsthetist should see that a good large size is provided, so that each compression delivers a fair volume of air through the column of chloroform. An invaluable addition to the Junker is a wooden slipper **foot bellows** which slips over the hand bellows, enabling it to be worked by the foot and saving a hand for other purposes ; its inner surface should be properly grooved for the reception of the rubber bellows and valve case. Some surgeons have objected to its use on the ground that the patient was being supplied with germ-laden air from the floor of the theatre. Whether it is really the case that

the air in this situation is more septic than in higher strata remains, I believe, to be demonstrated; in any case, it is quite unimportant as all of it passes through chloroform, and is efficiently sterilized thereby.

For the administration of **ether** I have for years used an apparatus designed by myself. It is extremely light,



THE BARTON ETHER INHALER (ORIGINAL MODEL).

A, Face-piece; *B*, expiratory valve; *C*, chamber; *D*, well; *E*, clip; *F*, cap carrying inspiratory valve. In later models the valve *B* is furnished with an obturator, and the junction of chamber and face-piece is purely telescopic.

portable, and simple, and equally useful for open and closed methods. Here I will briefly describe it, leaving the method of employment to a later chapter. It is made of metal, and consists of essential parts and accessories. The essential parts are a Roth-Drage face-piece, carrying an expiratory valve; a more or less cylindrical chamber open at the top with a short side branch on to

which the face-piece telescopes, a cap or lid fitting the top of the chamber and carrying a removable inspiratory valve; a circular spring clip to hold in place the lint lining the chamber. The accessories are a pneumatic pad for use in thin-faced people in whom a proper apposition of a metal face-piece is impossible; a short angular junction to be inserted between the face-piece and chamber in such cases (*e.g.*, thyroidectomy) as require the face upturned during operation; a wide-mouthed rubber bag to fit on to the top of the chamber when a closed method is necessary.

The apparatus is intended for use with the patient's head turned to one side; as the face-piece can be completely rotated on the chamber it matters not which side; with the face turned to the right the expiratory valve looks upwards, with the face turned to the left all that is needed is to rotate the face-piece till the valve looks downwards. This valve is made of mica, and its case is easily unscrewed if it is required to renew the valve. In the later models I have had this expiratory valve fitted with an obturator, so that it can be closed when it is desired to use the apparatus with a bag as a closed method. The chamber is also of metal about $5\frac{1}{2}$ inches high and 2 inches in diameter at the top, which is open, narrowing a little lower down. The bottom is slightly bevelled, so that when it is put down the whole apparatus rests on the base of the chamber and the edge of the face-piece in fairly stable equilibrium. In this position, instead of being perfectly vertical, the chamber leans a little towards the face-piece. About the junction of the middle and lower

third of the chamber comes off the branch by which it is connected with the face-piece, and in this is an attachment into which can be fitted the inspiratory valve. The part of the chamber below this opening I call the well; it is capable of holding nearly two ounces of ether with the chamber in the normal upright position; if more is put in or the chamber tilted it will overflow through the opening into the face-piece, a possibility which must be always borne in mind when using the apparatus.

The inspiratory valve is merely a circular piece of rubber screwed on to a short cylindrical frame, provided with a bayonet catch by which it may be fixed in one of two positions—viz., in the opening between the chamber and face-piece, or into the metal cap which in its turn fits into the top of the chamber. The thickness of the valve is of some importance. If too thick it is apt to be rigid, opening with some difficulty, and not closing entirely during expiration; it works stiffly, in a word. If too thin it is apt to droop, and is not caught or closed by the draught of expired air. *In medio tutissimus ibis.* I generally make my own valves of a piece of rubber such as is supplied for mending the inner tyres of bicycles, or a piece off the end of a Paul's tube does very well.

The chamber has to be furnished with a lint lining. Take a piece of lint sufficiently wide to wrap round the first three fingers, overlapping about ½ inch, and about 7 inches long; roll this into a cylinder with the smooth side outermost, and pass it to the bottom of the chamber with the junction of the edges towards the opening into the face-piece; press it out so that it closely

lines the inner surface of the chamber, then take the free edge at the top and evert it over the rim and fix it in place by the circular spring clip. When so fixed the valve-cap should fit closely into the top of the chamber but lint varies a little in thickness, and sometimes the junction is not airtight. If this is the case, turn the edge of the lint up again over the clip, and invert it into the chamber; this doubles the lining just at the top, and makes it thick enough to grasp the cap tightly. It is important that the lint is carried right down to the bottom of the chamber, otherwise it will not dip into the pool of ether when it gets low, and can no longer suck it up. The lining presents roughly an evaporating surface of 20 square inches when it is all moistened, as is the case when ether is poured on to it; but as evaporation takes place faster than capillary attraction, this surface is somewhat reduced in actual practice—in other words, an inch or two at the top becomes dry after a short period.

In purchasing the apparatus it is most important to see that the parts all fit together properly so that it is thoroughly airtight, otherwise much ether vapour is wasted and there is disappointment.

The accessories are not of much importance; the pneumatic pad should be made of red rubber, and furnished with a loop to fix around the expiratory valve case. It is seldom needed, but occasionally with hollow-cheeked individuals is indispensable. The angular junction is intended for insertion between the face-piece and cylinder where, as previously stated, an up-turned position of the face is essential for operative

procedures. Here, again, the junctions must be air-tight. The bag used for converting the apparatus into one for closed ether must be wide-mouthed, so that it fits over the top of the chamber; the one I use for ethyl chloride administration serves this purpose very well. In order to convert into a closed inhaler, all that is necessary is to remove the inspiratory valve, close the expiratory valve by means of the obturator, slip the clip a little further down so as to make way for the mouth of the bag, and then stretch the latter over the top of the chamber.

Ethyl chloride is not nowadays so frequently given *per se* for short operations as it was some years ago, the reason being the great advances recently made in the administration of gas and oxygen, both by the ordinary and nasal routes. However, there are occasions on which an administration of this drug alone may seem desirable, generally in children, sometimes in adults. For the former, rapid spraying, on a mask, and quickly covering up with a folded towel, is sufficient. But some form of closed apparatus is required for adults; there is nothing better than the Simplex (Duncan and Flockhart). The face-piece supplied with it is equally serviceable for use with a gas apparatus, and the bag can be used as described with my ether inhaler, all of which saves a multiplication of apparatus.

Drop-bottles require a little consideration. The essentials of a good set of drop-bottles are stability and distinctiveness, rendering easy their differentiation at a glance; simplicity in construction is a further advantage. All these qualities are found in the bottles used origin-

ally, I believe, at St. Thomas's Hospital; they are circular in cross-section, not too high, and plain or tinted amber and blue for ether, chloroform, and C.E. respectively; every theatre should be furnished with these, but to economize space in his bag the anæsthetist need not carry more than one for C.E. if he provides his stock-bottles of ether and chloroform with a spare notched cork.

Stock-bottles for ether and chloroform are supplied in boxwood cases of eight and four fluid ounce capacity respectively. If larger amounts are likely to be required they must be carried in the original bottles supplied by the manufacturers. Ethyl chloride is supplied in graduated vials containing 60 c.c. The stopcocks with which they are furnished are an occasional source of annoyance, either leaking or yielding an insufficient flow. On the whole, I think Duncan and Flockhart's model the most satisfactory.

The above remarks cover the apparatus for the actual administration—at least, so far as the essentials are concerned. There are some who may prefer other and more elaborate machines, such as Clover's Ether Inhaler, Vernon Harcourt's Chloroform Inhaler, or **Shipway's apparatus**, for administering warmed vapours. The last-named has the great advantage of being a *multum in parvo*, serving for the administration of ether, chloroform, or a mixture, and dispensing with the necessity of carrying stock- and drop-bottles. The claims of the "warm vapour" school are, in my view, a little extravagant, but this is not the place to discuss them. The **Vernon Harcourt** inhaler is useful, but I think it has

been abundantly proved that a great proportion, if not the majority, of *sudden* deaths under chloroform occur under a light anæsthesia, and this fact somewhat discounts the advantages claimed for the percentage method. If one is purchased, the later type, in which the face-piece is connected with the rest of the inhaler by wide-bore flexible tubing, should be selected.

The accessory apparatus required by the anæsthetist for ordinary occasions consists of the following articles —props, wedge, gags, tongue forceps, sponge-holders, Hewitt's airway, tracheotomy case, hypodermic case with selection of ampoulles or tabloids ; a small outfit for intravenous or intracellular injection of saline may sometimes be useful when going to private houses.

Props should always be connected together in pairs by a length of whipcord or chain. Hewett's set of five different sizes are as good as any, though the somewhat massive solid rubber props favoured by dentists have the advantage of being less easily shifted by the patient during induction. When used it should be seen that they are securely fixed in position—not just balanced between two isolated teeth—otherwise there will be disappointment on removing the mask.

The **wedge** is a dangerous tool, and should be avoided as much as possible, and only used with the greatest care and without any undue force or hurry, otherwise teeth may easily be dislodged or injury inflicted on the palate. Most adults have a gap somewhere between their teeth into which the blades of the gag can be inserted. If not, a moderately clenched jaw may frequently be opened by the following manœuvre : Put

a hand on either side of the face, the thumbs behind the angles of the jaw, and the fore- and middle fingers on the chin; by pressing the thumbs forward and the chin downward at the same time the jaw will generally open a little, the tongue at the same time protruding, and an assistant can insert the gag or seize the tongue.

Gags are required for two purposes—viz., to open the mouth promptly in case of emergency and to keep it fixed open during intra-oral operations. Two different types are consequently required. For the first purpose there is nothing better than a Ferguson's gag; the handles are long, giving good leverage; it is fitted with a "spring and ring" attachment, easily adjusted with one finger, and a great improvement on the ratchet supplied with some gags. This is an abomination which after a time frequently works loose, and in any case often requires a second hand to release it. The plates of the gag should be leaded on their dental surfaces; this does away with the necessity for rubber coverings, which take up room and harbour germs. This gag is not self-retaining and therefore unsuitable for prolonged operations in the mouth, though it answers well enough for dental extractions and other short cases.

Of self-retaining gags there are many, and all present some objectionable features. The three that I have used most are Doyen's, Wyatt Wingrave's, and Waugh's. The first is, perhaps, best known and, as modified by Probyn Williams by the addition of a Junker terminal, is useful. The disadvantages are that the dental plates are made much too big and bulky, taking up room that the operator needs. The dental surfaces are convex from

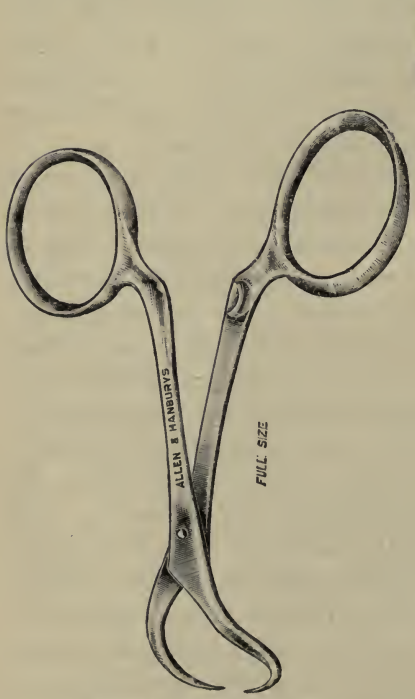
side to side leading to the rotation of the gag if left untended. The lower lip is extremely apt to worm its way between the dental plate and the teeth and get severely bitten, and if the incisors are loose and the gag hurriedly opened on a clenched jaw one or more will probably be dislodged. Finally, it is fitted with a ratchet catch, which for reasons given above is objectionable. Heath has recently modified it, and his gag is certainly an improvement on the original.

Wyatt Wingrave's gag is ingenious, and serves very well where the mouth is simply required to be kept fixed widely open, but it is difficult of adjustment in cases such as tonsil enucleation, which demand some relaxation of the gag during certain stages of the operation. Some years ago I modified it by the addition of a Junker terminal. This is a short metal tube soldered at its middle transversely to the lower surface of the upper bar a little behind the dental plate; the ends of the tube are bevelled away from the dental plate and their edges lipped to give a good hold to the rubber tubing. Thus to whichever side of the mouth it is turned one end of the terminal just projects inside the cheek, while the other receives the tubing from the Junker's apparatus.

Waugh's gag is excellent for his operation of dissection of the tonsils and most other intra-oral operations, but is unsuitable for enucleation with the guillotine. It would be improved by the addition of a Junker terminal.

Of **tongue forceps** there are roughly two types; the one holds the tongue by pressure, the other by piercing its substance. The former, which is usually figured in textbooks, is a relic of barbarism, and should be

relegated to museums, with thumb-screws and similar articles of torture. It is difficult to apply, requiring the mouth to be widely opened; if firmly applied the tongue will certainly be bruised, and if loosely it will



A Humane Tongue Clip. A Relic of Barbarism.

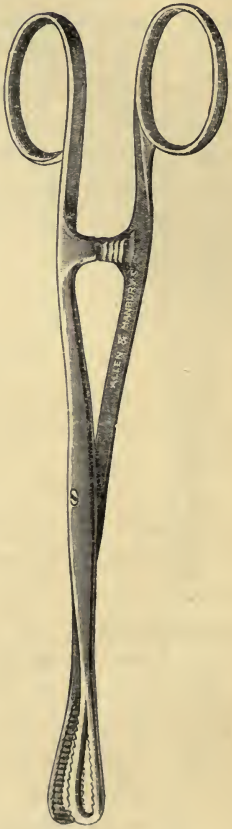
slip when traction is made and abrade the mucous membrane. Of the piercing variety there are again two types. One need only be mentioned in order to caution against its use. It pierces the tongue from above downwards, requiring an even more widely opened mouth

than the pressure type for its adjustment, and as it pierces the delicate mucous membrane of the under surface of the tongue is apt to cause some scoring or splitting of this when firm traction is used.

The towel clip makes the best tongue tractor. Separate the teeth ever so little, and the tip of the tongue will generally protrude; the closed blades are easily slid backwards along the tough dorsal surface, opened widely, the points pressed firmly down and quickly closed. The procedure does not take a second, and does no injury to the tongue, always provided that a pair is selected with fine piercing blades and sufficient room between their sides when closed to insure that the portion of tongue seized is not pinched as well as pierced. Some instruments supplied for the purpose have blades much too coarse and too closely set. In removing this instrument the tongue should always be firmly held with a towel, lest a sudden retraction should cause the surface to be scored by the points during the procedure.

Sponge-holders are of many kinds. The sort to avoid is the slender, somewhat flexible, type in which the sponge is held between two toothed ends fixed together by a ring. They require two hands to ship and unship the sponge, and if the ring is not firmly adjusted the sponge will surely come off just at the opening of the glottis. The best sponge-holder is a magnified pressure forceps with a fenestrated blade. With this a sponge is picked up or thrown out with one hand only, and will never slip off in the throat. One word about sponges: there is nothing better than rather coarse-meshed

THE INEFFICIENT SPONGE-HOLDER.



A SENSIBLE SPONGE-HOLDER.

marine sponges; as well as soaking up liquid blood these will, if rotated, entangle small clots in their

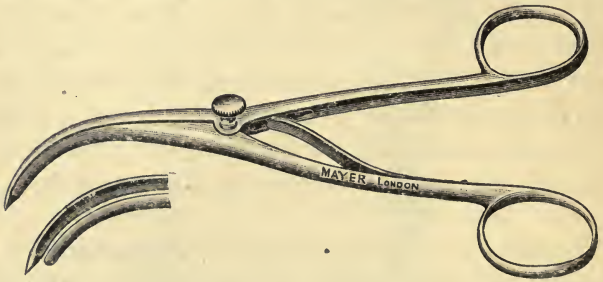
meshes which cannot be done by bits of cotton-wool or gauze. The latter, of course, have the advantage of being cheaper and easily sterilized. Marine sponges require a lot of cleaning and disinfection after use, and seldom survive the process more than three times.

Hewitt's airway is seldom required during an operation. The anæsthetist is then in control, and can effect all he requires with the gag and tongue forceps. It comes in useful, however, at the end of operation when the patient is removed to bed half unconscious, and under the supervision of unskilled attendants. Many patients during this stage will firmly clench their jaws and retract their tongues, and, with the nasal airway probably blocked by a swollen mucosa, alarming symptoms of asphyxia soon appear. By inserting the airway at the close of the operation these troubles can as a rule be avoided.

A simple set of **instruments** for **tracheotomy** in a suitable metal case should form part of the anæsthetist's outfit. As an alternative or in addition to this a Hill's direct-vision laryngoscope with small battery and catheter may be carried. With very little practice **intubation** is more quickly performed than tracheotomy, and the lungs can be flushed out from an oxygen cylinder instead of performing artificial respiration. The laryngoscope should be slotted to facilitate its removal when the tracheal tube is *in situ*. One speaks of tracheotomy, but, as a matter of fact, the operation if done is usually a laryngotomy through the crico-thyroid membrane, a more expeditious and less sanguinary procedure.

The **hypodermic syringe** should be of glass with a glass or metallic piston. A metal barrel is a snare, as you are unable to see that you are charging it with solution and not partly with air owing to some fault in the fittings, and pistons other than those mentioned are apt to get out of order. Pituitrin and strychnine are the principal "stand-bys" in emergency, and are best carried in solution in ampoulles.

It is useful to have some simple apparatus for injecting **saline** solution when giving an anæsthetic in a



A Useful Instrument for Emergency Laryngotomy. Combined Laryngotome and Dilator (Bart's. Pattern).

private house. A small glass funnel, length of tubing, one or two needles, and some sodium chloride soloids furnish all that is requisite.

The above instruments and apparatus provide the anæsthetist with everything that he is likely to require for any ordinary operation or emergency. To carry them conveniently I have designed a **bag** which was made for me by the Surgical Manufacturing Company. Its outside measurements are, length 14½ inches, width 7 inches, height 15 inches. A narrow, high bag

is easier to carry than a wide one, and stability in my bag is insured by the following internal arrangements. The bag is divided into two parts by a false bottom : the lower compartment, approached by a flap at one end, is $4\frac{1}{2}$ inches high, and just accommodates the gas cylinders and stand with foot-keys and tubing. The upper part serves as a container for the apparatus used in administration, and supported on metal ledges at either end of it is a light metal tray 2 inches high, which carries what I have described as the accessory apparatus, and occupies the space between it and the raised flaps which close the top of the bag. This tray is best made of aluminium, which is light and does not rust. If the bottom is perforated the whole thing with its contained instruments can be put into a sterilizer before being laid on the anæsthetist's table. When gas cylinders are not being carried, the tray of instruments should be packed in the lower part of the bag below the false bottom, thereby insuring stable equilibrium, and allowing room in the upper part for apparatus (such as Shipway's inhaler) that might otherwise be too high to fit in.

This bag was made to my design in pre-war days and with a tin tray at a cost of only £3.

ESSAY II

SOME POINTS ON CHLOROFORM

At this time of day it may seem a work of supererogation to discuss the **rival merits of chloroform or ether.** I doubt if an anæsthetist could be found who would not plump for ether on every occasion on which its administration was practicable. Some few surgeons there are, however, still, who from purely selfish motives, if one may say so without offence, prefer chloroform. After all, a surgeon is something of an artist, and has the artist's intolerance of anything which interferes with the exhibition of his skill. For the benefit of those whose memory does not go back to the days when anæsthetists were divided into two camps, the etherists and the chloroformists, it may be as well to recapitulate the arguments as they appear to me.

To take the **case for chloroform** first. The advantages are, that it is certainly pleasanter during induction, and the taste on recovery is less nauseating and persistent than ether. Compared with this latter, as given by the old method in Clover's inhaler, after-vomiting was, perhaps, less troublesome in the majority of cases. Nevertheless, the severe types of vomiting associated with acidosis are more prevalent after chloroform.

Again, it is undoubted that in the majority of cases a greater flaccidity and quieter breathing can be insured by chloroform—no mean advantage in abdominal operations. On the other hand, a prolonged experience of chloroform and of open ether (following alkaloids) in these operations has convinced me that, given gentle surgical handling, there is not so very much to be said after all in favour of the former. There is no doubt that in the ordinary case when the anæsthesia is good it is very good, but I have met with straining under chloroform quite as troublesome and frequent as under ether. At one time it was considered there was an age limit for ether, and that it should not be given under six or over sixty—an alliterative way of putting the matter. Experience with atropine as a preliminary has, however, shown that there are no such limits, and after its injection, open ether can be given with impunity to infants and the aged alike. I think the same may be said of all minor bronchial and pulmonary conditions which are fit for an anæsthetic at all, and which at one time were, and indeed are largely now, condemned to chloroform. On this matter, however, my experience is not sufficiently large to dogmatize. The liability of the healthy to pulmonary troubles after ether has, I think, been exaggerated. Possibly in the old days, when a patient was kept half cyanosed by the closed method, and nearly drowned in his own secretions from the lack of a preliminary dose of atropine, there may have been some justification for the remark "chloroform kills some on the table, but ether kills more afterwards in bed." There is still, however, a prejudice with some

surgeons in favour of chloroform on this account, and cases of bronchitis and pneumonia following the administration of ether are apt to be hastily attributed to the ether. This was particularly impressed on me one spring when I was temporarily working for a surgeon with strong views on the subject both of alkaloids and ether. Every week for a certain period he greeted me with the remark that all the patients operated upon on the previous occasion had developed ether bronchitis with, perhaps, rise of temperature and catarrhal pneumonia, generally on the day following operation. I had to point out that he himself was suffering from influenza, that it was rife among the staff and patients, and that, as the operation cases were admitted the night before they were brought to the theatre, it was only natural they should present the symptoms of influenza on the day following, which would be about the normal period of incubation. I don't know whether he believed me, but I do know that as the warmer weather came, and these infections died out, I heard no more complaints of ether bronchitis. So much for chloroform.

Now let us consider **the case for ether.** So far as the induction is concerned the unpleasant taste of ether need not worry us in the least, as the patient can be, and in my practice is always, got under by other means, and by the time he is inhaling ether vapour is no longer in a condition to appreciate its somewhat pungent and nauseous qualities. Ether can and should be administered in apparatus just as simple as that for the administration of chloroform—in fact, the apparatus necessary is less involved than that used for the dosi-

metric administration of the latter. With ether, the anæsthetist is always in a position of security; such a thing as anxiety about the patient is almost unknown with alkaloids and open ether, and in any case is never dependent on the dread of over-dosage. I should say this contingency is practically impossible. Again, the stimulating properties of ether are of great help in warding off shock; indeed, it is wonderful to see how great an improvement in appearance develops in delicate subjects submitted even to severe operations under this anæsthetic. Blood-pressure rises instead of persistently falling, as under chloroform. Owing to this, hæmorrhage is perhaps a little more troublesome, but that is a matter that is as a rule easily dealt with by the operator. The advantages of ether on the operating table should be apparent to all. After the operation I believe the balance still lies with ether, as given by modern methods be it said. Post-operative collapse is less marked than after chloroform. Of course, if the patient has been over-stimulated by ether, there will probably be some reaction as its effects pass off, but the careful anæsthetist will avoid giving more ether than is absolutely necessary for the surgical requirements. After-vomiting is as a rule trifling, and the liability to acidosis is infinitely less than after chloroform. So far as my practice is concerned, I have never heard of its occurrence after ether. Some experiments on rabbits by Apperley * go to confirm this clinical experience, and his work is of considerable practical value to anæsthetists. Bronchial and pulmonary troubles I

* *B.M.J.*, September 14, 1912, p. 624.

have already said I regard rather as a bogy nowadays. Independently of the risk of infection when spring catarrhs are prevalent, the patient is unfortunately sometimes exposed unduly for a prolonged period on the operating table, his skin perhaps covered with cloths damp with lotion, which chills him further by its evaporation. On the other hand he may during the operation be in an over-heated, ill-ventilated theatre, partially swathed in waterproof sheets, and thereby bathed in perspiration; in this condition he is taken out through cold, draughty corridors, and in course of time put to bed, possibly under an open window. Yes, I think there are many causes besides ether to account for the few cases of pulmonary trouble arising after its exhibition.

It is right to say that the views expressed above as to the benign influence of ether in the post-operative stage are not entirely based on personal observation—the exigencies of practice deny the anæsthetist his opportunities for this; but they are based on the almost unanimous opinion of those best qualified to know—house surgeons, general practitioners, and, perhaps most important of all, nurses in charge of the patients during their recovery.

In the administration of chloroform it is most important that the beginner should grasp the symptoms and signs of the various **degrees of narcosis**, and learn to differentiate between too light and too deep anæsthesia —conditions widely apart, but having many signs in common. Finally, he should have some sort of definite conception as to how danger may arise, and possibly death occur, on the operating table.

The degrees of narcosis as I see them are five in number; they merge gradually into one another, not being sharply defined. Again, a patient who on the whole is obviously in one degree may nevertheless present some of the signs of another—in other words, cases do not always go "according to Cocker." The anæsthetist must be prepared for these little abnormalities, and judge of the depth of narcosis on the balance of evidence. Finally, it may seem hardly necessary, but I take the precaution of pointing out to beginners that the frantic voluntary struggles of a highly nervous patient or fractious child coming on with the application of a mask have nothing to do with narcosis, and indeed sometimes appear before any anæsthetic can possibly have been inhaled. Briefly, the degrees of narcosis, as I see them, may be defined as follows:

1. *Excitement.*
2. *Stupor.*
3. *Surgical anæsthesia.*
4. *Impending death.*
5. *Apparent death.*

In the **first degree** the patient is in a condition resembling drunkenness: he frequently babbles freely, becoming more and more incoherent and repeating himself; is noisy and frequently violent. He struggles, but his movements are not entirely purposive like the initial struggles of the frightened child, and soon become quite inco-ordinated, ending not uncommonly in mere rigidity or spasm. Dreams and hallucinations are of common occurrence. The patient's appreciation of

external impressions becomes blurred and eventually lost. His reflexes, however, remain brisk, and appropriate stimuli will produce movements which appear purposive—for instance, if an attempt were made in this stage to avulse a toe-nail, the knee would be promptly and forcibly drawn up, carrying the foot away from the stimulus.

Respiration is generally at first somewhat irregular owing to emotional disturbances; later it becomes deeper and quicker. It is subject to various complications, such as swallowing, holding of breath, straining, and stridor from laryngeal spasm. The pulse rate is accelerated and its volume increased, and the patient becomes flushed; but circulation is never stimulated to the degree observed under ether or ethyl chloride. The opportunities for examination of the pupils in this stage are limited owing to the patient almost invariably resisting any attempt to separate the lids and turning his eyeballs up. They are generally said to be dilated, but in my experience they have been variable.

The first gradually passes into the **second degree**, which may be likened to a very heavy drunken sleep. The struggles have come to an end, and the patient generally lies quite still and inert; fine tremors and coarser rhythmic movements are, however, not infrequently present, rigidity sometimes continues, and in any case complete flaccidity is not present. The reflexes —corneal, laryngeal, faucial, skin, etc.—are all still present and brisk. Although he is quite unconscious and analgesic, he will through his reflex mechanism promptly resent any surgical interference. His respira-

tion, as a rule, has become regular, and is quicker and deeper than normal; it is still, however, liable to be complicated on the slightest provocation, as in the former stage, and retching and vomiting are very apt to occur if there is unnecessary delay in passing through this stage to the next. The heart's action is less excited, the patient less flushed, and, indeed, pallor will probably supervene if there is delay. It is in this stage, in my opinion, that most of the *sudden* deaths under chloroform occur. I shall deal with this matter later, however; all I need say at present is that it is far more dangerous than the next, and full of traps for the unwary. The pupils are generally a little enlarged, getting smaller as the anæsthesia deepens.

The **third degree** is that of "*surgical anæsthesia.*" In this stage the reflexes disappear, not simultaneously but in order; some, indeed, are in many cases not abolished till the fourth degree is reached. Roughly, and of course subject to exceptions, the order is somewhat as follows: The response to ordinary surgical stimuli is the first to disappear, but rough manipulation in the abdomen will still excite rigidity, and such measures as stretching the sphincter and distending the bladder will cause reflex increase of respiratory effort and crowing breathing. The next in order to disappear is the corneal reflex, and though constant meddling with the eye is to be deprecated, this is a sign of great value to the beginner as he can test it for himself, and its absence assures him that this degree has been reached. The laryngeal and faucial reflexes generally persist a little longer, and, indeed, to get rid of these and the bladder

and rectal reflexes in a lusty young adult frequently requires the anæsthetic to be pushed just into the fourth degree, as I have had occasion to note when anæsthetizing young officers in the R.A.F. for tonsillectomies. The muscular system is relaxed, becoming more and more flaccid as the degree deepens. Respiration should be regular, a little deeper than normal, and accompanied by some stertor in the stout and plethoric; but in the thin and delicate is generally quieter and shallower than in the last degree, and indeed than normal in the deeper stages of this degree.

The circulation becomes depressed, blood-pressure falls; the pulse becomes smaller and weaker. The face loses any flush that may have been present earlier, and generally the colour is paler than normal. The eyeballs are usually fixed, or may roll slowly from side to side; the eyelids are lightly closed, the pupils moderately contracted and generally fixed, but occasionally respond slightly and sluggishly to light. In a fairly light stage of this degree they will dilate in response to surgical stimulus, and, again, as the fourth degree is approached they get larger. A moderately contracted and fixed pupil is the ideal.

In the **fourth degree** the patient is *overdosed*, suffering from chloroform *poisoning* and moriturus. He may, however, be saved by withholding the anæsthetic alone, or in conjunction with rhythmic tongue traction and pressure on the thorax, or perhaps artificial respiration, or endotracheal insufflation of oxygen. Though commonly adopted, artificial respiration is as a rule unnecessary in this stage.

All reflexes have disappeared and the muscles are absolutely flaccid. Respiration has gradually become shallower and slower, till one expects every breath to be the last. The circulation is so depressed that the pulse is lost at the temporal and facial, but may with care be detected at the wrist, and the heart can at any rate be felt or heard feebly beating. The elicitation of such signs, however, take time; what obviously hits the anæsthetist in the eye is the respiratory failure, the *colour*, which becomes a greyish mauve, and the *ocular phenomena*. The eyelids lie half open, the pupils are widely dilated and fixed, the conjunctivæ as white as snow.

From this degree the patient may pass, even without further administration, into the last, or **fifth degree**, in which he is moribundus, all signs of life having disappeared. Even in this degree resuscitation is possible if only the preceding one has been recognized, and the anæsthetic withheld at its onset, and *all* the measures described above are now promptly and energetically undertaken, with the addition of heart massage and lowering of the head of the table. Hypodermic medication is obviously useless and a waste of valuable time in the face of the cessation of the circulation.

From the above description, which refers only to chloroform uncomplicated by other narcotics, in spite of the many limitations and variations to which it is subject in actual practice, it should be fairly easy for the student to pilot his patient into the third degree of narcosis, and on the face of it should appear equally easy to keep him there; but, unfortunately for the

student, in recovery from surgical anæsthesia, the signs do not simply revert through the second and first degrees to complete restoration of consciousness. They are a little more complex, and, in the departures from the signs of the third degree, there is much in common between those of **too light and too deep anæsthesia;** for instance, slow, shallow breathing, failing circulation, pallor, and a dilated pupil are equally likely to be present in both. In the condition of faintness precedent to the vomiting of recovery, the muscles are frequently flaccid up to the actual supervention of retching; the corneal reflex does not always reappear early. The combination of all these signs gradually developing, the respiratory failure first, in the presence of a known free administration, is serious, and calls for withholding the anæsthetic till the ground is assured. Fortunately, there is generally some hint as to the real condition. In too light anæsthesia perhaps the pupils are not dilated, or if dilated react to light. Normally they become quite small, and if dilatation is present in a narcosis becoming too light, it is produced reflexly by surgical stimulus or is due to impending vomiting. The colour again in too deep a narcosis is a peculiar bluish-grey; if pallor is present in light narcosis it is just the ordinary pallor of faintness, and the conjunctivæ are as a rule not absolutely blanched. Respiration generally stops gradually and regularly with an overdose, and a rapid or irregular failure is indicative of too light an anæsthesia, or, at any rate, danger from some other source. Failure of respiration must on no account be confused with "holding of the breath," which is an

active phenomenon, and only occurs in too light narcosis. A little phonation would indicate the same thing. The *muscular tone* is often a useful guide ; with too deep a narcosis the jaw drops and the eyelids lie apart. This is not usual in the contrary case ; in fact, the usual thing is the reverse, a little clenching of the jaw and some resistance to attempts to open the eyelids on the one hand, or a wide and *active* opening of the eyes on the other. Again, swallowing, holding of the breath, straining, the presence of reflex movements, lachrymation, may one or all indicate the trend of events. Pallor and depressed respiration are the only two signs that may be said to be practically always present in the two conditions and common to them both under all circumstances. The knowledge that these signs have developed with an increasing or a diminishing dose is also, of course, helpful to the anæsthetist in coming to a conclusion. As a rule, where signs are a little mixed, there are generally one or two indications present, in a too light anæsthesia, which definitely determine the nature of the case.

The table on p. 44 summarizes the signs to be looked for under three conditions—anæsthesia getting too deep, becoming light (uncomplicated recovery stage), becoming too light, and complicated by other factors (trauma, impending vomiting, impending fibrillation).

Let no man think, however, that, having mastered these intricacies, he can guarantee safety in the administration of chloroform. **Deaths** do not as a rule take place from overdosage, the symptoms of which are usually perfectly plain and of gradual onset. I am

	I. Too Deep.	II. Light (Ordinary Recovery).	III. Light (Complicated).
Muscular System	Flaccid. All reflexes in abeyance.	Tone returning. Movements, rigidity, and reflexes present.	Generally flaccid. Reflexes may or may not be present.
Eyes	Lids lie passively half open. Conjunctivæ blanched. Eyeballs fixed. Pupils gradually dilate and become fixed. Lachrymation absent.	Lids either closed or widely and actively open. Conjunctivæ normal. Eyeballs frequently oscillate. Pupils become quite small. Lachrymation present.	Lids either closed or wide open. Conjunctivæ blanched. Eyeballs fixed. Pupils suddenly dilate. Lachrymation sometimes present.
Respiratory System	Respiration gradually becomes shallow and infrequent. Slight duskiness.	Respiration irregular. Holding of breath, swallowing, etc.	May be as in II. (before vomiting). Trauma sometimes reflexly inhibits, and sometimes stimulates. Asphyxial gasps indicate impending fibrillation.
Circulatory System	Pulse gradually failing. Dusky pallor.	Pulse frequently not much altered, and colour not affected till vomiting threatens.	Pulse fails, perhaps suddenly. Colour simply blanched, unless respiration is inhibited, then cyanosed.

convinced from my own experience of danger signals and from the perusal of recorded fatalities that sudden deaths—and they nearly always are sudden under chloroform—occur during light anæsthesia. At one time it was the fashion to attribute these *sudden deaths during light narcosis* to the inhalation by the patient, during his struggles, of an overwhelming dose, which, perhaps, became locked up in his lungs by some immediately subsequent respiratory obstruction. This is a view of the matter quite contrary to my experience, and against the balance of evidence in reported cases.

Contrast these two reports of cases which came under my personal observation. The first was a case of sudden death during light narcosis to which, by good fortune, I had not actually administered any vapour myself. The second was a case in which, through somebody's carelessness, I gave an enormous overdose of chloroform, but which, nevertheless, recovered. A third case, illustrating the dangers and mode of death during too light an anæsthesia, is so excellently reported by Dr. Alex. Wilson that I reproduce his notes here; they are, perhaps, a little more typical of the usual happenings, and less open to the criticism of the overdosage school than are mine, which were taken at a time when I had no clear views on these matters, and was to some extent influenced by the overdosage theory.

Case I.—The patient was a somewhat delicate and prematurely-aged man suffering from cancer of the floor of mouth, for which a portion of the lower jaw was to be removed. The first stage of the operation

was drilling holes through the jaw as a preliminary to a subsequent wiring of the fragments. When I arrived in the theatre I found the house surgeon administering chloroform on a small Skinner's mask held over the nose only; the mouth was open, and the surgeon already commencing. I passed into an adjoining room to prepare myself to take over the case, a matter of two or three minutes only. During the whole of this time I could hear the patient phonating at intervals, obviously lightly under. On my return to the theatre, the mask had been exchanged for a Junker apparatus. The drilling had commenced, and, owing to the depression of the lower jaw caused thereby, respiration was considerably interfered with—in fact, the intake of chloroform was temporarily stopped. I noticed the man looked extremely ill. His corneal reflex was absent, but his pupils were normal. He was very pale, his brow moist and cold. He was slightly dusky, as one would naturally expect owing to the interference with his respiration. I pushed the jaw well forward, he took a few gasping inspirations, the pupil dilated, and all was over. All the usual remedies were tried, but proved quite ineffectual. From the time I took him over to the time he succumbed was less than a minute and a half, and during this time I made no attempt to give any anæsthetic. This case was quite obviously a death from cardiac syncope induced, probably, reflexly by surgical stimulus under light chloroform narcosis. The fact that there was some temporary respiratory obstruction did not, I think, have any influence except in so far as it limited the intake of chloroform. Contrast this appallingly sudden death with the next, in which the patient was inadvertently submitted to *overdosage* and yet recovered.

Case II.--In this case the induction was carried out by my usual method (see p. 66), C.E., followed by a little ethyl chloride, and was quite normal. My inhaler (see p. 17), charged from a bottle labelled "Ether," was then applied to continue the anæsthesia, between one and two ounces being put in. No valves were used at first, so that it was purely open. As soon as the patient was moved from the trolly to the operating table, the inspiratory valve was inserted so as to give the greatest concentration of vapour—"A" strength, as I call it. It was noted that the patient seemed deeply under, and yet the breathing was very shallow for ether (as she had had a little morphia previously, too much importance was not for the moment attached to this). On incision blood looked a little venous, but colour of face was fair. After a few *minutes* the valve was changed to "B" strength, making the vapour a little weaker. Breathing became shallower and face a little dusky; there was no pallor or apparent circulatory failure, corneal reflex absent, and pupil contracted. Thinking the patient was probably profoundly under the influence of morphia, I did not push the anæsthetic, giving some breaths of air, and later removed the inspiratory valve so that nothing should interfere with the intake of oxygen. The colour, however, got more and more dusky, and the respiration feebler and slower. The pulse was gradually getting weaker, and became impalpable at the temporal artery. With the removal of the valve, however, the odour of chloroform in the expired air soon became apparent. Examination of the stock-bottle labelled *ether* showed that someone had carelessly charged it with *chloroform!* I, of course, immediately removed my inhaler, and continued with ether by the open-drop method on a

Schimmelbusch mask. No further treatment was necessary, and the patient shortly recovered in spite of having been submitted for a quarter of an hour to enormously concentrated doses of chloroform vapour. But for one thing this would be a perfectly typical case of overdosage by chloroform. It was a little unfortunate, from this point of view, that the patient had had a preliminary dose of morphia and atropine, as this prevented the dilation of the pupil, which would, no doubt, have otherwise developed. The very gradual onset of the symptoms, commencing with respiratory depression and, only after a long interval, exhibiting those of circulatory failure, is in strong contrast with those present in the previous case.

Case III.—Reported by Dr. Alex. Wilson, of Manchester (*Lancet*, 1894, II., 1148),* is so typical of the fatalities under light chloroform anæsthesia that I reproduce it here: "The patient, a girl of fifteen years of age, was operated on for genu valgum by Macewen's method. Chloroform was given on lint; she took it well; the operation was performed, and the splint in process of being put on. At this stage, under the impression that all painful operative procedures were completed, the anæsthetic was discontinued. The patient was then breathing quietly; she had a good pulse and normal colour; the pupils were slightly contracted, and the corneal reflex was present—in fact, she was coming out of the anæsthetic, but was sufficiently insensible to bear ordinary manipulations, or even incisions, without feeling pain, and was as well as anyone could wish her to be. At this instant the surgeon suddenly forcibly flexed the left knee, which was stiff owing to osteotomy having been performed on

* Also quoted by Dr. Goodman Levy.

that side a few weeks previously. The adhesions gave way easily with a crunching sound, and the patient uttered a scarcely articulate cry, immediately became deadly pale, and began to breathe deeply. She passed at once into the following condition: The head was turned to one side, the face deadly pale, the eyes slightly open, the pupils widely dilated, and she was taking deep inspirations, the air passing freely into the chest; the muscles of the alæ nasi were also acting, and the pulse was imperceptible at the wrist. The symptoms conveyed the impression that she had fainted. To drop the head, elevate the limbs, and apply hot sponges, etc., was the work of a moment. She continued to make strong respiratory efforts, and air was freely entering the lungs, but there was still no sign of a radial pulse. It appeared at first that the patient would probably recover—it seemed impossible that she could die with such active respiration—but the breathing, without shading off in the least, suddenly ceased, and every effort to restore life failed."

Here, at any rate, is a fatality entirely uncomplicated by any respiratory obstruction or failure, and in which there can be no question of the sudden inhalation, during struggling, of an overwhelming dose. Many similar cases can be found in the literature of the subject—quite sufficient to discredit the theory that *sudden* deaths under chloroform are produced by overdosage.

So far as **deaths occurring during the induction** period are concerned, Embley some years ago undertook an investigation; an abstract of his researches was communicated by Professor Martin to the Society of Anæsthetists (*Transactions*, vol v., 1902). He arrived at the

conclusion that during induction chloroform irritated the vagus centre, causing inhibition of the heart and sudden death. Though his theory obtained a good deal of acceptance at the time, I confess that I never found it convincing, for many reasons which I need not enter into here. It did not explain why these dangers only occur under an imperfect anæsthesia—indeed, many of his experiments were conducted under high vapour concentrations—and then only in a very small number of cases in human beings.

Some years ago adrenalin was largely used in intranasal operations for the purpose of rendering the operation bloodless. When merely applied to the surface of the mucosa, no harm resulted; but when injected into it whilst the patient was under chloroform, in a certain number of cases most alarming symptoms of sudden circulatory failure arose. These symptoms were precisely those of sudden death under chloroform. As the number of cases in which they occurred only formed a very small proportion of the whole, it seems probable that they were the cases in which, owing to the needle penetrating a minute venule, some of the adrenalin entered directly into the circulation. I think all reported cases were stated to be under light chloroform anæsthesia. Investigating this matter, Goodman Levy proved that the injection of quite small doses of **adrenalin** into the circulation of cats under **light chloroform narcosis** was invariably followed by a train of circulatory symptoms, which may be briefly put in order as follows: a preliminary rise of blood-pressure, extra systoles, multiple tachycardia, ventricular fibrilla-

tion. Whether the cat went through the whole gamut and died depended, presumably, on the appropriate dosage of adrenalin and the appropriate degree of narcosis being combined. These results never followed when the cat was *deeply* under chloroform or under ether.

Here, then, to my mind, was an explanation of the cause of deaths under light chloroform anæsthesia, which has served me as a working theory ever since, and caused me to avoid or shorten this stage of narcosis as far as possible. The secretion of adrenalin is well known to be stimulated by emotional states, so there may well be a superabundance of it in the circulation of some patients undergoing the induction of anæsthesia. Later, also, Levy, in a contribution to *Heart* (vol. iv., No. 4, 1913), proved that stimulating the nerves controlling the secretion of the suprarenals produced the same train of symptoms under the same condition of narcosis, and that they could be brought about also by faradizing the central end of a cut sciatic nerve, suggesting that surgical trauma may also reflexly increase the flow of adrenalin. It is true that in some further experiments fibrillation was reflexly produced in cats under weak vapours whose adrenals had been excised some weeks previously. This suggests, of course, that some other direct reflex may be the cause—at any rate, in some cases. We all know, however, how quickly Nature compensates for the loss of many things, and it occurs to me that in the interval between the removal of the glands and the experiment some other endocrine gland may have taken on, if only partially, the functions of the suprarenals. The whole subject is one of intense

interest to the anæsthetist, and I strongly recommend a perusal of the paper, in which the author gives full references to his earlier work and that of others in the same field.

To sum up these somewhat discursive remarks on chloroform, I will put the conclusions in a nutshell :

Never give chloroform if you can possibly give ether.

Avoid inducing anæsthesia with chloroform where it has to be given later. Ether or, better still, ethyl chloride should be used for the purpose.

Under chloroform allow no operative procedures to take place unless the patient is in the third degree of narcosis.

Remember, your patient will be, on the whole, safer during an operation with a narcosis of a deep third degree than with one of the second degree.

ESSAY III

ALKALOIDS IN ANÆSTHESIA; THEIR USE AND ABUSE*

ALKALOIDS have now been used as a preliminary to the administration of anæsthetics for some years past. There is a general, almost unanimous, opinion amongst anæsthetists as to their value. Among surgeons, however, there is still some divergence of view. This is partly due, in my belief, to prejudice. A few unfortunate experiences early in their use led to bad impressions, and raised the cry of "scopolamine belly," "morphia rigidity," and so forth; the method is decried and abandoned. Again, those who have not studied the matter closely do not, perhaps, clearly appreciate the object of administration, the indications and contra-indications, and the limitations of the method.

The main object of giving preliminary narcotics is, in my view, the patient's safety and comfort. In some operations, as will appear, alkaloids are of assistance to the surgeon during his operative procedures, but in the large majority they do not affect them in the least; in some few operations there will be a distinct percentage

* Reprinted from the *Practitioner*, October, 1919, with slight verbal alterations.

of cases in which the surgeon must look for embarrassment. It is, therefore, for him to say, in this type of operation, whether they shall be employed or not. Generally speaking, it is in abdominal operations that this question arises. No anæsthetist can *guarantee* a perfectly quiet anæsthesia and flaccid abdomen with alkaloids and open ether; in the type of patient who has much rigidity, there is a distinct element of danger in changing, after morphia, to chloroform and pushing it to produce flaccidity. On several occasions when attempting this, I have seen the respiration dangerously depressed and the patient still rigid.

In giving narcotics, then, my object is to follow them with open ether. Many operations can be done under an extremely light narcosis, which otherwise might have called for closed ether or chloroform. The patient, therefore, is in a condition of absolute safety on the table, and, owing to the small amount of anæsthetic employed, free, as a rule, from the unpleasant after-vomiting, certainly free from the risks of acidosis and ether bronchitis. With regard to the latter, I believe that, even without alkaloids, the risks are grossly exaggerated, and that many cases are due, not to ether, but to other causes.

Other advantages are conferred: the patient is calm and placid, often even drowsy, and the operation has lost its terrors for him; his mucous membranes are dry, and the free secretion of mucus and saliva, commonly associated with the exhibition of ether, are absent. Again, if the operation is one usually followed by pain, such as the wrenchings common in orthopædic surgery,

there is less post-operative discomfort; surgical shock coming on during the operation is hardly ever seen. The amount of ether required is very much reduced; post-operative vomiting is generally absent. All these advantages are not always apparent, for there are certain individuals who react badly to morphia. In some, it causes excitement instead of drowsiness; in another few, it sets up vomiting, and may be followed by headache and constipation. If such idiosyncrasy is known beforehand, morphia should be avoided; otherwise, it is well to go on the principle of "the greatest good for the greatest number."

The **alkaloids I have used,** either alone or in various combinations, are morphia, scopolamine, hyoscine, atropine, and omnopon. Of these, scopolamine and lævo-rotatory hyoscine are chemically identical; whether there is any subtle difference in their physiological effects I have been unable to ascertain. In hospital work for a long period I used ampoulles of Riedel's scopomorphine, containing $\frac{1}{4}$ gr. morphia and $\frac{1}{100}$ gr. scopolamine in 1 c.c. Since the war, Messrs. Duncan and Flockhart have supplied a similar article. In private work, I have more commonly used morphia and atropine, partly because reliable samples of these drugs are always on hand, and partly because there is a slight prejudice against scopolamine still lurking in the minds of some surgeons and practitioners. Omnopon I have not used frequently. It is a mixture of all the alkaloids of opium and, theoretically, it has always appeared to me that some of them may be unnecessary, if not actually deleterious. In practice, however, I have invariably

found it satisfactory, and on some occasions patients, who have previously had other alkaloids before ether and suffered from vomiting, have reported this feature to have been less distressing after omnopon ; but the number of cases is not sufficient to found any judgment upon.

It would be well to consider the **effects** of the alkaloids individually, **before the anæsthetic,** during the induction, during the maintenance of anæsthesia, and in the recovery period.

Morphia is the principal factor in causing the drowsiness and placidity of the patient ; it frequently causes some giddiness, and has some influence in drying the mouth. Atropine has little or no narcotic effect ; on occasions it acts as an excitant ; it increases the rapidity of the heart's action, and in children a flushed face is generally remarked and the eyes are bright ; it has a powerful drying effect on the mucous membranes. Scopolamine has a distinctly narcotic effect, and a drying effect almost as decided as atropine ; for this reason, I seldom combine atropine with scopomorphine. Scopolamine does occasionally cause excitement in lusty young adults. Its effects develop more quickly than those of morphia, and are not so lasting.

On the induction, the effect of the narcotic elements is to render it more pleasant to the patient, to diminish the amount of excitement, and to prolong it somewhat owing to the diminished respiratory efforts under their influence.

During the anæsthesia, the effect of morphia on the respiratory centre must always be borne in mind. It is a

depressant, reducing the frequency and depth of respiration. Ether is a respiratory stimulant, and the result of the combination is to produce a good regular type of breathing, as a rule a little quicker and deeper than natural, but not the type associated with ether alone. Chloroform, except in the early stages, is a respiratory depressant, and so should never be deliberately preceded by morphia. If circumstances arise which render the administration of chloroform necessary subsequent to morphia, the greatest care should be observed, for the patient's breathing will become shallow and his colour dusky.

The kind of narcosis to be maintained after morphia demands a little consideration. I hold that it is not only quite unnecessary, but a mistake, to set out to produce the classical signs of the third degree of narcosis—surgical anæsthesia, as it is called. So long as the patient suffers no pain and the operator is not embarrassed by reflex movements, the requirements of both are satisfied. This state of narcosis can be attained with a brisk corneal reflex, the patient being in a condition of glorified "twilight sleep." Operations have indeed been performed under the influence of alkaloids alone. The results of such a method are a little too uncertain for ordinary work. Many years ago, in my practice, a patient was operated upon after $\frac{1}{25}$ gr. hyoscine without any further anæsthetic being administered. It sounds heroic dosage, but she had been a great sufferer, and when morphia, pushed to 1 gr. doses, ceased to relieve her, hyoscine was tried and the dose gradually increased. The effect was always to send her into a profound

sleep in a very few minutes. Being a diabetic, anæsthetics were considered unsafe, but the result of the hyoscine encouraged a surgeon to operate and relieve her of her trouble. I have wandered a little from the point, which was that the narcosis to be aimed at is something between drugged sleep and surgical anæsthesia.

The effects of alkaloids on the **pupil** are fairly constant, and need not embarrass the anæsthetist once he is familiar with them. Given hypodermically, atropine has little or no effect on adults. In quite young children, given in the full doses I generally use, it will sometimes cause dilatation, which is obvious previous to the administration of the anæsthetic, but passes off as the patient comes under the influence of ether or chloroform, and the pupil then follows the course usual in the different stages of these anæsthetics. Rarely have I seen a child with a large pupil before anæsthesia retain it throughout, so rarely that I am inclined to think that the patients probably had normally large pupils, and that the atropine had nothing to do with it. Morphia, whether accompanied by atropine or not, contracts the pupil. The degree of contraction is an index of the morphia effect on the patient, and, if it is pronounced, the patient will require very little anæsthetic; if it is not present, he will probably require a good amount. In old people, the contraction is sometimes very decided, the pupil being quite minute and not reacting to light. In such cases, I generally consider that the dose has perhaps been a little more than advisable for the individual, and should order a smaller one on another occasion. The contracted morphia pupil persists

throughout the anæsthesia, and does not follow the usual stages. A moderately contracted pupil, reacting sluggishly to light before the anæsthetic and not at all during its administration, is the best and most common in a combined morphia and ether anæsthesia.

The **reflexes** during these mixed narcoses are sometimes very brisk. The corneal reflex is especially so, and, in fact, I never aim at abolishing it. If it becomes necessary to push ether, it may disappear. Reflex movements of the limbs, slight phonation, and straining may be present with perfect unconsciousness, and as a rule are easily abolished by increasing the strength of the vapour inhaled. The effect of morphia is to diminish them, and it is only because the ether anæsthesia is light that they are present. The same applies to the cough reflex; morphia is an advantage to the surgeon in some operations on the upper air passages, but may be dangerous in others. The question is gone into later. After its administration, there is less likely to be that vexatious coughing and straining which so frequently occurs during the administration when the strength of the vapour is suddenly increased.

The effect of morphia on the **recovery stage** is to prolong it. The patient may, or may not, have a preliminary vomit on the completion of the operation and before returning to consciousness. In any case, he generally dozes comfortably for some hours after, which is much to his advantage, avoiding the pains and discomforts immediately following operation. Another vomit may occur when he wakes up, but quite frequently there is no further sickness at all. If the sleep is heavy,

there may be a tendency to falling back of the tongue, requiring a little attention to the position of the patient's head, and an occasional push forward of the jaw.

A preliminary injection of narcotics is specially **indicated in** many cases. In operations on the upper air passages, in which little bleeding is anticipated and a light narcosis is sufficient, it is useful in preventing coughing, straining, and swallowing movements; such are submucous resections and various endoscopic procedures. Owing to its power of diminishing secretions, atropine is advisable in all operations on those parts, as well as in all operations on children for which ether is to be given. In endotracheal, rectal, and intravenous ether administrations, in prolonged gas and oxygen cases, and endothecal analgesia, morphia, combined with scopolamine or atropine, is an almost essential preliminary. In operations likely to involve shock, it is invaluable, followed by ether, and the same may be said of bad septic cases.

The **contra-indications** must be considered from two points of view : the patient, and the nature of the operation. Atropine can be given with advantage practically to all patients of whatever age, unless it is ascertained that the individual is one of those rare cases which exhibit symptoms of poisoning under medical doses. In an experience extending over many years I have not so far met with trouble from this cause ; the utmost that I have witnessed has been a great deal of excitement not amounting to delirium, flushing of the face with tachycardia, and extreme dryness of the throat ; such cases have formed an insignificant fraction of

thousands of administrations. Morphia should not be given to the young, certainly not under the "teens." After that, in suitable doses, it may be given at any age, except in cases of Bright's disease, and in all cases in which the blood is insufficiently oxygenated, whether arising from heart or lung disease, from pressure on the diaphragm from below by fluid or tumours in the abdomen, or from large pleural effusions.

The **nature of the operation** does not affect the question of atropine. As regards morphia, there are two classes of operation in which the advisability of its administration is open to question—viz., laparotomies and certain operations on the nose and throat. Its administration previous to laparotomy has to some extent been dealt with. My own opinion is that, taking the average of a large series of cases, as good relaxation can be obtained with morphia and open ether as with chloroform. Nowadays most surgeons prefer this method, still there are others who prefer to operate under chloroform. Therefore, it is well before ordering morphia to ascertain the views of the surgeon, and if chloroform is demanded, morphia is contra-indicated.

The administration of morphia before operations on the nose and throat requires a good deal of consideration, and not only the operation itself, but the method of the individual surgeon is a factor in coming to a decision. The first point one has to consider is, what are the prospects of the pharynx becoming flooded with blood during the operation? If this is a possibility, then morphia had better be avoided owing to its inhibiting influence on the cough reflex. In coming to a decision,

much will depend on the methods of the surgeon—in some hands an operation is almost bloodless, in others very gory; on the position of the head during operation; on the duration of operation—if short, morphia is not barred, for the patient's head can quickly be put in such position that the blood gravitates away from the danger zone—and, if bleeding is likely to continue after the operation, on the character of the nursing supplied. Another point is the degree of quietude required by the surgeon. It is usual nowadays to enucleate tonsils under a very profound anæsthesia, the faucial reflex being abolished. Although morphia certainly tends to lessen reflex excitement, I doubt if any anæsthetist would guarantee in a lusty young adult to maintain the required degree of narcosis with morphia and open ether. Such cases, therefore, calling for other methods, are better without morphia (see p. 90).

The standard **dose** of morphia for an adult of ordinary physique is, in my practice, $\frac{1}{4}$ gr. Many anæsthetists give smaller doses, but with me "one-sixth grain is too much for chloroform and not enough for ether" is an aphorism. In big muscular individuals, especially of the alcoholic type, larger doses—$\frac{1}{3}$ gr. or $\frac{1}{2}$ gr.—may be given if either the anæsthetist himself or the patient's medical attendant, after careful examination, deems it advisable. On the other hand, in the old and the fragile or in puny adolescents a smaller dose is desirable—$\frac{1}{6}$ gr. or possibly even as little as $\frac{1}{8}$ gr. in some cases.

When prescribing scopolamine, I always order it in $\frac{1}{100}$ gr. doses. In the young and the aged I practically

never employ it, so the question of age does not arise.

Atropine also can be given in $\frac{1}{100}$ gr. doses at almost any age, certainly from two years upwards. There is a great tendency, when the anæsthetist has not the direction of these matters in his own hands, for too small doses to be given; especially is this so in the case of children. The practitioner or nurse, very naturally, follows the usual posological rules, and the result is that the little patient is apt under ether to be smothered with his own secretions. One has to remember the younger the child the more likely are the secretions to be excessive under the stimulus of ether, and the narrower the airway. Hence, respiratory obstruction may be embarrassing. When chloroform is the anæsthetic employed, the dosage of atropine is not of such great importance. For children under two years of age, I generally give $\frac{1}{200}$ gr. before ether and none before chloroform. One is sometimes asked: Cannot the dose be given equally well by the mouth, and the child spared the needle prick? My own experience is against oral administration. The results are not so good. If it is attempted, pretty well double the dose should be given, and that four hours before the operation.

The best **time** to administer alkaloids is one hour before that fixed for operation. Morphia, no doubt, produces its effects a little before this, and scopolamine acts even more rapidly. A prolonged experience in hospitals, where the exigencies of work prevent a very accurate time-table being kept, has convinced me that

the effect of alkaloids is at about its height between one and two hours after administration; thereafter it gradually declines, and is lost about two hours later on. On the other hand, alkaloids do not, as a rule, develop their action in less than half an hour. I have also observed another point bearing on this matter. Morphia depresses the respiratory centre, delaying somewhat the intake of ether; it also diminishes the laryngeal reflex, helping the intake by abolishing that closure of the glottis so apt to occur under the irritation of ether vapour. In my experience the first of these two effects is produced much more rapidly than the second. It follows that if the induction is commenced too soon after the administration of morphia we have one of its disadvantages without the compensatory gain. Attempts to hasten matters by increasing the vapour strength when the patient has only had his hypodermic half an hour previously generally set up laryngeal spasm, thereby further prolonging the induction. Hence, it follows that not only is one hour the ideal period, but, in the event of the operating list being slightly accelerated or retarded, this period gives the best chance of the patient arriving at the theatre in a suitable stage of preparation. In hospital work, occasionally, owing to the abandonment of one operation, the next is thrown on the anæsthetist's hands before the injection has had time to take effect. The result is that he is without its help at an early period and much anæsthetic is required, but later the effects develop and the vapour strength must be reduced.

ESSAY IV

THE HAVEN

ROUTINE methods have been decried, and it has been said with truth that the anæsthetist should be prepared to give any anæsthetic by any accepted method. Let this be admitted, there will, nevertheless, be a vast number of cases, forming the large majority in anæsthetic practice, for which one simple method is applicable. For many years past I have adopted the method I am now about to describe in, I am prepared to say, 90 per cent. of all operations exclusive of those on the upper air passages, and am convinced of its superiority in safety, ease of administration, range of usefulness, economy, and comfort to the patient.

The method consists of the administration of alkaloids followed by the C.E.—ethyl chloride—ether sequence, using my own ether inhaler. I have already gone pretty thoroughly into the question of **alkaloids** in a previous essay. I need, therefore, only repeat here that my preference is in favour of a full dose of scopomorphine in adults, or atropine in children, given one hour previous to the time fixed for operation.

In my *Guide to the Administration of Ethyl Chloride**

* H. K. Lewis and Co. Ltd., 1907.

I have described the method of inducing anæsthesia with ethyl chloride, so far as its use before chloroform and C.E. mixture is concerned, under the heading of the "C.E.—Ethyl Chloride—Chloroform Sequence." The account was written some years ago, and at a time when ether was given by the closed method in this country, so a similar sequence was not then used in the induction of ether anæsthesia. With the advent of open ether, however, I soon adopted the **C.E.—Ethyl Chloride—Ether** sequence, and found it led to a great saving of time in the induction of open ether anæsthesia, besides being much pleasanter to the patient. For a full description of the induction the reader is referred to this earlier work, to which I would only add that increased experience has abolished all fears I may have then entertained of recommending the use of the ethyl chloride induction to beginners. I regard it now as most safe, and the symptoms evoked during this induction are so definite and orderly that they are easily grasped by the tyro.

The whole art of the procedure is to get the patient under the ethyl chloride, and then to carry him from that to an ether anæsthesia without any return of struggling if possible, certainly without any return of consciousness. It is to insure that there is no gap between the fleeting anæsthesia of ethyl chloride and the permanent one of ether that I commence with a little C.E. mixture, thereby having already in the patient's circulation a little ether before he gets his main dose. I use C.E. mixture rather than pure ether in this, the first stage, partly from force of habit, and

also because it is pleasanter to the patient. The proportion of chloroform to ether in the mixture need not be a high one, a C_1E_3 mixture is as palatable as the C_2E_3 in general use, but as in any case the amount used is only small it is not a matter of much importance; there is no danger in it whatever. The quantity used varies with the age and physique of the patient from twenty minims in an infant to four drachms in a lusty young adult. The Skinner's or other similar mask having been adjusted and a small four-fold towel laid over the patient's chest and under his chin, the mixture is dropped or douched on to it as fast as may be, without exciting undue holding of breath or cough. This is the first stage. The drop-bottle is now immediately exchanged for the ethyl chloride phial, held in the right hand in such a manner that the index is visible; the left hand is inserted under the towel, bringing it up round the chin and partially over the mask. This saves the waste of droplets of ethyl chloride which splash off the mask during the spraying. The ethyl chloride is now sprayed on to the mask fairly rapidly, the dose given varying from 2 c.c. up to 7 c.c., again according to age and physique. The mask is now immediately covered completely by the towel, taking care that its edge fits closely to the chin and cheeks, and holding the gathered-up ends in the left hand at the frontal end. This manœuvre imposes considerable limitation on the passage inwards of air and outwards of ethyl chloride vapour, and no doubt a certain amount of re-breathing takes place. This constitutes the second stage of the induction, and ends in

the cessation of struggling and in the rapid, regular, and deep breathing indicative of anæsthesia. As soon as this is established, the patient's head is turned to one side, the mask and towel are removed, and my inhaler (see p. 17), previously charged with ether and without its inspiratory valve, is immediately applied. After a few breaths which allow of the expirations blowing away the ether vapour, which at first may be a little strong and irritating, the cap holding the inspiratory valve is inserted into the top of the chamber. The patient is, as a rule, now fit for operation. There is still some rigidity and possibly a tendency to reflex movements, but the surgical incision is of real benefit to the induction as it stimulates respiration, tending to flag a little as the effects of ethyl chloride pass off, and thereby hastens the intake of ether.

So far as the **signs accompanying** the first two stages of the **induction** are concerned, they are much the same as those described in the C.E.—ethyl chloride—chloroform sequence, such little differences as there are being due to the previous administration of alkaloids. In the **first stage,** for instance, struggling and emotional signs are generally absent. In the **second stage** also struggling is less marked, and in patients fully "doped" is absent entirely; many pass to unconsciousness without the slightest movement or sound, talking and shouting being very rare. With regard to other signs during this stage the stimulation of the **circulation** appears after the first breath of ethyl chloride, the ears becoming flushed and the colour returning to them immediately after pinching. There is less **respiratory** resentment to the

I.—Second Stage Commencing.

Face upturned. Mask partially covered by towel supported in position by left hand.

See p. 67.

II.—Second Stage Ending.

Note the thumb pressing forward the angle of the jaw. Face turned to right. Mask entirely covered by towel.

See p. 68.

concentrated vapours after morphia ; the patient frequently neither swallows nor holds his breath at all. At the same time morphia's depressing influence on the respiratory centre is evidenced by a diminution of the normal ethyl chloride effect on the breathing ; this is stimulated, but to a less degree. The first of these factors tends to shorten, the second to lengthen, this stage, and they generally neutralize one another in this respect. As soon as the breathing becomes regular and deep the **eye** should be examined, not removing the towel, but gathering it in tight at the fronto-nasal sulcus and pushing it over a little to the opposite side. Morphia produces two influences in this induction : one, a failure of the **pupil** to enlarge in this stage is only to be expected. If the pupil does enlarge it is an indication that probably the dose of morphia has been inadequate for the individual, and a hint to the anæsthetist that he must be prepared to follow on with full doses of ether, and possibly even resort, for a time, to a closed method. The other influence is rather curious ; the **corneal reflex,** usually lost during this stage, will now be found generally to persist. The eye, therefore, is not of much use as a guide, and the anæsthetist judges of the completion of the stage by the regular, deep, and sometimes stertorous, breathing, and by the passing off of any rigidity that may have appeared. **Rigidity** is particularly noticeable in the muscles of the neck and face in this stage. In my former monograph I drew attention to jaw spasm as a prominent symptom, and explained its value as a guide in following up with chloroform. When following up with ether there is no danger of

overdosage, so that jaw spasm is not of so much importance; also it is less marked after morphia, the effect of which, in full doses, is to diminish the force of struggling and rigidity generally in this stage. The patient's head is, however, not uncommonly raised from the pillow or, if not, the sterno-mastoids may be seen to stand out taut, and the neck is more or less fixed. When the second stage is completed this stiffness of the neck passes off. The face has to be turned to one side in order to continue with ether in my inhaler, and, as soon as this can be done without force, one knows that the patient is ready for the **third stage** of the sequence. In some very muscular individuals in whom the morphia effect is not pronounced, there may be, even after giving the second stage two minutes, considerable difficulty in turning the head. A little force should then be used, the head held over, and the mask exchanged for the inhaler, which should be firmly applied. In these cases, fortunately, respiration is generally very vigorous, the intake of ether is rapid, and the patient quickly passes under the influence of ether. Sometimes there is trouble from jaw spasm, and retraction of the tongue causing **respiratory obstruction,** generally in healthy, muscular males. Firm pressure with the thumb behind the angle of the jaw, extra force being used at the commencement of inspiration, will generally overcome this difficulty. If not, it means that the lower incisors are locked behind the upper, which prevent the jaw coming forward, and the wedge and gag may be required before tongue traction can be made. Such measures delay and spoil the beauty of the induction somewhat. Beginners

are therefore advised to use a prop before starting; with experience this can be dispensed with, except in the type prone to these manifestations, especially those with a full set of strong teeth. If the presence and position of a gap have been previously noted, it is only the work of a second to slip in a gag and open the jaw.

I have already fully described the **inhaler** I use for the administration of ether (p. 17). It would be as well to add a few explanations as to its inception and **method of use** before proceeding further. It was, I think, in 1907, at a meeting of the B.M.A. at Exeter, that my attention was first drawn to the value of open ether as an anæsthetic. Goodman Levy, who had recently returned from America, in a contribution to a discussion on spinal analgesia, was enthusiastic on the merits of the open drop method as practised in that country. I determined to give it a trial on the first opportunity. After a few months I realized its advantages, but found it wasteful and tedious, and devised my apparatus to overcome these disadvantages. Strictly speaking, my method is not an open one and it is certainly not a closed one, the ether being as a rule breathed through valves, and re-breathing not permitted. The constant dropping of ether is avoided, the inhaler being charged from time to time with substantial amounts of ether; when quite empty two ounces can be put in, about half an ounce of this immediately soaking into the lint, the remainder settling into the well and being gradually soaked up as evaporation goes on. Until the inspiratory valve is inserted the method is an entirely open one, and it is generally so used by

me in very young children on whose respiration breathing through valves throws a little additional strain. Beginners may well, first of all, use it in this way, employing the valve later as they become accustomed to it. By using the valve two advantages are obtained ; in the first place ether is not wasted, as it is not blown away during expiration ; this also makes a great difference to the comfort of everyone present at the operation. In the second place, a stronger vapour is available than by the open drop method, the reason being that during expiration the vapour is steadily accumulating in the chamber, and in addition, if this is held in the hand, a certain amount of chilling produced by evaporation is prevented by its warmth. In cold weather I not infrequently have napkins kept warm to hold it with, changing them as they become cool.

In using the apparatus there are three main **strengths available** ; intermediate ones will occur to everyone, but in practice I find these strengths the ones I commonly use, and denote them as A, B, and C. In A strength the lint reaches right down to the bottom of the well, lying in the pool of ether and presenting a large evaporating surface ; the cap with the valve *in situ* is fitted into the top of the chamber. In this position, at the commencement of expiration, a little air passes from the patient into the chamber to close the valve ; this tends to warm the interior, and at the same time sets up currents, both of which factors promote evaporation. Now, if we remove the cap from its position at the top of the chamber, and taking the valve out of it insert this into the side of the chamber leading into the face-piece,

these influences are dispensed with, as none of the expired air now goes into the chamber. The result is a slightly weaker vapour, which I call B strength, the lint in this being disposed of as before. To obtain C strength, which is very weak indeed, it merely remains to draw up the lint from the pool of ether into the upper part of the chamber. The liquid still clinging to it is soon evaporated, and thereafter the patient only breathes the vapour arising from the little pool in the well, instead of from a large evaporating surface of lint.

Now, supposing in a lusty subject there is a little difficulty at first in obtaining quietude, **A strength can be fortified** by taking a sponge, or, better still, a small strip of broad gauze, packing it loosely into the chamber and pouring more ether on to it. This increases the evaporating area through which the air is inspired. Frequent additions of small quantities of ether also increase the strength owing to fresh ether being warmer than that already chilled by evaporation, and to the splashing and commotion set up on pouring it in. Again, the upper part of the lint, which tends to become dry, can be moistened afresh at each addition, and the evaporating surface thereby increased. As, however, with A strength each addition means removal of the cap, with which is associated a certain amount of wastage and cooling of the contents of the chamber, frequent additions are not of much value in this strength. But suppose the patient to have been reduced to B strength and then to exhibit some reflex movements, the measures described may be used with ease, will strengthen the vapour considerably,

and may be tried before reverting to A strength. In the same way C strength, if apparently too weak, may be fortified by additions of small quantities of fresh ether, either directly into the pool, or more strongly by letting a few drops fall on the lint drawn up into the upper part of the chamber. One word of caution about the **additions of ether**: whether made frequently with a view to strengthening the vapour, or merely at intervals with the object of recharging, they are liable, in patients lightly under, to set up holding of the breath, straining, or cough, owing to the sudden increase in strength of vapour which they cause. The individual's liability to these symptoms is easily ascertained during the early pre-operative stage by a practical test. If he resents a sudden increase the greatest caution must be observed later when recharging, small quantities being added at frequent intervals, the patient being watched for any sign of resentment.

During the third stage of induction it sometimes, but very rarely, becomes obvious that at any rate without prolonged delay a satisfactory anæsthesia is not going to be obtained by this method. One must then have recourse to a **closed method,** and this is quite simply produced with the latest model of my apparatus which has the expiratory valve fitted with an obturator that can be opened and closed at will. To convert to a closed method, then, it is only necessary to remove the inspiratory valve altogether, close the expiratory valve, slip the clip fixing the lint a little further down the body of the chamber, and draw the mouth of a wide-mouthed rubber bag over the top. The patient then breathes

ILLUSTRATING THE AUTHOR'S ETHER APPARATUS

III.—In Use at B Strength.

The inspiratory valve is now within the facepiece. The jaw is lightly held forward by the ring finger; the facepiece held by thumb and forefinger; the middle finger rests on the facial artery.

See pp. 72-3.

IV.—In Use as a Closed Inhaler.

See p. 74.

backward and forward into the bag through the chamber. The principle is the same as the Ormsby inhaler, but recharging is not required so frequently.

We will now consider the **features of the third stage** of induction as manifested in the ordinary adult and the variations that arise in certain types. Immediately the second stage is terminated the towel and mask are replaced by the charged inhaler. This, like all the manœuvres of the induction, should be carried out promptly and with no delay, at the same time with no display of vulgar haste. After a breath or two it is noted whether the patient resents the ether; as a rule he does not, and the valve can be inserted to give strength A. If he does, this may be delayed a little, the apparatus slightly withdrawn from the face during inspiration and approached to it during expiration, until he becomes accustomed to it, when he can be allowed to breathe through the valves. As a rule he soon settles down, and the breathing becomes regular and slightly snoring; so much depends on the morphia effect; where this is pronounced respiration is generally very quiet indeed. Occasionally, owing to **tongue retraction,** there is much stertor, and this must be dealt with as described above. Cases are not infrequent which necessitate pressing forward the jaw during the whole time. The amount of resistance offered to this manœuvre is to some extent an index to the depth of the narcosis. A jaw which has offered considerable resistance in the early stages later becomes more yielding, eventually giving way to the slightest pressure in a satisfactory narcosis. The rigidity which is a feature of the second

stage sometimes persists for a time; usually, however, with the commencement of the operation, and the stimulation of respiration caused thereby, the patient comes a little more deeply under ether, and it passes off. The patient in this early stage is liable to **reflex movements,** and perhaps some phonation or laryngeal spasm, as a result of surgical stimulation.

Surgeons who are habituated to the method know these symptoms will soon pass off, and are not disconcerted. After all, what you lose on the roundabouts you make up on the swings. It is unreasonable to expect, after the rapid induction, a complete tranquillity to ensue at once. Nevertheless, so smooth is the induction that, in the majority of cases, such tranquillity does obtain. In a small minority only do these reflex symptoms occur. To say the patient feels because he makes a movement suggestive of resentment is a "terminological inexactitude," and displays a forgetfulness of one's early physiological studies which is lamentable; he feels as much as the pithed frog does when it responds to stimulation. The more the patient is stimulated the sooner will the reflex pass off, partly from wearing itself out, but also from the increased intake of vapour due to the respiratory response also evoked. Under a light ether narcosis there are none of the dangers associated with light chloroform narcosis, where it would be highly unwise to continue to operate in the presence of these reflex movements. Should they or rigidity, however, continue, and prove embarrassing, the anæsthetist must change to closed ether for a time, as described above.

During the third stage, if **the eye** is examined, the conjunctiva will generally be found injected; if this is not the case, the patient is either suffering from anæmia or some degree of shock, and will probably not stand a prolonged or severe operation at all well; a saline infusion is indicated. The corneal reflex is generally pretty brisk, though it may be sluggish, and in a few cases is absent. The eyeball may present some movements; if these are irregular, a very light degree of narcosis is indicated, slow rhythmic movements imply a deeper narcosis, and a fixed eyeball accompanies the fullest degree of anæsthesia obtained by these means. The pupil is generally pretty small, depending on the degree of morphia influence. Even in children who have only had atropine, and have, perhaps, come to the operating-table with dilated pupils, this contraction almost invariably appears; I have certainly never seen the dilated pupil of atropine continue after the child has come thoroughly under the anæsthetic. If morphia effect is pronounced or the patient well under ether, the pupil is generally also fixed; a ready reaction to light means, as a rule, light narcosis.

The above description, I think, adequately covers all points connected with the induction of anæsthesia. The operation being in progress, it merely remains to **keep the patient in a suitable condition** for its performance. It seems somewhat of a paradox, but is nevertheless true, that in giving chloroform, the dangerous drug, it is wiser to give freely as much as the patient will stand, whereas in giving ether, the safe one, the anæsthetist should aim at giving as little as possible The reasons

are that light ether anæsthesia has no dangers; that the less the tissues are soaked in it the less damage it will do them, and the more comfortable will be the recovery; that by giving little there is less risk of over-stimulating the patient during the operation, and thereby rendering him liable to reactionary collapse on its withdrawal.

At the commencement of the third stage, A strength usually suffices; as shown above, it may have to be fortified or changed to the closed method in rare cases. With children, one may commence the third stage with B strength. Whatever **strength of vapour** is used in starting, as soon as the patient is settled down—that is to say, submitting to the operative procedures without any resentment (rigidity, phonation, movements), and breathing regularly and a little deeply—an attempt should be made to reduce the strength to the next in order. Many cases can be got down to C strength in a short time. A very usual sequence of events in adults is, I find, to give A strength for a quarter of an hour, then reduce to B for about the same period, and thereafter continue with C. The anæsthetist must be guided by the signs; if these indicate the approach of too light anæsthesia he must maintain the same strength, not attempting reductions, or, if they have already been attempted, must revert to the next higher strength or fortify with frequent little additions, as explained above. In using this method the anæsthetist has *no worries* on the score of overdosage, sudden collapse, shock, and so forth. He is free to concentrate his attention on one problem only, the avoidance of too light an anæs-

thesia. By keeping on with a full strength, even this need not worry him, but for reasons given above this would not be good practice, and is inartistic. A few simple **signs** serve to indicate **that anæsthesia is on the light side** and must at least be kept at its present level, or, if they are persistent, deepened a little. The **respiration** requires to be carefully watched; this entails no trouble, as the regular "click-clack" of the expiratory valve is always audible if things are well. An increase in the rate and depth of respiration indicates that the patient is getting either deeper or lighter. If full doses of ether have been and are being given and the morphia effect is only slight, no very special surgical stimulus being in action, he is probably getting deeper; it is a sign of a pure ether narcosis as opposed to the mixed alkaloid and ether effect usually produced. On the other hand, if the onset of deeper breathing is coincident with surgical stimulation in a patient who is inhaling a weak vapour, and has exhibited the usual signs produced by morphia, it means that the anæsthesia is on the light side, allowing of the ready production of this respiratory reflex. The condition tends to cure itself owing to the increased intake of vapour. Alterations in the rhythm of breathing are most important; an occasional pause followed by a long sighing inspiration is a sure indication of light anæsthesia. Holding of breath, swallowing, and slightly phonated expiration are of course well known symptoms of the same thing, but are seldom seen in this method unless the first two are evoked by a sudden increase in strength of vapour. Should such signs, or **laryngeal spasm**, or **cough** come

on as the result of additions of ether, light anæsthesia is indicated. The presence of these respiratory symptoms alone does not call for an increase in strength, but they are a hint to the anæsthetist to keep steadily on, see that no reduction takes place, and watch for further signs of light anæsthesia, such as slight **movements**, **rigidity**, clenching of the jaw, and increased resistance to attempts to push it forward at the angle. Much information, too, can be gathered from examination of the **eye**. The corneal reflex should not be tested, as it is unnecessary. I have conducted some of the best and most tranquil narcoses with a brisk corneal reflex throughout. Movements of the eyeball, as explained before, help one. The pupil may be minutely contracted and fixed; if so, this is a sign that the morphia effect is pronounced, and that anæsthesia will be good with very little ether. Usually it is moderately contracted and fixed; this indicates a good mixed narcosis. Should such a pupil become a little larger and responsive to light it indicates, taken in conjunction with other signs, that anæsthesia is becoming light. A pupil that has never been notably contracted and becomes larger, with deeper respirations, under full doses of ether, means that morphia effect is slight and narcosis approaches the purely ether type. I have not been able to satisfy myself in the really mixed narcosis that the pupil ever dilates in response to surgical stimulus.

With these hints as a guide and a little practice the student should soon be able to conduct quite satisfactory anæsthesias by this method, with nothing but the happiest results for the patient, no anxieties for himself, and only

on rare occasions some temporary and trifling embarrassment for the surgeon. Much of his success will depend, not only on his watchfulness, but on the **proper working of the apparatus.** Air, like other things, follows the paths of least resistance, therefore it is important to see that all parts of the apparatus fit together with air-tight junctions, and that the valves work well and truly. The mica valve requires occasionally to be taken out and washed in alcohol, as, after weeks of use, it tends to get a little sticky, and may get hung up in the position of expiration. The rubber valve also wants renewing occasionally : if not quite stout enough it tends to droop, or sometimes it will stick to the valve case. Care should be taken that it does not come in contact with liquid ether as this immediately causes it to curl up. All these matters being in good order, it is still essential to **apply the apparatus accurately** to the face ; if there are any chinks air will pass in and out through them rather than through the valves. Undue pressure is unnecessary, and is apt to cause little ischæmic patches or extravasations. In patients with thin faces and prominent cheek-bones the pneumatic pad may be required. In a less degree of the same condition, not absolutely calling for its use, a fair amount of pressure falls on the malar bones, and a little occasional shifting of the face-piece to one side or the other will prevent any marking or subsequent discomfort to the patient. Keep the patient's eyelids closed, otherwise the upper part of the sides of the face-piece may rest on the eyeballs, and may cause congestion of conjunctiva. In applying the face-piece, first let the upper end rest in

the fronto-nasal sulcus; in the ordinary adult the lower end should then be opposite the lower part of the face, about half-way between the free edge of the lip and the point of the chin. It should not be pressed back on the jaw, but the jaw should be pushed forward to meet it. This is the usual position for the face-piece in adults. In children the lower end will generally rest on the chin, or if very small the chin will go inside it. Accuracy of fit in very small children is not of much importance as, in dealing with them, valves are as well dispensed with. In adults with larger faces the lower end may rest actually on the lower incisors, the lower lip being drawn over it to make the fit airtight. In still larger types of face, and in cases where it is necessary to keep the tongue held forward, the lower edge would rest on the dorsum of that unruly member, which is pulled forward by a towel clip held between the fingers of the hand grasping the chamber. If this position is prolonged considerable pressure falls on the sides of the upper lip, the mucous surface of which may be injured by the upper canine tooth of one or the other side. Bearing this in mind the lip, which is very mobile, should be moved a little occasionally, so that pressure is not always on the same spot.

Some further **small points** may be mentioned here at the risk of repetition. When arranging the lint lining, see that the junction of the edges is opposite the passage into the face-piece, so that there is here a little opening in the lint for the patient to breathe through. Don't put in more than an ounce of ether when first charging the inhaler; the bulk of this is quickly absorbed by the

lint, and no pool is left to slop over into the face-piece in case of a sudden unguarded movement of the patient's head in the third stage of induction. Remember that the apparatus requires recharging; an occasional sniff at the expiratory valve during an expiration will determine the presence or absence of ether in the chamber when A strength is in progress; in B and C the pool can be seen. Recharge cautiously to avoid choking, especially when the patient is very lightly under. With C strength the surface of the pool should be kept quite at or near the level of the orifice into the face-piece. This can be done, if desired, by rotating the chamber on the face-piece from the vertical in the direction of the horizontal plane—a procedure which saves recharging in cases where it may appear undesirable. Of course, in this strength the lower the level of the pool the weaker the vapour.

All these details seem very small and paltry, but it is the little things that count, and experience in teaching the use of the apparatus has shown me that it is through the neglect of them that disappointment arises.

The **amount of ether used** varies considerably with the amount of attention bestowed on the above points. All conditions being good it is quite usual in prolonged cases to maintain anæsthesia with an hourly consumption of four ounces of ether. With A strength two ounces evaporate in about twenty minutes, more or less, according to the temperature and the rate and depth of respiration. The same amount would last half an hour with B strength, and nearly an hour with C. These figures are, of course, only rough averages,

and subject to variations in different types, but are on the whole a very fair estimate. As one generally commences with a high strength, a series of short operations would naturally show a higher average consumption of ether per hour or half hour than a series of long ones. In the early part of 1910, when first using my inhaler, I took precise notes of these details in 100 consecutive cases, the result being that the average consumption of ether for the whole of them worked out at a little over six ounces per hour. Of these 100 cases only 17 lasted for an hour and upwards, and the average consumption per hour for these 17 taken separately was a little over five ounces. At that period I had not yet started using the preliminary alkaloidal injections, so these statistics derived no benefit from them, and merely serve to show the economy effected by the use of my apparatus alone. The further reduction in ether consumption which I now obtain is dependent on the combination of these narcotics with the anæsthetic.

The question sometimes arises whether **chloroform** can, or should, be given in addition to ether **in this apparatus.** It certainly can, and in all three strengths. Before giving alkaloids, I not infrequently met with cases which presented some resistance to a simple ether anæsthesia without re-breathing ; they were a little difficult to keep sufficiently deeply under or sufficiently relaxed for the operation in progress. I never hesitated to add a little chloroform from time to time, and this generally secured the desired result. In view of the more recent discovery of the dangers lurking in light chloroform anæsthesia, it is a question whether this is quite sound

practice, and whether it would not be better to discard ether altogether and go for a deep chloroform narcosis. But where a preliminary injection of alkaloids has been given I deprecate the use of chloroform altogether for reasons stated in a previous article (pp. 54, 57), and, in addition, in the cases in which I have felt compelled to try it, in the hopes of overcoming obstinate rigidity, I have met with little satisfaction. There are some types in whom no method, let it be pushed to the margin of safety, appears to produce complete flaccidity of the abdominal muscles. It has occasionally fallen to my lot to give a second anæsthetic to an individual of this type, and I have nearly always found that I got no better results on the second occasion with a straight chloroform anæsthesia than on the first with the routine method above described. If, however, in spite of the obvious objections it should be decided to add a little chloroform to the ether, the additions should not simply be poured in haphazard ; if this is done the chloroform will sink down into the well, mixing with the pool of ether there ; the latter being more volatile will evaporate first, leaving a mixture which becomes more and more charged with chloroform, until at last, when all the ether is evaporated, the patient will be inhaling a pure chloroform vapour, and one which at strength A or B will be highly concentrated. The way to add the chloroform is to plug very lightly the upper end of the chamber with a little gauze, and from time to time douche a little chloroform on this, not sufficient to saturate it. The air is then breathed through this, and the chloroform evaporates independently of the ether. When it is desired to cease

the chloroform, this can be done at once by removing the gauze, and the anæsthetist can continue with the same inhaler, knowing that there is no chloroform left in it.

The following **notes** may be of some interest:

I. Middle-aged male. Ruddy, medium build; chest wall rather rigid, has some cough as result of a recent cold, no rhonchi; heart sounds good; slight arterio-sclerosis. Operation: Transplantation of ureter for malignant disease.

At 8.50 a hypodermic of scopolamine hydrobromide gr. $\frac{1}{100}$ and morphia gr. $\frac{1}{4}$ was prepared, and the bulk of this, but not quite the whole, was injected.

9.10.—C_2E_3 given slowly on mask; after two or three minutes struggling commenced, not severe, and unattended by shouting. As it was inclined to be prolonged, however, I added ethyl chloride, which I had not intended to use in this induction. Struggling ceased at once, and he went under directly.

9.15.—Ether was commenced, A strength. Breathing very quiet, no stertor or mucus. Pupils moderately contracted. Lavage of bladder and other preliminaries now begun.

9.30.—Operation commenced; a little wrinkling of brow on incision. B strength now tried on two occasions, but had to revert to A, anæsthesia tending to become too light. He coughed once, and complaint was made of rigidity; a few drops of chloroform quickly corrected both. Breathing became more exaggerated, and some stertor was produced by dragging on the bladder. B strength again.

9.50.—He seems now thoroughly settled down. C strength.

11.15.—Have had no trouble with him whatever during the past hour and a half. He is snoring peacefully, and requiring hardly any anæsthetic. Pulse good, 64 to 68; face ruddy; no sweating and no shock. Trendelenberg position after opening bladder. Corneal reflex sluggish or occasionally absent.

11.30.—Operation finished; still snoring, though no anæsthetic for last quarter of an hour. Reflexes now brisk. Six ounces ether only used. He did not recover consciousness till 2 p.m. There was no vomiting, and at 8 p.m. he reported himself quite fit. Later on he had a little bronchial trouble, which was no doubt impending at the time of operation, and was probably contributed to by the prolonged exposure.

Comments.—These notes were taken nine years ago, and the case was one of the first in which I used the preliminary injection. It was given only twenty minutes before the induction, and had little influence during the first half-hour or more. At 9.50, just an hour after its administration, the effects reached their height and continued thereafter till the end of the operation, and for some time even after that. I had not intended inducing with ethyl chloride on account of his cough and arterio-sclerosis, as in those days I had not the unbounded confidence in this induction that has come with increased experience. The small amount of ether, six ounces in two and a quarter hours, is noteworthy, as is also the absence of shock and post-operative collapse and vomiting.

II. A little rosy-cheeked country girl aged seven and a half years. Operation: Osteotomy of femur and

wiring; duration one hour. Atropine, only, previous to operation. Induction C_2E_3, ʒi, ethyl chloride, 4 c.c.; screaming and struggling over in one minute; continued with ether, A strength for five minutes, then B strength for ten minutes; thereafter C strength, occasionally fortified by moistening the rolled up lint at top of chamber. Only three ounces of ether used altogether.

Pulse was good throughout, rather quick, 120; colour slightly heightened; some perspiration; no shock. Corneal reflex was absent during the first half-hour, then sluggish; pupil contracted throughout; no movements.

I have had one death in over 3,000 cases in which this particular method has been followed in every detail. I append these notes and think it should be obvious that the death was in no way connected with the anæsthetic.

III. The patient was a stout man between fifty and sixty, suffering from acute intestinal obstruction of some duration. His condition was somewhat desperate; the pulse was rapid and weak; undoubtedly he had auto-intoxication. The only chance of saving his life lay in immediate operation. The abdomen was opened, and several inches of gangrenous bowel resected, the procedure lasting one hour. The preliminary alkaloidal injection was morphia $\frac{1}{4}$ gr. and atropine $\frac{1}{100}$ gr. The induction was marked by a little fœcal vomiting in the second stage; some of this vomit was inhaled, as thereafter a moist tracheal râle was heard throughout the operation, and dyspnœa with duskiness supervened. This dyspnœa and duskiness were not abolished by oxygen, which was administered freely as soon as possible and continued throughout the operation, which

tends to show that circulatory failure was a more potent factor than the respiratory obstruction, which, after all, was only slight. Ether was given at A strength for the first quarter of an hour, then at B strength for another quarter of an hour, thereafter at C strength. He gradually got worse, the pulse becoming feebler and feebler, the respiration more distressed, and the colour bluer. Saline injection and strychnine were given. Being over fifty pituitrin was not considered advisable. He died exactly one hour from the commencement of the operation, which in view of his condition was only roughly finished. In my view, the cause of death was failure of the circulation due to auto-intoxication, and no doubt to some extent contributed to by the respiratory embarrassment.

This method, alkaloids, ethyl chloride induction, and ether through valves, is so simple, so satisfactory, so inexpensive, both as regards apparatus and anæsthetic, so safe, so free from after-effects, and of such general utility, that one wonders why chloroform, mixtures, and the old gas-ether sequence still retain so many adherents. To venture on prophecy is risky, but I foresee the time when an intelligent coroner's jury, inquiring into a fatality under chloroform, will have some very pertinent questions to ask the anæsthetist as to his reasons for preferring this drug to ether in this individual case, and a failure to produce entirely satisfactory reasons will be followed by censure. Further, I maintain that in all cases in which chloroform is deemed essential the services of an expert should be secured. The training in anæsthetics of the average medical man, with its

minimum of twenty administrations (a few, or possibly none, of which will be chloroform), is utterly inadequate for the production of a safe chloroformist, even when supplemented by the occasional experiences gained in general practice.

Since writing the above, another nail has been hammered into the coffin of chloroform. Surgeons who practise **the removal of tonsils by dissection or enucleation** demand a very profound narcosis involving the entire abolition of the faucial reflex. For long this has only been considered attainable by chloroform ; the average anæsthetist would have thought it "as much as his place was worth" to experiment with ether under the circumstances. Courage, however, came with Rood, and confidence with Tilley and Waugh, and under their auspices a properly conducted ether anæsthesia has been established as the "better 'ole" in these cases.

When I first heard of it I must confess I was a little sceptical, but experience soon showed that the method was entirely satisfactory and most valuable. As generally practised, it consists of the induction of a profound ether anæsthesia, using for the purpose a gauze mask and plenty of towelling, thereby restricting the entry of air and the escape of ether vapour, and continuing thereafter with ether in a Shipway or Junker apparatus. Ether has to be given very freely, a considerable quantity being used: in Rood's practice it is pushed till breathing becomes shallow and pupil widely dilated. The method can hardly be called open, nor is it an entirely closed one. It might well be called Rood's method, as in its application to this operation it certainly

is, but others would claim priority, and the claims go back until the shade of the original administrator of ether arose from the grave and asserted his title. (See Trans. R.S.M., Anæsthetic Section, February 6, 1920.)

There being a deficiency in the air supply, why should it not be called the "aeropenic" method?

For myself, I practise it in the following way, which I think shortens, and adds a little to the comfort of, the induction, and saves some ether. On the chest I have two fourfold towels instead of one. I thoroughly moisten the mask with ether, spray on a little ethyl chloride—only half the amount I ordinarily use for induction—cover in with the first towel and, as soon as the first signs of unconsciousness appear, distribute rapidly over its surface the amount of ether I propose to use: for children between four and eight, 1 oz., between eight and twelve, 1½ oz., and over twelve, 2 oz. I then immediately cover all in with the second towel. The reasons for employing smaller doses of ethyl chloride are that the patient breathes through much thicker coverings, and they are not removed at the end of a second stage. It just serves to abolish consciousness quickly and stimulate the breathing. This early stimulation must not deceive the administrator; he must carry on for some minutes until the type of breathing is absolutely settled, regular, and deep, the pupil enlarged and fixed, and the corneal reflex abolished for some time. He then inserts a Probyn-Williams gag and continues with Shipway, having the ether standing in a hot water-jacket. If the anæsthesia is very profound and the operator rapid, this latter procedure is unneces-

sary, but preparation for it should always be made. Atropine, of course, is always given beforehand, and in adults I think morphia is a useful addition, provided the conditions as to hæmorrhage are likely to be favourable (see p. 61).

ESSAY V

GAS

The administration of gas is an art. The guiding principles may be acquired from textbooks, but facility can only come by practice. In this article, therefore, I shall confine myself only to a few practical points, little details too small to receive prominence or even place in textbooks. But in anæsthetics it is often the little things that tell.

In the first place, let the beginner use the simplest **apparatus** available. The various cumbersome, costly, and intricate apparatus recently devised are not to be recommended. The anæsthesia produced by gas, if given continuously, is very fluctuating, and apt very easily to be marred by deficiency or excess of oxygen; again, if only an ordinary "fill-up" of gas is being given the anæsthesia ensuing is very evanescent, and the moment has to be looked for at which the longest available anæsthesia may be anticipated. Hence it follows that the beginner's attention must be concentrated on the patient; he has none to spare for apparatus the working of which is somewhat of a mystery. Later, when he has mastered the secret of the production and maintenance of a smooth anæsthesia, he may find some

advantage in a more elaborate apparatus; on the other hand, it is more than likely he will find the simpler varieties answer all purposes, are less likely to get out of order, and are easily repaired on the spot. I have already described elsewhere all that is essential in the way of apparatus (p. 9 *et seq*).

Gas is given with various **objects,** which require slightly different **methods.** Briefly, they may be summed up as follows :—

1. The simple "fill-up" for dental work and so forth.
2. The continuous administration through the nose for prolonged dental operations.
3. The continuous administration through the ordinary face-piece for surgical operations.
4. The induction of anæsthesia in the gas-ether sequence.

These methods are all fully described in the text-books, and need not detain us here. The first was the original practice, and is still that most commonly used. In the old days oxygen was not used, and, although it became customary to allow a breath or perhaps two of air at intervals during the induction, **asphyxial symptoms** generally developed to a certain degree, and the anæsthesia was in part due to them. Indeed, the very signs of anæsthesia were generally given as stertor, cyanosis, and jactitation. The first was aimed at, the second was generally present, and the third to be avoided if possible. I remember being rather disturbed in early days by the frequency and suddenness with which **jactitation** and opisthotonos developed in children, to the embarrassment of the operator. An "old

hand " from whom I inquired the cause of this shelved the question, whether from ignorance or a more subtle motive I cannot say. However, experience soon showed me that these were purely asphyxial symptoms, and that children are less tolerant than adults of oxygen deprivation ; the remedy was to allow them more air. Partly on this account and partly because they are generally nervous or frightened I early adopted the practice of giving gas by the nasal route to **children.** It is so simple—whilst the child's attention is occupied with the insertion of the prop by the dentist—to lightly adjust the nose-piece and quietly without undue pressure turn on the gas. The child is generally under before he realizes that the administration is begun and as he gets a certain amount of air by the mouth no asphyxial symptoms arise. If he is getting too much air it is simple to raise the pressure in the gas bag and firmly adjust the nose-piece ; very seldom is it necessary to use the oral expiratory valve.

In these days it is customary to give **oxygen with gas;** the advantage is that a longer period of available anæsthesia can be obtained, and that owing to the non-development of asphyxial symptoms it is quieter and safer, especially for people with cardiac impairment. If Weiss's oxygen attachment is used and the gallon bag filled to start with, this is generally sufficient for the single administration. Pressure can be kept up as desired by arranging that the bag lies between the anæsthetist's body and the dental chair. With children and the weakly a little oxygen can be given from the start, but in the robust adolescent or adult care is

necessary; oxygen given too freely is apt to be an excitant, and it is wise not to turn it on till the patient is just becoming slightly dusky. The induction by this method is slower, and the indications of its completion less defined than with gas alone. It is always wise for the beginner to err on the side of a prolonged induction, as the patient is not asphyxiated and no possible harm can be done; in adults, especially, only give enough oxygen just to prevent blueness. A little rebreathing may be allowed towards the end. Now, what are the **signs** that **anæsthesia** is complete? A slight degree of stertor may be present, the amount depending on the patient's colour; the less oxygen given the more pronounced the stertor. The eye should be examined; if the lids resist the attempt to open them, the patient is not under. If on opening the lids the eye looks around, again he is not under; but if the eyeball is fixed or merely shows purposeless oscillations or nystagmus, you may know he is anæsthetic. Cut off the oxygen, if he is pink, and let him rebreathe into the gas-bag until he just gets dusky, and you will have the maximum available anæsthesia under this method. The pupils are not of much assistance; it is nice to have a moderately contracted fixed pupil, but frequently they may be a little enlarged or respond readily to light. The corneal reflex is also variable and not to be depended on as a guide, unless, of course, it is absent.

In giving **gas and oxygen continuously** for a surgical operation (No. 3.) the patient requires keeping at the level indicated above. A preliminary injection of morphia is always advisable in adults. It steadies the

patient and renders him less liable to reflex movements, tremors, and rigidity. It must be remembered, of course, that morphia depresses the respiratory centre. Rebreathing, therefore, is valuable, not only in economising gas, but also in stimulating this centre through locking up the CO_2 in the system. In addition the expired air going into the bag warms its contents, and the slower flow of gas from the cylinders renders their valves less likely to freeze. When the patient is well under and the operation in progress, the following sequence of events can generally be repeated till it is concluded. Assume the patient is breathing through valves from a full bag and getting in addition sufficient oxygen to keep him the right colour ; now turn back the gas till it just trickles slowly into the bag, and let the patient nearly exhaust the reserve therein. When this stage is reached, give him one inspiration of air, and let him expire it into the bag by turning the stopcock to "no valves," and thereafter continue rebreathing until the bag has again gradually refilled from the slowly trickling cylinder. This will be from half a dozen to a dozen breaths, according to the rate of flow from the cylinder. During this period, if the patient starts with a good colour, the oxygen can be turned off, and the bag containing it also slowly refilled. At its termination the valves are once again brought into play, the oxygen turned on, and the process repeated again and again. The patient's eye and his colour must be watched throughout. The oxygen bag should always be kept under a little pressure, as if it becomes deflated, and at the same time pressure rises in the gas-bag, the tendency will

be for gas to find its way through the mixing chamber into it.

In the Weiss's oxygen attachment there is a tap regulating the size of the orifice through which the oxygen is delivered, but it must always be remembered that the flow depends not only on this but on the pressure in the bag, and it should therefore be kept just a little distended. **Movements** should not take place, but unfortunately they will occur sometimes, and may indeed prove embarrassing. They are of two kinds—reflex from surgical stimuli in a too light anæsthesia, or clonic movements with or without rigidity, due to insufficient oxygenation. For the former give more gas and less oxygen, and for the latter less gas and more oxygen. The difference in the character of the movements is generally obvious; if there is any doubt the colour and the eye will guide one. Should they persist and be troublesome ether will have to be substituted, and it is in such cases that the more elaborate apparatus allowing of the occasional administration of ether with gas has its value. In using such apparatus, however, it is quite easy to let the administration develop into an ether anæsthesia, and so to lose the advantages of pure gas and oxygen—viz., rapid recovery and absence of post-anæsthetic vomit, etc.

In America it is customary to introduce a **warming** chamber into the apparatus, thereby supplying the patient with a warm vapour. The practice has also been advocated by some in this country. To my mind it is quite unnecessary. The specific heat of gases and vapours is extraordinarily low, and if the administration is conducted as described above the gas will pick up all

the necessary heat, partly from the air surrounding the bag, but more largely from the patient's expirations into the face-piece or bag, as the case may be.

As regards No. 2—the continuous administration of **gas through the nose**—there are just one or two points to which I would call attention. The object is to prolong the anæsthesia during the operation while allowing the dentist free access to the mouth. It is practically necessary where more than three teeth are to be extracted at a sitting. It is an essential **condition for success** that the patient should inspire through the nose throughout. Hence it must be ascertained before starting that the nasal airway is free, and during induction the habit of **nasal inspiration** must be established. Apparatus has been devised which permits during induction of the patient breathing either by the nose or mouth. Now this is, I think, a mistake ; the original Coleman apparatus, which I recommend, allows of expiration only through the mouth, and by its use the habit of nasal inspiration is established during induction. This is important, as with the mouth widely open there is a great tendency even in normal nose breathers to inspire through it after removal of the expiratory valve. This of course in such types is overcome to some extent by keeping up plenty of pressure in the gas-bag. If a person is allowed *ab initio* to inspire through his mouth, the difficulty of establishing nasal breathing after he is under is greater. It must not be forgotten that many persons whose nasal airway is apparently free, and who normally breathe through it, may in times of stress breathe through the mouth. I would draw attention to **two types** who are

particularly liable to do this under the influence of gas. The first is the middle-aged, robust, and perhaps stout and plethoric individual. Under the influence of gas (or any anæsthetic for the matter of that) the turbinal mucosa is very apt to swell up and, at any rate partially, block the nasal airway. In such types it is wise, previously to the administration, to spray or apply in some way a little adrenalin solution to the nasal mucosa ; in addition a good pressure in the gas-bag during its progress helps to overcome the block. The other type is generally a thin person with somewhat pointed nose, slightly narrowed nostrils, and thin, unsubstantial alæ nasi. In this type, under the stress of stimulated breathing, the alæ are apt to collapse during inspiration, closing the nostrils. Here increased pressure in the gas-bag is useless, as it only tends to press the alæ more firmly down on the septum. The best plan is before the administration to introduce the little silver wire dilators, known as Francis's. They are supplied by Mayer and Phelps in different sizes, and I have found them most useful.

It is important that the **nose-piece** used should fit the individual patient. Two or three different sizes or patterns should be carried—for instance, the original pattern made of metal with a pneumatic pad, the later all-metal pattern, which is somewhat narrower, and the latest which is all rubber. Amongst them one will nearly always be found to fit anything but abnormally large noses.

Weiss's oxygen attachment can be fitted to this inhaler. If it is not used a breath of air will be required occasion

ally where none is getting in by the mouth, probably about one to every five or six inspirations of gas. The thing is to watch the colour, and never let the patient become blue. I always remove the inspiratory valve from the apparatus; this allows of the patient expiring into the bag through his nose if he is so inclined, thereby economizing gas. Too much rebreathing may tend to a light anæsthesia; this can be stopped by raising the pressure in the gas-bag to a point at which the expirations find a more ready exit from the mouth.

The above are just a few hints on the administration of gas. I trust they emphasize two points in particular: the importance of avoiding cyanosis, and the influence of pressure in the administration of gases, whether N_2O or oxygen.

Of gas as a preliminary to ether I need say very little. Personally I have no use for it, but it is described in every textbook, so cannot yet be considered obsolete. It involves the use of the old cumbersome Clover's inhaler with all the drawbacks of closed ether. As a preliminary to open ether it is practically useless as ordinarily given; possibly, administered in the open (gravitational) method of Flux, it might serve as an adjuvant to the induction, but the C.E. ethyl chloride-ether sequence provides me with all I desire.

A **word of warning** to the beginner. It is as well he should realize from the commencement—otherwise he will soon learn it from painful experience—that in the matter of giving gas there is a deadly and subtle conspiracy against the anæsthetist. It begins with the gas merchant who, by way of a joke, will every now and then

supply him with a dud cylinder : it may be empty, half-full, or partially filled with water ; the last is particularly exasperating, as in addition to the gas being short, its supply is intermittent and somewhat explosive owing to the freezing up of the tap. It is so artful, too, as the presence of water is not likely to be suspected, and can only be demonstrated with certainty when the discarded cylinder is emptied out. It ends with the probationer who, overcome by her interest in the operation, will as likely as not put her dainty foot on the gas-tubing. It includes the surgeon, who may suddenly order the table to be moved into a better light, disconcerting one's carefully prepared arrangements ; or, on the other hand, "lights out" may be the order if a headlight is in use ; observation of the patient becomes strictly limited, and any other observation that it occurs to the anæsthetist to make had better be suppressed. The patient himself frequently takes a hand, but his wiles are easily overcome with a little practice. The arch-conspirator of all, because it is always in evidence, is the very floor on which one works. This is invariably slippery and shiny. In its highest development it is of hard stony composition, or if not up to this standard, it will at least be a well-polished linoleum. On such a surface, when one attempts to turn a foot-key, the cylinders and stand simply revolve *en masse*. A small mat or piece of board is of little service, as they generally join in the revolution. Any substructure of this kind should be large enough for the anæsthetist himself to stand on, and stiff enough to resist a tendency to wrinkle up. Failing this, the anæsthetist has to be pretty adroit in supplying

counter-pressure with his spare foot. It is hardly a consolation to know that lack of adhesion in one direction is more than compensated for in another. The foot-key will surely cling to those goloshes provided for you in the interest of asepsis, or to those rubber soles with which the leather shortage has impelled you to furnish your boots. Be wary how you lift your foot when readjusting, or the key will come bodily away with it just as your bag is either over-distended or nearly deflated!

ESSAY VI

MODERN METHODS

In the field of anæsthetics the early part of the present century has been very fruitful of new ideas and methods. Many of these have emanated from abroad. The reason of this is not far to seek. Whilst in this country the administration of anæsthetics has been for half a century in the hands of experts, on the Continent and in America this ideal has not obtained, and indeed, to my knowledge, although the state of affairs has vastly improved, does not yet obtain to anything like the extent we have it here. The consequence was that foreign surgeons, being perpetually plagued by indifferent and dangerous anæsthesia, conducted more or less under their own supervision, have cast about them for methods that, either in their own hands or those of an inexpert assistant, might offer increased efficiency and safety. Some of these methods are now in everyday practice, some have a distinct sphere of usefulness, and some have fallen into a well-deserved oblivion. Every innovation does not necessarily mean progress. Admitting this, however, I think it is fair to say that the science and practice of anæsthesia has made enormous strides in the past twenty years—perhaps as great or greater

than any other branch in the field of medicine during the same period. To mention all the novelties would involve too profound a study of the literature, but the following list will be found to cover all that have ever had any sort of reputation :

I. Ethyl chloride.
II. Open ether.
III. The preliminary administration of alkaloids.
IV. Intravenous ether.
V. Intravenous hedonal.
VI. Intravenous paraldehyde.
VII. Intravenous alcohol.
VIII. Intratracheal methods.
IX. Intrarectal oil ether.
X. Intramuscular ether.
XI. Warmed vapours.
XII. Dosimetric chloroform.

Then come the partial methods :

XIII. Endothecal, or spinal.
XIV. Subdural.
XV. Regional.
XVI. Local.
XVII. Intravenous regional (Bier).

This is, I think, a fairly comprehensive list. Of the first group I have practised all except VI., VII., and X. Of the analgesic methods I have only personal knowledge of XIII. and XVI. The first three items have now a fairly long-established reputation, and I have already dealt with them in other articles.

With regard to the intravenous group, my experience

was not particularly encouraging and consequently limited. One advantage of the method was supposed to be that the anæsthetist was got well out of the way of the operator, especially in operations in the region of the head and neck; but respiratory complications are just as apt to occur in these methods as others, and require the attention of the anæsthetist, calling him perhaps from duties connected with the saphenous vein. On the whole, the method is a bit cumbersome, and offers few advantages to compensate for the trouble involved. I have not practised it myself for several years, and believe it is falling into desuetude. I embodied my experience at the time in a paper, hitherto unpublished, which I read at a discussion on the subject at a B.M.A. meeting at Liverpool. The gist of this is as follows :

Intravenous Ether and Hedonal.—"There is one minor inconvenience about the intravenous method which militates against its general use in hospital, where there is usually a long list of operations to be got through—that is, the little preliminary operation necessary before the infusion can start. I have generally considered myself lucky if I have the patient ready for the surgeon within ten minutes of his being put on the table. To obviate some of this delay I have, on a few occasions, attempted to canalize the vein with a sharp needle without dissection. When the veins are prominent this may be done, but even then I have found that later on there is a chance of the sharp point fouling the walls of the vein and causing further delay or abandonment of the method. To prevent this

I have had made for me a needle of larger bore than Bailie's, and having an inner blunt cannula, which can be thrust beyond the point when the needle is *in situ*. This answers very well in many cases, but there will always remain a good proportion in which, owing to the veins not standing out well, it is best to dissect them out.

"To the intravenous infusion of ether there is to my mind another, rather serious, drawback—that is, the impossibility of infusing at blood heat. Wherever I have tried to do this the ether has bubbled out of the solution at an uncontrollable rate. In my first case the infusion had to be stopped half an hour before the completion of the operation owing to the amount of ether vapour that suddenly got into the last section of tubing. Very fortunately, thanks to the preliminary injection of scopomorphine, the operation was easily concluded without any further anæsthetic being required. I cannot help but think that the infusion directly into the blood-stream of large quantities of fluid below body temperature must have a depressing effect, especially in long operations involving some shock. However, I am ready to admit that this has not been particularly brought out by my own cases. I have only noticed two points bearing on this question. Of my thirteen cases three complained of pain in the arm directly the infusion started ; whether this was due to its relative coldness I cannot say, but I suspect it. The other point is that during the recovery from the anæsthetic three patients either complained of feeling cold or looked and felt cold and pinched. In hardly any case did the

patient appear stimulated during the administration as one would expect from a combination of ether anæsthesia with saline infusion.

"A word as to the strength of the solution. I started by using a 7½ per cent. solution in the first four cases. Afterwards I used a 6¼ per cent., except in two cases, a fragile woman, where I used a 5 per cent., and a very big stout man, where I reverted again to the 7½ per cent.

"In all the cases the induction was satisfactory, and there was no struggling of any consequence. The time was generally from three to seven minutes, and the amount from 200 c.c. to 600 c.c.

"As regards the anæsthesia it was absolutely satisfactory in eight cases. In five there was some clenching of jaw and retraction of tongue or laryngeal spasm causing cyanosis; in one case oxygen had to be administered.

"In one or two cases there was some rigidity or slight movements, and in one a tendency to retch during the operation, but this was for a parotid tumour pressing on the pharynx, and the nature of the operation no doubt accounted for the retching.

"Taking the cases all round, I think I may say that the anæsthesia gave the surgeons complete satisfaction.

"I will now deal with recovery and after-effects. Here, I regret to say, the picture is not so pleasing.

"As one of the chief advantages of intravenous infusion was held to be the abolition of after-effects, my experience has, I regret to say, caused me some disappointment. In three cases the recovery was excellent, and there was no vomiting or after-effects of any kind. In

three there was a little faintness, coldness, or trifling vomiting during the recovery. In six cases vomiting gave a good deal of trouble, and the curious part was that in the majority of these patients the recovery appeared to be excellent, and when I saw them from one to three hours after the operation they made no complaint, and yet afterwards had more or less severe vomiting lasting for several hours, and accompanied in some cases by headache. One or two patients have complained of pain at the site of infusion, but I am glad to say there has been no real trouble with any of the arms.

"In three cases there were serious after-effects, but how far due to the method it is difficult to say. One was a thyroidectomy for Graves' disease. She was very ill and extremely excitable. Forty-eight hours after she developed symptoms pointing to a low type of pneumonia, though no physical signs were discovered in her chest; her condition precluded a thorough examination. Ultimately she recovered after being in very great danger. The condition came on suddenly, and the possibility of pulmonary embolism was considered. Mr. Colledge, under whose care the patient was, kindly gave me a full account of her progress, and concluded by saying: 'I think the anæsthetic should be acquitted.'

"In one patient hæmaturia supervened the day following operation. It was very free, clots forming in the bladder, and lasted forty-eight hours, but the patient seemed none the worse for it.

"My last case brought the method into some little disrepute with the surgeon, Mr. Jackson Clarke, and

caused us to hold our hand. No doubt the anæsthetic was to blame, but I doubt whether the particular method of administration had anything to do with it. However, it was the second case in a very short series in which there was hæmaturia—real hæmaturia, not hæmoglobinuria.

"The operation was plating an ununited fracture of femur. The patient was a big, fat man of sixty-one, pale and flabby. He had been operated upon three months previously, when I gave him scopomorphine and C.E., and he did very well. His urine had been examined and he was not suspected of any renal disease, though very possibly his kidneys may have been somewhat cirrhosed. He had a preliminary injection of scopomorphine, and was infused for two hours with a little over two litres of a $7\frac{1}{2}$ per cent. solution. The anæsthesia was excellent. The pulse was rather poor, and his colour at first rather dusky and later pale. He got rather cold towards the end.

"He vomited for twenty hours after the operation, and then got suppression of urine and hæmaturia. For eight days the daily quantity of urine varied from $\bar{3}$i. to $\bar{3}$vi. only, and then gradually increased. During five of these days he was sick from two to five times daily. No doubt he had an acute nephritis. Eventually he recovered sufficiently to leave hospital. On the whole, I am convinced that the after-results of scopomorphine and open ether are decidedly superior to those of the method under discussion.

"I trust I shall not be going beyond the limits of the subject under discussion if I make a brief reference

to my experience with hedonal. This has been limited to ten cases. The inductions were for the most part quiet and satisfactory; in two or three instances I noted the slight transitory duskiness which has been observed by others, but the majority simply seemed to fall into a quiet, natural sleep, from which in many cases they were partially roused by the application of the surgeon's knife, as shown by slight reflex movements generally quickly abolished by increasing the rate of flow. In one case, although the patient seemed well under, her movements were continuous throughout the operation, were not abolished by increasing the flow, and required restraining. In spite of the apparent lightness of anæsthesia this patient took twelve hours to recover consciousness, and was drowsy the whole of the next day. In another case, a big woman weighing over sixteen stone, 1,050 c.c. were infused in nineteen minutes without producing complete anæsthesia. The operation was concluded under the influence of C.E. mixture, a very little being required. In two other cases I have had to conclude with C.E. mixture; in one the cannula came out of the vein whilst the patient was being turned on to his face, and in the other the supply of hedonal solution ran short. The amount required was again quite trifling. On the whole, with the exception of a few cases where there were slight early movements due to an insufficient amount of the drug having been administered, the anæsthesia was characterized by great quietude and muscular relaxation. The respirations were particularly quiet, jaw relaxed, and tongue inclined to fall back. Hedonal must, I think,

cause some depression of the respiratory centre, as any obstruction to the airway excites no response, and the laryngeal reflex is lost early.

"As regards the corneal reflex I generally aimed at keeping it present, but was not always entirely successful. Very little change was noted in the pulse. In one severe abdominal operation in a bad subject I was pleased to note entire absence of shock. The main feature about hedonal infusion is the slowness of recovery from its effects. Three of the cases took about twelve hours before recovering consciousness. This was looked upon as an advantage in certain orthopœdic cases involving, as a rule, much post-operative pain. On the whole, however, I regard it as a grave disadvantage, as in the nature of things the anæsthetist cannot remain on the spot all these hours. In only one case was there a little vomiting. In the cases which had to be supplemented with C.E. there was much restlessness. In one case the temperature gradually rose during the first twenty-four hours to 102° F., at which level it remained for twenty-four hours, and then gradually fell; there was nothing to account for this from the surgical point of view. In one of the cases, which took twelve hours to recover, the pulse during this period was extraordinarily rapid and rather weak, causing some anxiety. She was a very delicate child, and the pulse had been quick before and during the operation. The majority of the patients caused no anxiety during the recovery stage, and woke up feeling quite comfortable as though from a refreshing slumber.

"The last case calls for special notice, although, in the

limits of time available, it is impossible to go into it fully. Briefly, the facts are these. The patient was an ill-nourished tailor who had lately been on strike. There was no complaint of cough, and his respirations and temperature were normal; nothing was noted amiss with his lungs. Pulse was of course rather poor. Operation was opening and draining both frontal sinuses, the posterior nares being first plugged with a sponge. The induction was very quiet; in three and a half minutes and after the infusion of 400 c.c. he appeared to be under. Rate of flow was slowed down, and at the end of five minutes he had had nearly 500 c.c., and operation was commenced. The rate was now cut down to slowest possible and remained at that. It was apparently one of the quietest and best anæsthesias I had had. The only adverse point about it was that his colour was dusky throughout. I attributed this at the time to the post-nasal plug and a towel over the mouth causing some obstruction. The operation lasted one and a half hours; 1,000 c.c. were infused in all. A quarter of an hour before the termination of the operation I ceased the infusion and administered oxygen, which speedily improved his colour. No blood got into his air-passages during the operation; the post-nasal plug was removed at its termination. I left him still unconscious, but apparently in good condition. He died two hours after without regaining consciousness. Without entering into all the details, the principal facts elicited at the autopsy were that the lungs were absolutely studded with small miliary tubercles, and his air-passages contained a

quantity of fluid blood. This was not churned up and frothy as it would have been if any effort had been made to overcome the obstruction, nor was the slightest attempt made to cough it up. I don't consider that death was due to an overdose of hedonal, but the depression of the respiratory centre, allowing the air passages to be flooded by the post-operative hæmorrhage, and the delayed recovery (present in all these cases), were important factors in this unfortunate occurrence.

"To sum up: This brief experience has led me to certain conclusions. The intravenous method is a good one, and I think might possibly replace the inhalation method, but not with the drugs at present in use. Ether given intravenously offers no special advantages either in regard to the type of anæsthesia or the after-effects. Hedonal is dangerous, quite as dangerous, I think, as chloroform, if not more so, owing to respiratory depression and delayed recovery. It should never be used in cutting operations on the upper air passages, nor, I think, in feeble subjects, or those suffering from any disease of the respiratory system. When used, the flow should be cut down to the slowest drops as soon as the patient is apparently asleep, and only increased when necessary to prevent reflex movements. The corneal reflex should never be abolished."

Of **intravenous paraldehyde and alcohol** I have no personal knowledge. I believe they have been given quite an extensive trial by their sponsors, but so far as I know, there has been no prominent discussion

as to their respective merits. Perhaps this may be in store for us now that "the war is over." Up to the present, at any rate, neither method can be said to have caught on.

Intratracheal methods are of very distinct value. I use the term "intratracheal" because it is that commonly employed, but in doing so apologize to the philological purists who quite rightly insist that it should be "endotracheal." The method comes to us from across the Atlantic, and was originally devised for the purpose of keeping the lungs distended in operations involving the opening of the pleural cavity. Air is forced under considerable pressure through a tube passed *per vias naturales* into the patient's trachea. On its way from the bellows it passes over the surface of ether contained in a glass jar. It should, furthermore, pass over hot water contained in another jar. By these means it is etherized, warmed, and moistened. In addition, it is usual to introduce a mercurial manometer into the system to register the pressure at which it is administered. Some very elaborate and cumbersome apparatus has been devised with electrically driven bellows, which finds a useful place in a hospital theatre. For practical purposes something more portable is necessary, and this is supplied by **Boyle's Apparatus**, which is simple, and meets all requirements, and, being driven by a foot-bellows, is available in the absence of electric supply. As the method is one for which there is a distinct and increasing demand, and is only described in the larger textbooks, a few words on the **technique** may be worth while. After a preliminary injection of alkaloids the

patient is anæsthetized by one of the ordinary methods, the main point being to get him deeply under ether before an attempt is made to introduce the tube, and the beginner would be well advised, in addition, to arrange for the continuance of the anæsthetic by means of a Junker apparatus during this manœuvre. The fauces and larynx are now painted with a little cocaine solution, and a slotted direct vision laryngoscope is introduced down to the vocal cords. This is best done with a sandbag under the patient's shoulders and the head extended. The epiglottis should be looked for first ; when it comes into view, tilt the point of the laryngoscope over it and bring it hard up against its posterior surface, then gradually press onwards till the cords are plainly visible. By hugging the posterior surface of the epiglottis you avoid getting into the œsophagus or to one side of the glottis. When you are quite sure you have the vocal cords fixed steadily in the line of vision, pass the catheter, keeping its tip as far forward as possible lest it slip at the last moment behind the larynx into the œsophagus. There is a distinct tendency to this, and a slightly coudé catheter has its advantages. The passage of the catheter into the trachea excites considerable spasm and expiratory effort, causing a rush of air through the former, which can be plainly heard and felt, and advises the anæsthetist that he has got his instrument home. Having thoroughly satisfied himself on this point, he withdraws the laryngoscope, slipping the catheter through the slot, connects the latter with the tubing of the apparatus, and now maintains anæsthesia and air supply by working

the bellows. Pressure is kept up in proportion to the vigour with which these are worked. Its degree *within* the apparatus is measured by the manometer, but although this probably nearly corresponds with that in the lungs, it is apt to be a little fallacious. The air is going into the lungs by the catheter and emerging by the space between it and the windpipe; if the calibres of entrance and exit are equal, the manometer registers the pressure right through the system; but this is seldom the case, the calibre of the terminal connecting the apparatus to the catheter being generally quite small. Hence the pressure in the manometer is usually higher than that in the lungs with even a full-size catheter, and the smaller the catheter the larger the calibre of the orifice of exit and the greater the discrepancy between the two pressures. Really the manometer is an unnecessary addition; the true guide to the anæsthetist is the effect on the respiratory movements. If necessary, sufficient pressure may be kept up to render these imperceptible, though it is not wise to keep the lungs continuously inflated to that extent for a long period. With such a pressure the rush of air escaping from the glottis is audible as a continuous murmur. With a less degree of pressure there is, of course, a slight rise and fall of the chest corresponding to the respiratory rhythm, and associated with this alterations in the expiratory murmur.

I have never experienced the least difficulty in **maintaining a good anæsthesia** by this method. The narcotic strength of the vapour is, if necessary, increased by standing the ether chamber in hot water. It should

also be borne in mind that as the ether evaporates and its surface recedes from the afferent tube the strength diminishes. There is seldom any difficulty in retaining the catheter in position ; it is a possibility which must not be lost sight of, especially in operations within the mouth or in which the position of the head has to be altered. A simple means of fixing the tube is to bind a piece of flexible wire round it and fix the other end round an ear, after the manner of a spectacle frame. In the early stages it is wise to have a Doyen or similar gag in the mouth in case the patient should attempt to bite on the tube. It is a great advantage of the method that all asphyxial troubles are abolished, and the anæsthetist, not having to worry about the tongue, can really keep out of the way. In operations on the upper air passages blood is blown away from the glottis and cannot obtain entrance thereto. It is in such operations and in thoracotomies that the method has its principal **sphere of usefulness,** but there are many other operations in the region of the head and neck in which it has a distinct value owing to the absence of the anæsthetist from the neighbourhood of the operation, and the entire freedom from respiratory complications. For such cases it is quite unnecessary to administer at high pressure, and the Boyle's apparatus is not required. I generally use the more portable **Shipway,*** which allows of the administration of either ether or chloroform, but which, unless adapted, does

* Since this was written Shipway has devised an apparatus for high-pressure intra-tracheal ether. This is not the apparatus here referred to, but his well-known "warmed vapour" apparatus.

not permit of moistening the vapour. If this apparatus is used it must be remembered that the construction is such that the air is forced *through* the liquid anæsthetic, not *over* its surface, as in the orthodox tratracheal apparatus, and one result of this is that, if the system be entirely closed, a reverse current is set up by violent expiratory efforts forcing fluid from the bottle into the bellows. Therefore, with such apparatus, use a catheter with a fenestrum near its junction with tubing—this allows of the escape of expired air during any spasm of the glottis—and time your bellows compression with each inspiration to avoid any waste of anæsthetic vapour. An alternative plan is to remove the long tube from the ether bottle (it has a telescopic junction, hidden in the rubber stopper, connecting it with the tubing from the bellows); by so doing the method can be converted to a "blow over" one. At the same time, the lower bone terminal in the chloroform bottle should be unscrewed with the same object. In order to take up moisture as well as heat in passing through the thermos flask, the U tube can also be disconnected from similar telescopic junctions in the cork. The vapours then pass over the surface of the hot water.

The method is one, I am convinced, of great value in many cases. Except for the introduction of the catheter it is one of extreme simplicity for anyone with the slightest knowledge of mechanics. For what little skill I have acquired in this manœuvre I have to thank Dr. William Hill, whose pioneer work in endoscopic procedures is so well known. I have so far not met with any case in which the larynx appeared to be in

any way the worse for the passage and retention of the catheter. Gentleness in introducing the endoscope is, of course, necessary lest the soft parts be bruised or teeth broken or dislodged.

Rectal Oil Ether, introduced to this country by Gwathmey at the International Congress held in London in 1913, is another very useful and simple method. In simplicity, it has the advantage of the last method, but as it does not abolish respiratory complications, and sometimes requires helping out at first with a little inhalational anæsthesia, the anæsthetist's presence at the head of the table is in occasional demand. The patient must be thoroughly prepared, his rectum well washed out and a half or one grain morphia suppository left *in situ* some two hours previous to the operation ; alternatively the usual alkaloidal injection may be given hypodermically one hour beforehand. A 65 per cent. solution of ether in olive oil is made, a soft rubber rectal tube passed fairly high up and the end connected with a glass funnel. About 8 ozs. of the solution are now very gradually allowed to gravitate into the bowel through the tubing. Too rapid a flow causes discomfort and leakage from the bowel. The patient should in any case be encouraged to do his utmost to retain the solution. Anæsthesia is very slow in developing—a quarter of an hour or twenty minutes even in some cases—and there is usually a good deal of struggling, so it is important to have plenty of assistance at hand in this stage. If it appears necessary to shorten it, a little ethyl chloride and ether given in the semi-open way I advise will speedily quiet the patient, and he does not

as a rule require anything more during the progress of the operation. Immediately on returning to bed the rectum should be well cleared of all remains of the solution, and a small starch or starch and bismuth enema after the wash out will probably add to his comfort.

In the early days it was a little uncertain what was the best **percentage of ether** to give. I have given as much as 80 per cent. in one case. High percentages cause considerable pain and intolerance during the injection, and are apt to set up tenesmus with bloody stools afterwards. Gwathmey now recommends the 65 per cent. solution, and since I have used it I have certainly not heard of any post-anæsthetic bowel trouble. In the event of an operation being prolonged, and the patient showing signs of impending recovery, another ounce or two of solution can generally be injected, provided, of course, the site of operation is such that its progress is not interfered with by the procedure.

I append notes of one of my early cases, which is of interest more especially as regards the sequel:

December, 1913.—M., aged sixty-two. Average physique and colour; looks young for his age; has heart disease, and has recently been for some time in the medical ward, where under digitalis, etc., his condition has much improved. At the moment I noted nothing beyond a little irregularity and tachycardia. After his enema he had had at 4.15 p.m. a half-grain suppository of morphia.

At 5.25 I administered per rectum about 8 ozs. of

a 75 per cent. solution. He complained very much of griping pains, and declared he could not retain it; however, he did so. In a few minutes he became flushed and talkative, then incoherent and struggling. He would probably have been quite under in ten minutes, but as the surgeon was waiting, I gave him a little C.E. at 5.30, and he quickly became relaxed with regular breathing. Operation—removal of three-quarters of the tongue—now began, and was completed in about an hour, no further anæsthetic being given. Pupil was small, and corneal reflex brisk throughout. No movements till the last few minutes, when there was some wrinkling of the brows, opening of the eyes, and occasional groaning. His pulse kept perfectly good throughout—in fact, his condition rather improved than otherwise. On return to the ward he was getting quite wakeful; his rectum was washed out, and he made a rapid and perfect recovery with no rectal or other troubles. The pain and discomfort from which this man suffered during the injection—no doubt due to the high percentage of ether employed, plus inadequate morphia preparation—were responsible for his refusing the method when he came again for the removal of a recurrent growth some year or so later. His heart was now in a very bad state; pulse 200, but no dyspnœa or cyanosis. He had had scopomorphine, and I induced with the C.E.—Ethyl chloride—C.E. sequence. His respiration soon stopped, colour got dusky, and pulse fell to somewhere about 50. Tongue drawn out and artificial respiration performed. Breathing restarted, but stopped again for short periods once or twice. The pupil remained contracted and corneal reflex absent, the eyeballs fixed and eyelids open. Operation was abandoned.

The mistakes made in this case are obvious. A good course of treatment previous to the second operation would probably have improved his heart again. A lower ether percentage at the first anæsthesia would not have set him against the rectal method. Finally, it was a mistake to give C.E. after scopomorphine, and I have no doubt this is one of the cases which impressed me with this fact.

Of the **intramuscular** route for the administration of ether, I need only say that it also was reported upon at the International Congress by Dr. Descarpentries of Roubaix. It was admittedly a painful method, and had no very obvious advantages to recommend it. So far as I am aware it has not been practised in this country, nor is it, I think, at all likely to come into favour.

The administration of **warmed vapours** was originally practised in America, and has many staunch advocates in that country; efforts have recently been made to establish it in this. In dealing with the question I feel that I am on debatable, not to say highly polemical, ground. There are many who will differ from my views. Briefly, the attitude I take is that, in view of the **low specific heat of gases and vapours**, warming is quite unnecessary. The fact that the smoker draws air through the burning end of his cigar, perhaps within an inch of his lips, and yet feels no uncomfortable heat from the products of combustion has been quoted before, and is an everyday evidence of the rapidity with which heat may be taken up by air and lost again. The advocates of the method are somewhat inconsistent. They will tell you that under an

anæsthetic the heat-regulating centre is paralyzed and the patient in the condition of a cold-blooded animal, and in the next breath warn you not to give your vapours too hot lest the patient break out into a perspiration. Well, if the perspiration is not evidence of some mechanism being at work in an attempt to regulate the body heat, what is it? Again, if you ask how often it is necessary to renew the hot water in the thermos flask during an hour's operation, you will be told that the fall in its temperature is so slight that there is no need to do this at all. Very well, if in passing through the thermos the air takes up all the necessary heat and yet reduces the temperature of about half a pint of water so little that it is negligible, how much less will it reduce the temperature of the human body, weighing anything from eight to sixteen stone, if it takes up its heat in Nature's way as it passes through the air passages? Undoubtedly, during an operation the body is liable to lose heat. This is due partly to exposure and evaporation from moist surfaces, and partly to the fact that chemical changes productive of heat are practically in abeyance. The rectal temperature seldom falls more than one or perhaps two degrees Fahrenheit during the progress of an operation, and these are the main factors causing the fall. The amount of heat lost in warming air inspired at the ordinary *theatre temperature* is negligible. If, however, ether is given by the open drop method, the air is *chilled* considerably in passing through frozen gauze. In using my apparatus for ether administration such chilling does not obtain, as whatever the temperature in the ether chamber, that in

the face-piece is usually 70° to 80° F. or more, being kept warm by the expired air. Some years ago I took records of some fifty cases and noted the following temperatures —that of the theatre, rectal before operation, rectal after operation, and temperature in face-piece and chamber under A, B, and C strengths respectively—and found the results in every way satisfactory and in accord with the views expressed above. The temperature in the face-piece was recorded by a thermometer introduced into a short, specially made junction between the face-piece and chamber; that in the chamber by a thermometer introduced into it in B and C strengths; in A strength it was assumed, the face-piece and chamber being one continuous cavity, to be the same as that in the face-piece.

In this series of cases the rectal temperature before and after operation was noted in forty-three. The cases in which no record was kept were either operations which turned out to be so short as to render a comparison of little value, or else those in which other anæsthetics or methods were employed for a considerable part of the time. The rectal temperatures as a whole before operation were rather low, due probably to the fact that nearly all patients had had scopomorphine beforehand. What is striking is the slight amount of lowering of temperatures that took place; in twelve cases it actually rose, and nearly all the cases in which the drop was over a degree, eight in number, were subjected to either considerable exposure or evaporation from moist surfaces (wet towels or exposed viscera) or both. The average rectal temperature of the

whole series was before operation 98·9 F., and after 98·6. The cases were in no way selected, and included a large proportion of laparotomies and lengthy operations on bones and joints. Here are the results in three successive cases taken at random from the list :

First Case.—*Theatre Temperature*, 68° :	F.
Temperature in face-piece, strength A ...	73°
Temperature in chamber, strength A ...	73°
Temperature in face-piece, strength B ...	75°
Temperature in chamber, strength B ...	48°
Temperature in face-piece, strength C ...	84°
Temperature in chamber, strength C ...	74°
Temperature in rectum before operation ...	99·6°
Temperature in rectum after operation ...	98·6°

The operation, an exploratory laparotomy for malignant disease, lasted three-quarters of an hour.

Second Case.—*Theatre Temperature*, 74° :	F.
Temperature in face-piece, strength A ...	78°
Temperature in chamber, strength A ...	78°
Temperature in face-piece, strength B ...	82°
Temperature in chamber, strength B ...	46°
Temperature in face-piece, strength C ...	84°
Temperature in chamber, strength C ...	78°
Temperature in rectum before operation ...	99·6°
Temperature in rectum after operation ...	100°

Operation, amputation of thigh, lasted forty minutes.

Third Case.—*Theatre Temperature*, 71° :	F.
Temperature in face-piece, strength A ...	76°
Temperature in chamber, strength A ...	76°
Temperature in face-piece, strength B ...	84°
Temperature in chamber, strength B ...	50°
Temperature in face-piece, strength C ...	84°
Temperature in chamber, strength C ...	70°
Temperature in rectum before operation ...	98·8°
Temperature in rectum after operation ...	98·4°

The operation was appendicectomy and lasted one hour.

The above cases are just a fair sample from the bulk which would occupy too much space to reproduce in its entirety. The chief thing that strikes one is the marked difference in the temperature of the chamber and that of the face-piece at B strength, although the two are only separated by the thin rubber inspiratory valve. This should satisfy anybody of the rapidity and ease with which gases take up heat. Before this investigation I was considering the advisability of adding a warming chamber to my apparatus, but the results satisfied me that any such addition was quite unnecessary. The Shipway apparatus is of such general utility that it is advisable for every anæsthetist to possess it, and the use of the thermos is specially indicated in cases where the vapour is delivered by the oral route, or by the low-pressure intratracheal method, as mentioned above.

Whether the **Dosimetric method** of chloroform administration should be included among modern methods is open to question. It was practised, somewhat imperfectly, by Snow and others many years ago, but seems to have become obsolete for a time. It is now over a quarter of a century since the method was again taken up and warmly advocated by Waller. The practical outcome was an accurate and portable inhaler designed by the late Vernon Harcourt early in this century, improved by Dudley Buxton and ably supported by the great weight of his opinion. The idea at the bottom of the method is that it is impossible

to overdose a patient so long as the strength of vapour inhaled does not exceed 2 per cent. of chloroform, and the construction of the original apparatus is such tha this strength cannot be exceeded. For use with patients who require a higher percentage (and they are not uncommon) an increase tube has been added which causes the strength to be double that shown on the indicator. The convenience of knowing exactly what percentage you are giving, and the feeling of confidence imparted to the administrator in the presence of anomalous signs, render this machine particularly valuable to those who only occasionally have to give chloroform. The apparatus, of course, does not prevent those *sudden* deaths that occur occasionally under light chloroform anæsthesia, and if used for induction this—the struggling stage—is apt to be somewhat prolonged, a factor which, perhaps, adds a little to the risk. Being a confirmed etherist, it is a little difficult for me to judge of the value of a method which I have scarcely had occasion to use, but to those who use chloroform I feel it must offer many advantages, and it is certainly more scientific than the usual procedure, described by some humorist as the " rag and bottle " method.

Partial methods are rather the province of the surgeon than the anæthetist. Nevertheless, the anæsthetist is sometimes called in to produce them, and for his information whole textbooks have been written on this branch of the craft alone ; an excellent one is by Allen of New Orleans.

Local analgesia, the simplest form, demands no very special knowledge, and is perfectly harmless and

satisfactory for small superficial operations. Indeed, the anæsthetist sometimes wonders that it is not more frequently employed, and his services dispensed with. Is it merely habit, or is it prejudice in favour of a state of unconsciousness during operation on the part of the patient? However, these are matters on which the anæsthetist need not worry himself. They are no concern of his.

I do not gather that **regional** analgesia, obtained by the perineural injection of large nerve trunks, has received much support in this country. The method demands a special knowledge of the distribution of the nerves and of the superficial guides to their trunks, and is of value in suitable cases where a general anæsthetic is not desirable.

Bier's method is suitable for operations on the limbs. The limb being first rendered ischæmic by means of a rubber bandage, a portion of it is isolated above and below by means of tourniquets, a vein on this area dissected out and injected under pressure with from 50 c.c. to 80 c.c. of a weak solution of novocaine. This forces the valves and finds its way to the capillaries, rendering the isolated area directly anæsthetic, and the part below indirectly so through nerve-blocking. The anæsthesia lasts as long as the tourniquets remain in position, and on their removal and the restoration of the blood stream, is speedily lost. The method is fairly simple, but involves, of course, a little time for the preliminary operation necessary for its production. Prolonged pressure by tourniquet is painful and damaging to the tissues; these objections can be

met, it is said, by using a rubber bandage in place of the ordinary tourniquet. The procedure is one falling rather more in the province of the surgeon than the anæsthetist, but the latter may be called upon to adopt it. The idea has been extended to intra-arterial injections, a purely surgical problem, and one which has not, I think, been practised in this country.

Subdural or Sacral analgesia, obtained by injecting the solution into the sacral canal, catches the nerve trunks after they have escaped from the theca, and is practically a form of regional analgesia.

There remains for discussion **spinal** analgesia. Introduced to this country some fifteen years ago, extravagant claims were made for it by some of its advocates. Those in whose hands results were satisfactory were loud in its praises, whilst those who experienced disappointment or disaster were less prominent in the press or on the platform. Modern views are more temperate. Whilst all admit that there are cases in which the method is desirable, the number who practise it in preference to inhalation anæsthesia is very strictly limited, and of these a large and increasing proportion like now to combine it with a light gas and oxygen or ether anæsthesia. At a time when any criticism of the method was rather unpopular I went into the literature of the subject, and arrived at certain conclusions which I ventured to put forward in a paper read during a discussion at the B.M.A meeting at Belfast, 1909. Little has happened since to cause me to alter those views, nor has a practical acquaintance imbued me with the enthusiasm of some. I might, indeed, reproduce that paper here (it has never so far

been published), but for the fact that it is rather ancient history, and the statistics founded on the work of years ago are not now of the same value as they then were. To obtain accurate **statistics** to date would be a laborious task indeed, and could only be fallacious, as the man in whose hands the method has been successful publishes his thousands of cases, but the one who has met with failures or deaths does not as a rule publish his statistics.

Briefly the **claims made for spinal anæsthesia** are : (1) That the patient needs no special preparation, and can take his usual meals before and after operation. (2) That the after-effects are less. (3) That greater relaxation can be obtained. (4) That it abolishes shock. (5) That the patient retains consciousness. (6) That it is safer.

To take these seriatim. The first proposition, that **preparation** is unnecessary, is a half-truth. When I worked out statistics from thousands of cases published by Continental observers and some hundreds in this country, there were no less than 8 per cent. in which a satisfactory analgesia was not obtained, and resort had to be made to general anæsthetics. The percentage of failure nowadays is probably much less, but, on the other hand, a combination of spinal analgesia with a little ether is so commonly practised that, except in cases of emergency, it is advisable to prepare the patient in the usual way. As regards the **after-effects**, it is a little difficult now to compare spinal with general anæsthesia. In the bad old days headache, vomiting, general discomfort, and bronchial catarrh were almost

regarded as necessary sequelæ of anæsthesia, but modern methods have rendered such evils negligible. On the other hand, the position of spinal analgesia appears to have improved somewhat in respect of after-effects. I found immediate after-effects—such as headache, vomiting, rise of temperature, incontinence of urine—of fair frequency, and the remote or lasting ones most alarming. In a little over 300 cases, one surgeon had one case of retention of urine lasting nine months, two cases of syncope on the day following operation, four of intense meningeal reaction, and two deaths weeks after from paralysis with incontinence of urine and fæces. Similar results were of constant occurrence in other series, and additional complications, such as gangrene, suppurative meningitis, and oculo-motor paralysis, were reported. At a discussion held on the subject at the Royal Society of Medicine in December, 1918, with the exception of headache and paralysis of the external rectus muscle of the eye, there was no allusion to any after-effects. The former was said to be avoidable by care in moving the patient back to bed, and the latter to have occurred only three times in one list of 20,000 cases, and then only lasted a few weeks.

As regards the third proposition there is no question. **Muscular relaxation** is perfect. Whether this method abolishes **shock** is somewhat open to question. The theories as to the causation of shock are as plentiful as blackberries in a Surrey lane. If one accepts the theories founded on the transmission of traumatic stimuli to the higher nervous centres, then nerve-blocking by stovaine should abolish shock. But if the later theory

that it is due to the absorption of a chemical poison produced by injury to tissues is true, no amount of nerve-blocking will make any difference. The fact remains that shock does appear in this method; no less an authority than the late Arthur Barker admitted its occurrence in two cases in his series of 300. The advantage of the **retention of consciousness** during operation is dubious; modern advocates of the method regard it as a disadvantage in many cases. Rood suggests twilight sleep or a little general anæsthetic to overcome it. As Mummery points out, pain is abolished but not fear. This is a depressing influence, and in any one of nervous temperament calls for a general anæsthetic. The last claim made for spinal analgesia is on the ground of **safety**. There may have been some grounds for this claim on the Continent; that I cannot judge, as I do not know the death-rate there from general anæsthesia. I do know that when I investigated the matter, the death-rate from spinal analgesia on statistics available at the time worked out at about 1 in 500. For reasons which I have previously given, no reliable statistics could very well be compiled at present. I have little doubt, however, that a considerable improvement in this respect has been effected. But what of general anæsthesia? Has there been no improvement there? I maintain that in capable hands the death-rate under modern methods is almost negligible.

At first spinal analgesia was recommended in the case of patients already suffering from shock. It is now, however, generally recognized that owing to the

lowering of **blood-pressure** which it brings about it is best avoided in such cases. This sudden lowering of blood-pressure is alarming in some cases. I have seen quite a number of patients become grey, pinched, and cold; beads of perspiration stand out on the brow, and attempts at vomiting ensue. I think the method should be limited to the following: Operations for the relief of acute intestinal obstruction on account of the tendency to fæcal regurgitation, so prevalent and embarrassing under a general anæsthetic; abdominal operations in which the surgical procedures demand a very high degree of muscular relaxation, or in which there is good reason to believe that general anæsthetics will not be likely to overcome rigidity; emergency operations conducted shortly after a meal, provided shock is absent; in preference, perhaps, to chloroform in operations likely to involve shock, and in which for some reason ether or prolonged gas and oxygen are not deemed expedient.

Technique of Spinal Anæsthesia

(*Abstracted from Mr. Barker's Paper.*)

1. Site of puncture is second or third lumbar interspace in mid line. (The spine of fourth lumbar vertebra is on a level with the highest point of the iliac crests.)

2. Antiseptics used on site of puncture should be thoroughly washed away by sterile saline solution. (This does not apply if iodine is used.)

3. Instruments and gloves should be boiled in a separate sterilizer *without any soda.*

4. Position of patient—on the side, with knees well drawn up, or sitting on edge of table with back bowed.

5. Affix inner blunt cannula to syringe and charge—the usual dose is 1 c.c. of the solution, equal to 5 centigrammes of stovaine.

6. Pass needle armed with sharp stylet into theca.

7. Withdraw stylet and allow about 10 c.c. of spinal fluid to escape.

8. Pass blunt cannula through needle into dural space and inject.

9. Put patient on back with head and buttocks slightly elevated.

The only **solution** of which I have personal experience is that employed by Barker, known as Billon's stovaine glucose solution; it is supplied in ampoulles containing 2 c.c. of a 5 per cent. solution of stovaine, to which is added 5 per cent. dextrose to render it heavier than the cerebro-spinal fluid. Samples are not considered reliable after being kept for more than a year. In using this solution the height of the analgesia may be regulated to some extent by the height to which the buttocks are elevated during the first few minutes. At one time it was considered dangerous to lower the head lest paralysis reach too high a point. The result of the practice of keeping the head raised was the frequent appearance of such symptoms as yawning, nausea, faintness, and even collapse. Stovaine causes a very marked fall of blood-pressure—the circulation comes much more under the influence of gravity in these circumstances; the result is, with the raised head, the brain is starved of blood and these alarming symptoms appear. That they

can be entirely abolished by lowering the head I am not prepared to say, but undoubtedly the best practice is as soon as signs of analgesia begin to appear to lower the head and keep it at a lower level than the rest of the body until the influence of stovaine has entirely passed.

Other solutions such as novocaine and tropacocaine are in favour with some; they can be obtained in similar ampoulles, and are usually made lighter than the cerebro-spinal fluid.

ESSAY VII

SHOALS AND RAPIDS.

The **common troubles** arising during the progress of an anæsthesia are associated with the muscular system. When the musculature of the air passages or of respiration is affected they are called respiratory. All originate in the nervous tissue, being due either to the effect of stimulation or depression. They are of common occurrence in those in whom the nervous system is in a general way lacking in control: people who are spoken of as being of a nervous type.

Respiratory troubles are of two kinds, active or spasmodic, passive or paretic. To take the **active** first. I have seen during the induction period on some rare occasions **spasm of the entire respiratory musculature.** This, unless it is quite temporary, calls for the withdrawal of the anæsthetic; as soon as it passes off and the patient commences to breathe again the anæsthetist must use his discretion, guided by the severity of the attack, as to whether he proceeds again, using a different anæsthetic, or not. It is more likely to occur under ethyl chloride than under chloroform or ether.

Other minor troubles are holding of the breath, swallowing, retching, retraction of the tongue, jaw

spasm, laryngeal spasm, cough, straining, hiccough, and entire closure of the glottis at the commencement of inspiration. They have this in common, that they occur under light anæsthesia and are dependent on some reflex action ; the origin of the reflex is in some cases apparent, in others obscure. Two common sources are the irritation caused by the anæsthetic vapour and the surgical procedures. In those lightly under the anæsthetic a slight increase in the strength of the vapour is resented by the air passages, and results in holding of breath, swallowing, retching, coughing, or crowing inspiration. By continuing the increase of strength the patient will become accustomed to it, and in time more deeply narcotized, and perhaps the reflex will then be abolished. This is the usual course of events, but every now and again patients will be found very intolerant of ether ; increasing the strength, even if persisted in for some time, only makes the respiratory spasm worse, and owing to its interference with their intake they do not get more deeply under.

In such cases, if the patient has had morphia beforehand and show no other signs of light anæsthesia, an attempt may be made to continue with a very weak vapour, taking great care at no time to increase suddenly the strength. This sometimes answers where the other fails. Of some assistance in these troubles is the practice of pinching and pulling on the lower lip ; or, if that fails, to render the respiration regular, one may try tongue traction—rhythmic for choice. Finally, there is the expedient of changing the anæsthetic. There is this to be said about these worries, that, as a

rule, except in abdominal operations, they do not embarrass the operator, and they are not dangerous in themselves. Of more importance are **retraction of the tongue** associated with **jaw spasm**; and complete **inspiratory closure of the glottis**. These conditions block the airway and cause cyanosis; during their occurrence inspiratory efforts are vigorous, and the beginner may be deceived, as they are, if complete, unaccompanied by stertor, and the abdomen and lower ribs rise and fall rhythmically, but with their rise the upper part of the chest falls and no air enters. The latter of the two conditions is not preceded or accompanied by crowing breathing; all one hears is, at the commencement of each inspiratory effort, a slight click like the closing of a valve. For these reasons I had for long considered that it was due to the epiglottis being sharply closed down, but laryngologists tell me it is due to complete approximation of the vocal cords. The origin of these reflexes is not quite so obvious as the others, but is also probably due to the irritation of inhaled vapours. The remedy is to open the jaw and pull forward the tongue, the method I have described already (p. 24). Short of the complete block to inspiration caused by forcible retraction of the tongue, a minor degree of embarrassment of respiration accompanies mild active retraction or passive falling back of the tongue. These conditions are of common occurrence, and, though not a source of danger, give rise to stertor and increased respiratory effort, which may be embarrassing in abdominal operations; they also interfere with the proper oxygenation of the blood.

It is the anæsthetist's duty always **to keep the airway** as **open** as possible. In order to do so in these lesser degrees of obstruction, it is not as a rule necessary to seize the tongue. Pressure *behind* the angle of the jaw carries it forward, or sometimes raising the chin by pressure *under* its point suffices. The common mistake of the beginner is that he attempts to accomplish both objects by placing two or three fingers under the *middle* of the body of the jaw and pressing upwards and forwards. Thus he works at a disadvantage in both respects, and in addition his finger-tips generally stray into the soft parts below the floor of the mouth, pressing them and the root of the tongue over the pharyngeal opening, thereby enhancing the very condition which he is attempting to relieve. Pressure forward should be made from behind the angle, upward from the point of the chin; the rest of the body of the jaw is hallowed ground.

The **surgical stimulus** is the cause of straining, exaggerated breathing, and, in some cases, of laryngeal spasm (crowing inspiration). Straining is particularly caused in abdominal operations in the handling of the viscera and the pulling upon their attachments, which must occur during evisceration, and may occur in other procedures; the remedy is, of course, to deepen the narcosis. Breathing is stimulated by almost all surgical procedures, but particularly so by operations on the pelvic organs. This is of no importance *per se*. The operations particularly liable to cause laryngeal spasm are those at either end of the alimentary canal, the pharynx, and the sphincter ani. Here, again, if trouble-

some, the remedy is more anæsthetic. Better than remedy in all surgical reflexes is prevention ; a knowledge of a surgeon's procedures is everything to the anæsthetist, as he can then generally forestall any of these minor troubles by increasing his vapour strength at a suitable time previous to the expected onslaught.

Two forms of respiratory trouble which do not exactly fit into the classification adopted here are **gag asphyxia** and **foreign bodies** in the air passages. They may be termed accidental. The former occurs in certain patients, more commonly those with small, receding mandibles. In this type, when the mouth is opened by the gag, the airway becomes blocked ; the wider it is opened, and the more the point of the chin is depressed into the neck, the greater the obstruction. Raising the point of the chin from the neck relieves it ; this involves, of course, extending the head, which may not always be quite convenient. In such case the gag should not be opened any wider than absolutely necessary during the operative procedures, and relaxed at every possible moment in the intervals to enable the patient to get as much air as possible.

In operations on the upper air passages the anæsthetist should take every precaution to avoid the entrance of foreign bodies into the windpipe. In the case of blood and pus the position of the head will assist ; it may be extended so that the vertex rests on the table, the shoulders being raised by a sandbag ; or the patient may be put in the latero-prone position with the mouth dependent. Again, in operations on the nose or accessory sinuses, the posterior nares may be plugged,

or the soft palate held up by a sponge on a holder ; or high-pressure intratracheal ether may be relied upon to blow these fluids away. Solid obstructions vary from teeth to tonsils, adenoids, or various other fragments in process of removal, which may fly or be inhaled into the larynx. A wire screen on a holder held just in front of the entrance to the pharynx is useful in dental operations. Prevention is always better than cure, but occasionally, in spite of these precautions, and sometimes through neglect of them, sudden obstruction will arise. The first thing to do is to pass a sponge—or if the obstruction is known to be due to a solid fragment the finger—over the opening of the glottis and either sweep it away into the œsophagus or hook it out through the mouth. The futile dabbing of the posterior wall of the pharynx with a piece of cotton-wool more or less securely attached to a flexible sponge-holder, which one so often sees performed, is perfectly hopeless in such serious conditions. If the finger is not employed—and it is only for solid fragments that it is recommended—there is nothing better than a marine sponge securely fixed on a rigid holder. With the head a little extended and the tongue held forward lest it be pushed back in front of the sponge and obstruct its passage, the latter is passed rapidly backwards and downwards over the glottis, given a half turn, and withdrawn. Anything lying over the orifice of the glottis must thus either be pushed on into the œsophagus or entangled in the mesh of the sponge and withdrawn. Should nothing be felt at the orifice of the glottis by the finger, and symptoms of obstruction

continue in spite of this search and sweeping with the sponge, a laryngotomy had better be performed at once, unless, indeed, the fragment is known to be small, the anæsthesia light, and cough reflex lively, in which case a few seconds may be allowed to see if it will be coughed up. In such cases as these intubation and insufflation of oxygen, even if everything is at hand for its immediate practice, is contraindicated because blood and laryngeal spasm prevent a good view of the cords being obtained.

The remaining respiratory troubles are those due to **cessation of respiration.** They are more serious than the active or spasmodic variety, and may be very alarming, as from the symptoms they are difficult to differentiate from overdosage with chloroform, and it is practically always under this drug that they occur. The *slow* onset of respiratory failure typical of *progressive* **overdosage** by chloroform I have already described and illustrated by notes of a case (p. 47). Sudden deaths under chloroform are generally associated with light anæsthesia, cardiac failure, and deep, gasping inspirations. Whether *sudden* arrest of respiration may occur through *sudden* overdosage with chloroform vapour I cannot say. I have not seen such sudden overdosage myself, and cannot imagine its occurrence in the absence of gross carelessness or unusual accident.

There are a few varieties of apnœic pauses occurring during the administration of chloroform which simulate overdosage. I believe I have personal knowledge of three. The first and simplest is Cheyne-Stokes breathing, the second is surgical inhibition of respiration, and

the third is the result of over stimulation and fatigue of the respiratory centre, followed by lack of stimulus.

The occurrence of **Cheyne-Stokes breathing** is rare. I have only once seen something approaching it under ether. Under chlorofrom I have seen typical examples—perhaps a dozen, certainly half a dozen, times. The patient will be breathing quite normally when, without any obvious reason, respirations gradually become shallower and less frequent ; this diminuendo continues till they finally cease. Although the patient's colour and pupil remain good, the respiratory symptoms are most alarming ; tongue traction and cessation of anæsthetic make no difference. Presently of his own accord the patient draws a feeble, shallow breath, and starts on a crescendo which finally lands him into deep regular breathing again ; this soon, however, becomes depressed, and the whole cycle is gone through once more. After the second cycle probably even the tyro will recognize what he is up against. The onset is most alarming, but the anæsthetist must take courage from the knowledge that he has not been giving large doses, and from the fact that the colour, circulation, and pupil keep good. This type of breathing may only last for a few cycles, or continue throughout the operation. What is the cause or the remedy I have yet to learn.

The **surgical stimulus** nearly always sets up an increased respiratory effort. Very rarely, indeed, does it inhibit the respiration. I have only two cases in which this occurred amongst some ten thousand. The possibility of its occurrence, however, must always be

kept in mind, and such cases should not be hastily put down to overdosage.

The first case was a small boy on whom skin-grafting was being performed. The induction by the C.E.—ethyl chloride—C.E. sequence was quite uneventful. At the moment the graft was being taken he was lightly under. Respiration stopped suddenly and cyanosis supervened, but pulse and pupil kept good. Respiration was restored by rhythmic pressure on the chest and tongue traction. This is, I think, quite a typical case of surgical inhibition. The signs of light anæsthesia were obvious; the arrest of respiration was sudden, and the circulation and pupil kept normal.

The second case caused me more anxiety; the origin of the symptoms was not quite so obvious and might be debatable. For myself, I have no doubt it was one of surgical inhibition occurring in a patient in whom the effects of ethyl chloride were passing off, and who had not yet come completely under chloroform.

Mr. ——, a young adult, Chilian, healthy, and a heavy cigarette-smoker. The operation was simply a small injection of paraffin to remedy a slight defect in contour of patient's nose. It was done on the patient's bed without any nursing assistance or any of the usual adjuncts and accessories of an operating theatre. The patient had previously had chloroform for an operation on the antrum, and no history of any trouble was given.

Having regard to his age, race, and physique, I expected a little trouble during induction. He had had no alkaloids. C.E. mixture to the amount of ʒiv. was dropped and douched on the mask, then ethyl chloride—

5 c.c. or 6 c.c.—sprayed on and the towel applied. Somewhat to my surprise he went under quite quietly, and there was no struggling. Beyond a little cough the induction was uneventful. The corneal reflex was lost and the pupil dilated on removing the towel. Chloroform was administered fairly freely for a minute or two longer on the mask. Cough still continued, pupil remained slightly large, and jaw was clenched. Probyn Williams gag was inserted, connected with the Shipway apparatus, which was now worked with the foot-bellows. The needle of the paraffin injector had just been inserted when he suddenly stopped breathing. Tongue traction and rhythmic pressure on the chest failed to restart, and, as he was becoming cyanotic, artificial respiration was begun, and after a few anxious moments natural breathing was restored and the operation was completed. Chloroform only was given by the Shipway, as I felt that with his cough ether would only make matters worse. During the crisis he was very blue, and broke into a perspiration, but the pulse kept fair, the pupils slightly large, the corneal reflex absent; the conjunctivæ were not pallid, nor did the eyelids remain in the half-open state common in the overdosed. *The jaw was never relaxed.*

The case is instructive. What was the cause of the cessation of respiration and serious symptoms that developed? I can honestly say that, though the surgeon was perturbed, I never felt any real anxiety about the case. To my mind the symptoms were due to surgical inhibition in a patient recovering from ethyl chloride. The points which guided me

to this decision were the fact that respiration stopped *suddenly* when the patient was of a good colour, quite different to the gradual slowing down and greyness that comes on with an overdose of chloroform ; the jaw spasm induced by ethyl chloride had never passed into a stage of complete relaxation characteristic of an overdose of chloroform; neither had the ethyl chloride pupil passed through the contracted pupil stage of the third degree of chloroform narcosis. The condition of the eyelids and conjunctivæ confirmed my opinion as to the cause of the trouble. As to its event, there was one source of anxiety and one only. Regarding the patient as rather a "tough proposition," I had dosed him fairly freely with chloroform during the third stage. Would there be an excessive absorption during the period of arrested respiration ? Fortunately this did not take place. The young man was probably one of those cases occasionally met with, a bad subject for ethyl chloride.

The **third type of apœnic pause** is illustrated by the following case :

Miss ——, medical student. Operation, appendicectomy. Atropine $\frac{1}{100}$ gr. previously administered. Anæsthesia induced at patient's request with gas and ether, and was to have been continued with chloroform by desire of the surgeon. The induction was uneventful, and after about four or five minutes of closed ether, the Clover was exchanged for a mask on which at first was given C.E. No cyanosis had been permitted to develop during the induction, an occasional inspiration of air being allowed, but all the expirations

were caught in the bag. Respiration, which had been well stimulated by ether, fell a little under C.E., but only to the extent one would anticipate. There was no difficulty in maintaining anæsthesia with quite a moderate amount of C.E.—I doubt if the chloroform percentage reached 2 per cent. The pupil was moderately contracted and corneal reflex absent. Just previous to the incision I started pure chloroform, but, before she could have inhaled it, the respiration suddenly fell, there were three rather shallow breaths, and it ceased. This all happened before the incision was made, so there was no question of surgical inhibition. The pupil now dilated, and the colour and circulation, which were perfectly good at the onset, gradually altered, the lobe of the ear got a little dusky, and the return of the capillary circulation after pinching became slow after the lapse of two or three minutes. Meanwhile, tongue traction having proved ineffectual, rhythmic pressure on the chest with administration of oxygen were started. A good colour, normal pupil, and respiration were soon restored; the corneal reflex did not return; the anæsthesia was continued with open ether. The operation, which had commenced directly after the onset of the symptoms, was hardly interfered with. I noted that the incision had no effect in stimulating the respiration.

I have noted a similar train of events in some few other cases in which I have changed from closed ether to an open method involving chloroform—at any rate as one element. The explanation is, I think, that the respiratory centre under the double stimulus of ether and CO_2 becomes a little fatigued. The elimination of

these during the next few minutes, and the introduction of the respiratory depressant chloroform, settles the matter ; in the absence of anything to stimulate it, the centre temporarily ceases to work. I feel convinced in this case it was not a question of overdosage, and am only sorry I was not using a dosimetric inhaler, which would have settled any doubts on the matter. It is such cases as these that impress one with the advantages to be obtained from the use of the Vernon-Harcourt in reaching unassailable conclusions.

Under ether one very rarely gets these apnœic pauses. In a list of some thousands I have notes of two cases, in both of which it was due to the preliminary injection of morphia. Here is one :

The patient was a young soldier. Morphia $\frac{1}{4}$ gr. and atropine $\frac{1}{120}$ gr. had previously been administered. The induction (C.E.—ethyl chloride—E.) was very quiet and respiration was not stimulated. The anæsthetic was continued in my inhaler at A strength for several minutes during sundry preliminaries to the operation. The breathing was shallow, and became more so until it stopped, the colour being decidedly dusky at this point. Tongue traction caused a breath, and the administration of oxygen restored the colour. The incision was made and breathing then became regular, but remained shallow throughout. Anæsthesia was easily maintained with the weakest vapour, C strength. The following points also confirm me in the view that here was a patient particularly susceptible to the effects of morphia. The pupil was contracted to a pin's head ; sudden additions to the strength of the ether vapour, made later on, did not excite any reflex

response on the part of the patient, such as holding of the breath, cough, or laryngeal spasm.

Under **chloroform and morphia** this form of arrested respiration is far more common, as both it and the morphia act as respiratory depressants. I have alluded to this matter elsewhere.

Other **troubles** associated with the muscular system, as **apart from the respiratory mechanism**, are reflex movements, rigidity, clonic rhythmic movements, ether tremor, and epileptiform attacks.

Reflex movements, due to surgical stimuli, are evidence of light anæsthesia, and must be abolished by deepening it. **Rigidity,** amounting sometimes to tetanic spasm, is in evidence during the induction, and generally disappears as the patient settles down; sometimes, however, it persists, at any rate to a degree that is embarrassing to the operator. Chloroform, if that is the drug employed, may have to be pushed even to the fourth degree of narcosis. If alkaloids and open ether are the anæsthetic agents, a change may be necessary temporarily to closed ether. But a change to chloroform in these circumstances is not advised.

Slow **rhythmic movements** are occasionally observed, sometimes of thumb or finger, sometimes of the whole limb; they are not of much importance, and generally subside of themselves after a time.

Tremor under ether is not infrequent. There are two kinds—local, due to a strained position of the limb, similar to ankle clonus, and relieved by placing in an easy position; general, occurring under light ether

anæsthesia, agitating the whole or a greater part of the body, and usually got rid of by deepening the narcosis. I have seen cases in which it has returned over and over again every time the narcosis was lightened, and been abolished again by deepening it.

Attacks of **epilepsy** occasionally occur under anæsthetics, and I have seen on one occasion an attack of a convulsive nature simulating epilepsy in a person who was not the subject of that complaint. On the face of it, an anæsthetic appears quite a good treatment for an epileptic seizure, so on the rare occasions on which I have met this complication I have continued the administration, and the attack has passed off in time quite happily. The cases have been so few, however, that I should be sorry to draw any conclusions as to the soundness of this practice.

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