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CLOSED ANAESTHESIA *

BY

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Closed anaesthesia has lately been attracting considerable attention, and investigation shows that many workers have interested themselves in this method during the last few years. The present discussion of this method is entirely due to the thought and experiment of these workers, not all of whom have published their views and results. It may be as well first to state what is meant by the term "closed anaesthesia," for, as it stands, it does not convey very much in the way of definition or of special meaning. Most anaesthetists are accustomed to conduct general anaesthetics which cannot be described otherwise than as "closed," so that some definition of the term is required to indicate the special light in which this form of anaesthesia has now come to be regarded.

Closed anaesthesia is general inhalational anaesthesia maintained indefinitely by the continuous rebreathing of a relatively small fixed amount of anaesthetic gas, which is constantly kept in a respirable and life-supporting condition. This definition implies some special treatment of the gases in the closed system by which the anaesthetic gas is recovered in a state of purity for reinhalation. The closed system may also be called the "recovery principle," which term conveys the additional fact that the anaesthetic gas is recovered from the breath, is used over and over again by the patient, and is not allowed to escape into the general atmosphere during the anaesthesia.

Gas-recovery is not new, the absorption of carbon dioxide from the breath being well known as a method employed in physiological research, as also is the fact of the chemical stability of the anaesthetic gases. It is not remarkable, therefore, that the idea of applying these facts to the management of gaseous anaesthesia should have occurred to many workers both at home and abroad. What does seem strange, however, is that the principle of carbon dioxide absorption, which seems so simple and effective, has not produced more decided results and established itself as a workable and reliable method.

The idea presented itself to me originally less as a method of using the anaesthetic gases with improved effect than as a means of making gas-oxygen apparatus portable. The construction of apparatus of manageable weight had interested me for several years, but there seemed to be no means by which cylinder dead weight might be reduced until the recovery principle was thought of and tried. With this scheme working successfully, it should be possible to make a really portable apparatus, since it would no longer be necessary to carry about the large supplies of gases required by the "flow" principles.

There might also be other advantages from the working of a completely closed system.

Mechanical Difficulties of Administration

At the outset it was seen that there would be no great difficulty in making a machine that would be gastight, but would it be possible to get the necessary security of joint between the machine and the patient? This was a matter of great importance, for, if leakage could not be controlled, the system could not be kept completely closed, which is a condition demanded by the recovery principle. On reviewing the various instruments which have been described, I cannot help thinking that this joint between the machine and the patient has proved a great difficulty, and, from my experience in dealing with it, there seems to be little doubt but that this detail has held up the development of this method from the beginning.

A very early conclusion reached by me was that the joint could not be maintained for the purposes of the principle by any means applied to the face. A mask might be necessary for induction, but other means would have to be used to maintain the closure of the system upon which the recovery principle depended.

Gas Supply Connected Directly with Pharynx

The obvious solution to this problem appeared to be the fitting of some tubular device into the pharynx immediately behind the tongue, the tube having an inflatable cuff or tyre at its free end for making contact with the pharyngeal wall upon distension. Experiment at once showed this to be quite feasible.

It was found that such a device, when made to correspond with the general configuration of the throat, filled the cavity completely, and, by being made to expand laterally, did not open the oesophagus as might be expected. When connected with the instrument this gas-tight joint was capable of withstanding all the higher pressures used, even up to 30 mm. Hg without leakage. This throat tube therefore provided the means for joining up the patient with the machine, and so fulfilled the condition of complete closure.

An outstanding difficulty in connexion with the making of this tube was to find the rubber which, in a tyre of the small size required, would stand the inflation often needed for capacious throats. Elasticity of rubber is apt to be variable, with the result that a weak spot may develop with use, and soon rupture. This difficulty threatened failure for a considerable time, but ultimately a suitable rubber was found, which was more than equal to the conditions imposed upon this small tyre, and the tube is now manufactured successfully by the India Tyre and Rubber Company of Inchinnan. The rubber used is

* Read in opening a discussion in the Section of Anaesthetics at the Annual Meeting of the British Medical Association, Bournemouth, 1934.

remarkably durable, and is capable of doing many dozens of cases; in fact, I have not yet reached the limit of durability of a single tube which is used for almost every one of my cases, and which is boiled after each occasion. This property of sterilization by boiling is unique for rubber, and of the utmost importance in the use of such an instrument.

Absorption of the Carbon Dioxide

Another matter requiring consideration was the most suitable method of absorbing the carbon dioxide. Generally speaking, there are two methods in use: (1) the granular or dry method, using a soda-lime compound, which operates most successfully as an absorbent in the various kinds of respirator, particularly those which have to be carried about on the person; and (2) absorption by means of a strong solution of caustic soda or potash. The latter method is impossible for use for most purposes, yet the special conditions of general anaesthesia make it the most suitable.

The solution is undisturbed during use, so that there is no danger of its escaping into different parts of the tubular system, and its avidity for carbon dioxide is high and very constant at all rates of breathing. It is also possible to apply a simple test to the solution to ascertain the need or otherwise for renewing it. This latter is a point of importance, particularly in hospital practice, where an anaesthetist may wish to use a machine, the absorbing capacity of which may be quite unknown to him. This estimation is a very uncertain matter with even the coloured granular absorbents when used occasionally as is the case with anaesthetic apparatus, and their use entails considerable waste under these circumstances.

Simple Method of Estimating Limit of Absorption

The devising of a suitable test for the limit of absorption of the liquid gave some concern, for the usual double titration method of estimating the increasing percentage of carbonate as it formed was quite unmanageable by the anaesthetist who wanted to use the machine without delay. The method also failed to operate after a little over 16 per cent. of carbonate was formed, for in the cold solution crystallization took up the excess over this figure. For the purposes of the anaesthetist it was necessary that a result be quickly arrived at by simply adding a sample of the absorbent to an indicating reagent of some kind. This was finally achieved by modifying the double titration method, and the test now consists of adding 1 c.cm. of absorbent to 1 c.cm. of 80 per cent. hydrochloric acid in water, using two drops of phenolphthalein as indicator. If the purple colour remains the solution may be used for at least two hours. If the colour is discharged the solution should be changed, although it is not actually exhausted.

This point of discharge was fixed arbitrarily by ascertaining when the absorbing solution allowed 3 per cent. of carbon dioxide to remain unabsorbed from exhaustion of the soda, and, considered along with the lowered metabolic activity of the average case during an anaesthesia, it provided a good margin against the point being overreached. The machine has also another means of dealing with such possible oversight. As the unabsorbed carbon dioxide accumulates along with the other gases the pressure in the system rises, and relief is given by the blow-off valve.

A Machine for Administering Closed Anaesthesia

A machine constructed according to the foregoing principles is exhibited here and known as "anaesthetor M 7." It represents the results to date of my investigations into the recovery or closed method of using the anaesthetic gases. It consists of a basal part, which is the absorbing tank, on the removable lid of which are

mounted the tubular and valve parts, sight-feeds, etc. In front are the two turret valves which interrupt the metal part of the respiratory tube for the purpose of diverting the breath through the ether chamber, absorbing tank, or both, or of directing it straight through to the breathing bag at the extreme left end of the tube. At this point also are seen the blow-off valve, which consists of a spring-loaded ball capable of adjustment, and also the nitrous oxide inlet. Behind are the sight-feeds for the anaesthetic gas and the oxygen; these are of simple design, for in the closed system there is no measuring or proportioning of the gases, since they do not flow as in the other methods. The stable nitrous oxide is an atmosphere like the nitrogen of the air, and is therefore absolute; oxygen is merely added to the requirements of the patient as these vary. The other fittings are, the ports to the ether chamber and the absorbing tank placed at either corner behind, and the level and levelling screws seen in front.

The lid is removable from the absorbing tank by undoing the six straining clips, and, when removed, reveals the shallow ether chamber and the baffle, which is fixed to its underside, and surrounded by four limiting walls. The baffle divides this box-like space equally but irregularly into two parts, each of which communicates with one of the two passages seen to lead up to the turret valve above. The free edge of this baffle is deeply serrated throughout its length by triangular serrations. These, along with the surface of the solution into which they dip almost entirely, constitute a device whereby a series of apertures is formed through which the breath has to pass as it moves through the machine. These triangular apertures vary in their size with the volume and the strength of the breath passing through them, and, being open below, cannot become occluded with crystals of carbonate as happens with round holes. It is the need for the even dipping of this baffle into the solution that necessitates the use of the level and levelling screws.

The absorbing tank works with one litre of solution, which may be made up in the tank by dissolving the contents of a 1 lb. tin of caustic soda in a sufficiency of water, and, when cool, filling up with water to the line marked on the inside. The baffle is arranged to work *only* with this amount, as it ensures effective absorption with the lowest resistance to the breathing. This quantity of solution keeps the unabsorbed carbon dioxide down to 1.5 per cent. for about eight hours, after which it slowly rises until the test gives indication that the 3 per cent. point is passed. Ten anaesthetic hours represents the usual range of absorption of this amount of solution.

The apparatus is connected with the patient by the corrugated rubber tube, which ends in a swivel-valved joint. To the rotating part of this joint can be attached a mask for induction purposes at one point, and the throat tube for the maintenance of the anaesthesia at the other, with, of course, provision for breathing to the air. Attached to a small nipple on the inside of this valved joint is the delivery tube from the oxygen sight-feed, which is seen to enter the side of the respirator tube. By this means oxygen is supplied directly to the mouth of the patient. A mouth prop of oval tubular pattern keeps the mouth open during induction for the passage of the throat tube at the proper time. This prop is held in place by the sponge rubber covering of the mask, so that it cannot be ejected by the patient as he "goes under." The throat tube is in two parts: a rustless steel oval wire coil fixed to a coupling, and a rubber tubular covering which is pulled over the coil and also fixed to the coupling by a rubber ring. The free end of the rubber tube shows the tyre from which the small inflating tube passes along one side to end in the strong pressure tube, to which the inflating bulb is attached when in use.

The Machine in Use

From what has already been said certain preliminaries are essential before attempting to use the machine. In the first place, the absorbent must be tested unless it is known that this is unnecessary: ether should show on the indicator seen through the glass top of the filler cap, and the gaseous supplies must be adequate and under complete control. When placed beside the operating table the instrument must be levelled by using the screws at each corner in front. A bagful of gas may now be admitted, and then forced through the absorbing tank by hand pressure to remove as much of the air as possible, and also any ether that may have been left from the previous case. The swivel valve at the end of the respirator tube allows of this "washing through" when set to either extreme position, but when set to "air" the machine is closed, and may now be filled with gas ready for use.

With the mouth prop in position, induction is effected with the mask. Breathing on "valves" is secured by having the absorber "on"; the small resistance so set up to expiration causes the breath to escape through an expiratory valve on the mask. Closing this valve stops the process. When induction is completed, with the use of a trace of ether when required, the throat tube, previously assembled, is fitted to the swivel valve, and, at a suitable moment, is swung round and inserted into the throat, where the small tyre completes the joint on being inflated. After this the nitrous oxide will be turned off unless raised pressure is required; the oxygen will be regulated to suit the requirements of the patient, and ether used to suit those of the surgeon; and in the average case the absorber will be turned "on."

When anaesthesia is established the first point to require attention will be the throat tube. It is necessary that the tyre be not over-distended, and to avoid this one finds the lowest sealing pressure. In one case over-distension which inadvertently occurred, and was allowed to continue, resulted in some pharyngitis, which, however, soon passed off, but the experience provided the lesson in its avoidance. The lowest sealing pressure is easily found by deflating the tyre until breath is heard to escape in the throat, when one pressure of the bulb will close the joint. The joint may be tested in this way once or twice during a lengthy anaesthesia; the muscles of the pharynx tend to relax as time goes on, and to accommodate themselves to the tyre more readily, so that, combined with lower pressure in the instrument, less distension is required in the tyre. Attention of this kind ensures the complete absence of pharyngeal irritation, even after prolonged anaesthesia. A special soapy lubricant made by Allen and Hanburys facilitates the insertion of this tube, but no oily or greasy matter should ever be used, as these substances attack the rubber very quickly.

When the closed system has been established and the patient is breathing quite clearly, relaxation—for example, of the abdominal muscles—will call for the use of ether. Along with this the pressure of the gases should be raised by admitting nitrous oxide up to pressure indication. This pressure may be as great as 20 mm. Hg, or even more in the case of a very strong man suffering from an acute upper abdominal lesion. Pressure greater than this usually stops breathing, however, especially as the ether takes rapid effect, and embarrassment to the breathing must be removed by lowering the pressure. With the production of relaxation the ether is discontinued, and the pressure maintained at about 10 mm. If further effect is required, say, to close the abdomen, it is better to add a little more ether than to use raised pressure again.

The further use of much ether or pressure is rarely called for owing to a peculiarity of the closed system. The ether that has been added to it in the early stages of an operation mostly remains in it, except for a little that is absorbed into the tissues. In many cases the ether tension in the patient's circulation and in the machine would appear to become stabilized and to remain uniform. The patient's vitality in these cases does not remain constant but diminishes, and in so doing makes him more susceptible to the etherized atmosphere. Relatively to the patient, therefore, the original effective dose of ether now becomes an overdose, as shown by the depressed breathing with inspiratory tugging of the chin and the dilating pupils.

This situation, so easily seen developing in such cases, is as easily dealt with and corrected. The breathing bag is emptied by hand pressure through the blow-off valve, and filled with fresh gas. Ether is exhaled into this gas, which may be renewed once or twice more at four- or five-minute intervals. Normal conditions are soon re-established, and a more definite gas-oxygen anaesthesia supervenes until the end of the operation.

This relative overdosage makes its appearance slowly, as a rule, and some time after the ether has been turned off. It seems to occur in patients of the nervous type, whose reserves of nerve energy are not great. In the stolid types of patient the ether used is absorbed to a much greater degree, so that light anaesthesia tends to supervene, with its vigorous breathing and smallish pupils. This lightness of anaesthesia may also be detected by turning on the ether full for one breath or so, when its irritating effect on the larynx produces a kind of grunting on expiration. A few breaths of ether stop this noise, and restore the deeper state of anaesthesia. Occasionally a patient may phonate continuously throughout a long anaesthesia, in spite of other signs of adequate depth.

In using the instrument conditions may arise in the patient which call for the closure of the absorber in order to accumulate carbon dioxide for purposes of stimulation. It is interesting to observe the restoration of blood pressure under these conditions, and the general improvement in vitality in enfeebled cases. The pressure gauge on the instrument gives a remarkable amount of information about the patient after one has become familiar with it. It indicates the fact of clear breathing by its steady movement to and fro on either side of the zero mark. When the absorber is switched on the needle vibrates at either end of its excursion, owing to the passage of the breath past the baffle. If the instrument is level, this disturbance is equal on either side. At normal pressure good breathing imparts a swing of about 10 mm. to the needle, so that one can form an idea of the respiratory vigour under most conditions. If overdose with ether begins to appear the negative side of the excursion representing inspiration will increase and be more active than the expiratory or positive excursion. This corresponds with the jerky inspiration previously referred to.

As regards metabolism, a very good relative idea as to its changes in the course of an anaesthesia is obtained from the visible amount of oxygen required to keep the complexion well coloured. Metabolism inevitably diminishes as an anaesthesia and operation proceed, and, of course, some patients show this more than others. The machine shows it through the pressure gauge. At the beginning of an operation a given supply of oxygen maintains a steady anaesthesia with steady carbon dioxide absorption, but it may be noticed after a little that the pressure of the system is gradually rising. This is due to the fact that in the closed method the oxygen supplied for metabolic purposes is not all being used up by the patient. It collects, and thereby raises the pressure of

the system. On cutting down the supply a little, the pressure returns to the previous reading. The use of ether, with depressing effect on the respiration, frequently shows this rise of pressure in the system. Finally, pressure must rise when the absorbent becomes exhausted or is put out of action for any length of time, but the ball-valve relieves this as previously explained.

Experience with the Closed System

The true criterion of the success or otherwise of any method is the general opinion based on actual experience of the use of that method. My experience of the closed system is based entirely upon the use of the instruments with which I have experimented; it is therefore necessarily limited, and my attitude towards the system may not be quite free from bias. It is unfortunate that experimental conditions do not allow of the distribution of such instruments, even among anaesthetists, in order to get a collective opinion. On this account I have frequently felt the want of collaboration with some of my colleagues, particularly on clinical matters. However, the experience I have gained will, I think, be of interest, and may incline others to turn to this field the attention that is necessary to develop it.

My experience with this machine, and one or two of its less successful predecessors, covers about 350 cases of the usual surgical type. Owing to the convenience of "receiving nights" at hospital for trying out this machine with its innumerable alterations, a great many of the cases were the usual urgent abdominal conditions—appendix, strangulated hernia, perforation of gastric and duodenal ulcers (usually in strong men), and the other odds and ends of a receiving night theatre. The management of such cases very soon showed the capacity of the instrument for dealing with them, and also its limitations.

Positive pressure, one might imagine, would so increase the solubility of nitrous oxide in the blood that its anaesthetic effect would be correspondingly enhanced. This, however, only takes place to a limited degree, merely producing an increased steadiness of the gaseous anaesthesia. Positive pressure does not profoundly deepen the anaesthesia with gas, but let it be used with ether and the strongest man very soon succumbs to its influence. For ordinary work, however, a pressure of 10 mm. is quite sufficient, and this may need to be reduced in some cases. Positive pressure reduces the amount of ether required for muscular relaxation. With this control over ether, it will be understood that difficulty in managing any acute case such as may occur when using an open anaesthetic does not arise, and this is one of the great advantages of the closed system.

Many of the patients were seriously ill, and constituted definite risks with the usual open anaesthetic; with this apparatus, however, they revived, or appeared to do so, on the table under the influence of their own carbon dioxide, which was collected for them by closing the absorber. The stimulated conditions so produced are apt to give a misleading idea as to the patient's true condition, but they may make a desperate operation possible, and so extend the patient's chances of recovery.

Two such cases are of interest in this respect. One was that of a man of 92 with a perforation of a large simple duodenal ulcer. Owing to contraindications to other methods, gas-oxygen was asked for. It so happened that this apparatus with its throat tube was not available at the time; the ordinary apparatus was rendered useless owing to the patient having a profuse beard, and the usual open anaesthetic using some chloroform was resorted to finally. Everything went well with him for the first four days, when his heart began to fail. It was believed that here was a case in which this closed apparatus with its

throat tube would have turned the balance towards a more successful issue. The other case was of a woman of 53, acutely ill from gangrene of part of the small gut. After a rapid anastomosis, ten feet of bowel were removed, and in spite of the usual surgical experience of this condition, the patient survived. It was believed of this case that the patient would not have survived with an open anaesthetic.

The experience of routine surgical cases covers some of considerable length; two, each lasting two and a quarter hours, are notable. One was of a difficult gastrectomy, and the other of an extensive bone graft; both patients did very well. Other cases were of the usual duration—for example, gastro-enterostomies, gall-bladder cases, and the various operations of the lower abdomen, including an abdomino-perineal excision of the rectum. The instrument has also been used for operations on the kidney, breast, and thyroid gland. In toxic cases of the latter reliance should not be placed entirely upon a general anaesthetic, some infiltration being desirable. Nasal operations are successfully dealt with, as the throat tube occludes the pharynx and remains out of the operator's way.

So far as one can see the effects of the method upon the patient are not markedly different from those produced by the other methods. Recovery is quiet and remarkably free from sickness, especially when nembutal is used. It is to be noticed, however, that an opiate as a preliminary drug provides calmer respiratory movements than does the barbiturate, and so may be preferred by some abdominal surgeons. An excessive dose of an opiate should be avoided, for a general anaesthetic may develop its power to a toxic degree, as shown by depressed respiration and sighing, which may last from some hours to two or three days. Such extreme medication is quite suited to the use of spinal and local anaesthetics.

The other aspect of the closed system upon which I may comment is its economics. In this field the closed system is quite supreme. The use of gas-recovery makes it possible to carry out up to thirty cases with 100 gallons of nitrous oxide, as was found when the working costs of the principle were under consideration. Oxygen, of course, is used continuously, but as none can be wasted during anaesthesia on account of the closure of the system, only the smallest amount required for the purposes of metabolism is used. Taking the above thirty cases as generally representing twenty-five hours' anaesthesia, the oxygen required for them amounted to about ten cubic feet. The ether works out at about twelve cases to the pound, but this figure must necessarily vary. The other commodity required is caustic soda. One pound lasts about ten anaesthetic hours, as compared with granular absorbents, which last about half this time.

From these facts there can be no question as to the difference between the recovery principle and the "flow" principle, and with the greater flexibility of the former as a result of the use of the throat tube, a method of using the gaseous anaesthetics is now available which it will be most advantageous to develop.

Conclusion

The advantages of the closed system may be briefly summed up. As a method of using an anaesthetic gas such as nitrous oxide there is some improvement in the steadiness of the anaesthesia, and a little more oxygen is permissible in the average case. One cannot say that the anaesthetic effect of the gas is greatly exalted, even with positive pressure. The need for ether still leaves us with the desire for a more potent gas, and in this connexion we are beginning to hear of one, cyclopropane. The employment of positive pressure is a great advantage, but its use is limited.

With the closed method less ether is required per case, since to a very great extent it is retained within the system, where it quickly becomes warmed. The use of the throat tube, while making the system workable, assures a clear and adequate airway in any position in which the patient may be placed, and also prevents saliva and other matter from reaching the lower air passages. The anaesthesia is conspicuously dry, even where atropine has been omitted and saliva has flowed profusely. The use of the tube extends the scope of surgery to the head and face, including the teeth.

The apparatus used is compact and light, easily handled, and simply constructed. There are no fine adjustments to become deranged. The working costs are the lowest possible, as consumption of anaesthetic gas is independent

of the duration of the anaesthesia, being estimated at so much per case. Where working costs have to be considered, as in most hospitals, the recovery principle provides the usual gas-oxygen anaesthesia for less than the cost of open anaesthetics in cases of average duration. The necessary apparatus and supplies are easily portable.

Reviewing the position as it appears to me from a limited experience of this closed system of anaesthesia, I think we have gained access to a new field of anaesthetic administration sighted by others a long time ago. We must now set about its exploration by developing apparatus and technique, and, with the possibility of finding newer and more potent anaesthetic agents, no one can say what further advantages the closed system has to give.

X-RAY TREATMENT OF DISEASES OF THE GENITO-URINARY SYSTEM*

BY

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The x-ray treatment of diseases of the genito-urinary system is a somewhat wide subject, and one that cannot be dealt with adequately in the time at my disposal. It is a little difficult to decide where to begin, but it will be well perhaps, in the first instance, to say a few words about technique.

Unit Skin Dose

There is still a good deal of controversy and confusion as to what is implied by a unit skin dose—a skin erythema dose; the number of r units which represent these doses, etc., so many factors, and the grade of erythema produced varying considerably in different clinics. All this is too controversial to enter into in this short communication; nevertheless, it is advisable for me to give some idea of what I am talking about when I refer to an erythema dose. Personally, I mean a dose which, when applied to the skin of the abdomen of an adult, produces a slight redness within three weeks after the application, followed by some bronzing or pigmentation of the skin, but no desquamation. This is at least 25 per cent. less than that often given and described by many as an erythema dose, and may perhaps be described as the mild or minimal.

After some thirty years' experience, however, I have been much impressed by the importance of preserving the integrity of the skin, and would rather limit the skin dose and increase the number of ports of entry wherever possible than run the risk of causing damage. I am well aware that this is not always possible, and there are cases where the dose mentioned may have to be exceeded, but one must be careful not to produce a cure which is worse than the disease, many such having come under my notice. I know that those who advocate a so-called epidermicidal dose say that complete repair takes place; but is this permanent? I doubt it, as most patients so treated do not live long enough to tell the tale. There may be those here, however, who may be able to show that I am wrong.

The dose I have mentioned, if applied at a single sitting, in a certain time, at a certain distance, and at a certain kilovoltage, is a fairly definite one, and is what is implied when I refer to a unit skin dose in this paper; if spread over several days the total exposure required to produce the same effect will be greater. Levitt has stated that a 100 per cent. dose given in one day if spread over

one week would require 150 per cent., and spread over a fortnight some 220 per cent. to produce the same effect. From my own observations I would say that this is a fairly accurate estimate, and important to remember when mapping out a dose that has to be spread over an interval of time. Different diseases require different techniques in order to obtain the best results, and having decided on what is likely to be the most beneficial dose in a certain case, the next thing to consider is the best way to administer it, and we have various techniques to choose from.

Fractional Dose

This is by far the oldest method, and is still largely used, chiefly in the treatment of benign conditions. It consists in giving fractional doses of one-third to four-fifths or so of the unit skin dose at intervals of a few days, a week, or longer, and kept up, in some cases, for a considerable period of time.

Single Massive Dose

This method created a great stir when it was first introduced into this country, and some very exaggerated claims were made for it, which were not substantiated. Its aim is to apply uniformly throughout a malignant growth the largest dose which the tissues will tolerate, the whole dose being given in one day. I tried the method when it was first introduced, in a few cases of malignant prostate, but very quickly abandoned it on account of the practically constant, and often somewhat alarming, constitutional upset which resulted. It still has certain uses, as in the treatment of rodent ulcer, etc., but not, to my mind, in any disease of the genito-urinary system.

Divided or Split Dose

This is a modification of the preceding method. The dose, instead of being given in one day, is spread over an interval of time, at daily or two-day intervals, according to circumstances; and here it must be remembered, as I have already pointed out, that the actual dose given at each exposure will depend upon the time over which the treatment is to be spread. This is the method I consider to be the most suitable in the majority of cases.

Saturation Method

The saturation method is one I have never used. Its aim is, after a maximum dose has been given, to keep up the effect by giving further daily doses of some 15 per cent. of the unit skin dose for several days.

Protracted Fractional Dose Technique (Coutard)

This method is also one of which I have no personal experience. Malignant genital tumours so treated have been reported by Schumacher, who states that although

* Read in opening a discussion in the Section of Radiology and Electrotherapeutics at the Annual Meeting of the British Medical Association, Bournemouth, 1934.