RECENT ADVANCES IN ANAESTHETICS *

BY

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There are three main types of anaesthesia in use to-day: (1) inhalation combined with premedication, (2) spinal combined with premedication, and (3) intravenous, with or without premedication. I will deal with them in this order.

Before considering the anaesthetics themselves it is advisable to stress an important point—namely, that all patients who are to undergo a major surgical operation ought to be carefully investigated. This should include a blood and urine analysis, in addition to a general clinical examination. Special attention is paid to the blood pressure and the Moot-McKesson cardiac energy index. The formula for this index provides an approximate index to the cardiac reserve.

$$\text{Moot's index} = \frac{\text{pulse pressure} \times 100}{\text{diastolic pressure}} = 50 \text{ (in normal subjects)}$$

Patients presenting an index of between 40 and 60 show ample cardiac reserve; those in whom the index lies between 25 and 40, or between 60 and 75, have probably adequate cardiac reserve, whilst the reserve is gravely inadequate in those having an index below 25 or above 75. (This index is unreliable in cases of thyrotoxicosis, owing to the high pulse pressure.) No enemata, purges, or any other form of dehydration should be permitted for at least forty-eight hours before any major operation. The patient is supplied with ample fluids and glucose, and everything is done to ensure that his general condition is the best the pathological state allows.

Inhalation Anaesthesia with Premedication

The public has lately become aware of the tremendous advantages which are derived from being put to sleep in their own beds, and many patients more or less demand some drug that will bring about complete oblivion before any type of operation. For this purpose the chief drugs that we have at our disposal are as follows. First, the popular barbiturate group, which includes nembutal, sodium amytal, pernocton, medinal, di-dial, and the latest—evipan. All these may be given intravenously except medinal, and all may be administered orally except pernocton. Evipan appears to be the least toxic of all the barbiturates. The next group consists of drugs administered per rectum, such as avertin, paraldehyde, and ether-olive-oil emulsion.

It is possible to produce a mild surgical anaesthesia with any of these drugs, and they may be used either as premedication to inhalation anaesthesia or as the total anaesthetic. For the latter purpose, however, large doses must be given, and toxic effects are apparent. Headaches, nausea, and vomiting have been reported following the use of all these drugs—complications which have rarely been seen when evipan has been the sole general anaesthetic. With evipan, induction and return to consciousness are much more rapid than with any other barbiturate, and if reasonable care is used it does not appear possible to give a fatal dose. Patients generally prefer an intravenous injection to either a rectal or inhalation anaesthetic. A combination which has proved efficacious over a very large number of cases is that of omnopon and scopolamine, the dose varying according to

age. The routine dose is omnopon 2/3 grain, scopolamine 1/150 grain, and these amounts may be given to patients between the ages of 16 and 65. It is fairly easy to produce the desired effect with any of the drugs mentioned above, and each has its merits.

In my opinion the best type of inhalation anaesthetic to use after them is nitrous oxide and oxygen. This is best given at varied pressures with an apparatus such as the McKesson.

Before and during the war the most popular anaesthetics were chloroform and ether. Why, one asks, have they fallen into disuse with up-to-date anaesthetists? It is on account of the complications which frequently follow their administration to dangerously ill patients. The complications following chloroform and ether are many and well known. They are: delayed chloroform poisoning, sudden collapse or status lymphaticus, chest complications, bronchitis, bronchial pneumonia, lobar pneumonia, pulmonary collapse, paralytic ileus, post-operative vomiting, and shock. It became essential to find another anaesthetic which would reduce these complications, particularly the shock. Nitrous oxide and oxygen, combined with only small amounts of ether, was the result.

ADVANTAGES OF N₂O-OXYGEN AS AN INHALANT

The use of nitrous oxide and oxygen considerably lessens the incidence of the complications described above. Its particular advantages are as follows.

1. It is the safest and the least toxic of all general anaesthetics, and there is therefore little sensitization of the tissues to surgical shock. It is pleasant for the patient at the time of induction, even if little or no premedication has been given, while sufficiently large doses of narcotics may with safety be given beforehand, so that after the operation the patient cannot remember that he was removed from his bed.
2. Surgical relaxation is quickly obtained when required.
3. Operations with the diathermy knife can be done with absolute safety.
4. Bodily functions are scarcely interfered with, and the clinical state is not aggravated.
5. The most desperate cases may be operated upon with comparative safety so far as the anaesthetic is concerned.
6. Dangerous signs of an overdose are conspicuous enough to give timely warning, and the respiratory centre remains responsive until late.
7. In the absence of premedication, recovery of consciousness and rational control is almost immediate, even after prolonged administration.
8. The after-effects are conspicuous by their absence. There is never any vomiting, except when it is caused by other conditions, and so thirst may be quenched and nourishment taken soon after the operation.
9. The anaesthetic may with safety be repeated many times at short or long intervals.
10. The stay in hospital is shortened and the convalescent period is reduced.

The advantages of the McKesson apparatus are as follows.

1. It delivers the mixture at the percentage desired, whether the breathing is shallow or deep, whether re-breathing is employed or not, and whether the pressure of the gases is high or low.
2. The percentage of oxygen can be varied accurately, definitely, and simply.
3. Rebreathing can be employed at all pressures.
4. The pressure at which the gases are delivered can easily be varied at will without disturbing the percentage of oxygen in the mixture.

* Read before the Chelsea Clinical Society and the Watford Division of the British Medical Association.

The scope of nitrous-oxide-oxygen anaesthesia is unlimited. By means of the ordinary facepiece any operation may be performed, though spinal analgesia gives a better relaxation for abdominal work. In order to exteriorize the larynx a transnasal intratracheal tube may be passed, which prevents anything from going down into the trachea or a bronchus. A direct intratracheal tube may be passed for nasal operations, and the field of operation can be completely closed off and the patient entirely covered without any danger whatsoever. Dental operations and tonsillectomy can also be done with safety. Further, this form of anaesthesia is extremely valuable in all cases of midwifery, whether it be a natural delivery, a forceps case, or a Caesarean section. It can be given intermittently during the first two stages, and continuously for the third. The uterine contractions are actually strengthened, thus shortening the time of labour. The mother's condition is definitely better than when chloroform is used, and the baby is not affected in any way, and usually cries as soon as it is born.

OTHER INHALANTS

Apart from nitrous oxide, there are two other gases that are in use to-day. One, ethylene, has been employed for some years; the other, a new gas called cyclopropane, is in the process of being investigated.

Ethylene has had many advocates, but owing to its unpleasant odour and the possibility of an explosion it has not come into general use. The great advantage of this gas is that it gives a deeper and quieter anaesthesia than nitrous oxide and oxygen alone, and enables a higher percentage of oxygen to be given.

Cyclopropane (trimethylene) is a hydrocarbon gas, an isomer of ethylene. It produces an anaesthesia as deep as that from ether, and the induction and return to consciousness are as quick as is the case with nitrous oxide. It is extremely potent, and oxygen from 75 to 90 per cent. has to be given with it. As yet only one cylinder of this gas has to my knowledge been used in this country, and it is difficult, therefore, to give an opinion on it; but so far as one can see it has real possibilities. A full report has been made by its users at the University of Wisconsin Medical School, U.S.A.

Spinal Analgesia with Premedication

With spinal analgesia I usually employ omnopon and scopolamine premedication, and sometimes supplement this with evipan. The advantages of a spinal anaesthetic are as follows: (1) it can be employed in certain cases where an inhalation anaesthetic must be avoided; (2) it produces a complete anoci-association—that is, cutting off of all apparent pain impulses—and it provides an adequate relaxation in abdominal surgery; (3) as spinal analgesia does not increase the sensitization of the tissues with histamine, the resulting shock to the patient is considerably less than with an inhalation anaesthetic such as ether or chloroform.

There are, however, certain disadvantages as well—namely: headaches, which occur in 1 per cent. of cases; pain in the back (0.02 per cent.); severe nausea and vomiting (0.5 per cent.); paralysis (0.01 per cent.); and sudden collapse (0.01 per cent.). There is also a definite fall in blood pressure, and this varies with different types of patient.

THE SOLUTION

The solution I prefer for a spinal analgesic is percaine, though I have also used stovaine, spinocain, etc. Percaine is the least toxic of the preparations. Its effect

upon the blood pressure is considerably less than that of any other spinal analgesic, while, as it has a prolonged and lasting effect covering from one to three hours, the surgeon need not work against time. A high abdominal anaesthesia can be produced with a maximum of safety, and the same solution may be used to infiltrate the skin before introducing the intrathecal needle. The anaesthesia is so enduring that the patient is free from pain for from six to twelve hours after the operation, and the amount of narcotics required is thus minimized. This is particularly valuable with piles and operations on the perineum, and others that give a great deal of discomfort. Finally, a smaller number of headaches occur than is the case when stovaine, etc., are used.

Percaine is used in two strengths—the dilute (20 c.cm. of a 1 in 1,500 solution) and the strong (2.3 c.cm. of a 1 in 200 solution). The dilute solution is being used more often than the other, and this is the one I employ myself for all types of operation, though the stronger is most useful for operations of the perineum, etc., where small doses from 0.6 c.cm. upwards to the full dose may be given.

Operations such as removal of piles, cystoscopy, and prostatectomy may be done with this strong solution with ease. It may be given either in the lateral or the upright position, and the operation can be proceeded with almost at once. Certain operators mix this solution with the spinal fluid, but this course is not necessary unless one requires anaesthesia at a slightly higher level than that of the crest of the ilium.

TECHNIQUE OF ADMINISTRATION

There are two quite different methods of administering the dilute solution. The one most frequently used is known as the Howard Jones technique; the second, which has only recently been brought to notice, is the Etherington Wilson technique. I have used the former for my last 1,200 cases, and it is performed as follows:

One hour before the operation the patient is given the routine premedication of omnopon 2/3 grain and scopolamine 1/150 grain. When he is brought into the theatre or anaesthetic room he is put into the lateral decubitus, and the skin and the tissues down to the spinal column are infiltrated before the spinal needle is inserted into the third lumbar space. This needle is one of fine calibre, and the fluid is allowed to drip from it in order to ensure that it has penetrated to the spinal theca; the percaine solution, having been heated to blood heat, is slowly introduced with a syringe into the canal. The quantity varies with the upward extent of analgesia required. For low abdominal operations 10 c.cm. are necessary, for medium 12 c.cm., and for high 15 or 16 c.cm. After the needle has been withdrawn the patient is immediately turned on his face, and the table tilted into 15 degrees Trendelenburg. After six minutes he is turned over on to his back, and the operation proceeds. No further anaesthetic is necessary, but if for any reason it is desired to have the patient unconscious gas and oxygen may be given throughout the operation. When the operation is over he is kept in the slight Trendelenburg position for some hours in order to avoid the complications that may occur after any spinal anaesthetic. This is effected by raising the foot of the bed on high blocks for eight hours, then on low blocks for eight hours. The patient is finally kept supine for the same length of time, after which he may be slowly raised into the sitting position. In cases of necessity Fowler's position may be assumed gradually three hours after the injection.

Etherington Wilson's technique differs from that described above in that the injection is given in the upright sitting position. After the commencement of the injection this position is maintained for twenty-five seconds to produce anaesthesia up to and including the perineum and hypogastrium, for thirty seconds for the level of the umbilicus,

and for forty seconds to reach the epigastrium. The patient is immediately laid on his back in the 15 degrees Trendelenburg position, and the operation may begin at the end of seven minutes. This technique is the method of choice for pregnancy, for patients with large abdominal tumours, and for similar cases.

Intravenous Injections

This is the third and most recent method of producing a general anaesthesia. I have been using evipan over a period of twelve months, and for upwards of 1,000 cases. It may be used as a form of premedication, followed by either gas and oxygen or a spinal anaesthetic, or it may be used by itself as a general anaesthetic. There are two distinct types of case for which this anaesthetic may be employed.

SHORT ANAESTHESIA WITH EVIPAN

It is useful for operations in the out-patient department, where anaesthesia is only required for a moment or two. No premedication is necessary or desirable here, and only the minimum dose of evipan should be used. There is no need to withhold food, or to wait until three or four hours have elapsed since the last meal. The dose of evipan injected intravenously is from 2.5 to 5 c.cm. The operations which are commonly performed under this minimum dose are: dental extractions, the opening of abscesses, whitlows, etc., the removal of nails and specimens for biopsy, and any similar procedures in out-patient work where anaesthesia from thirty seconds to a few minutes is required. The operation should be commenced immediately the patient is unconscious, and everything should be quite ready before the injection is begun. If no more than the minimum dose is injected the patient is "round" in two or three minutes. He is allowed to rest on a couch or chair for from twenty to thirty minutes, and is then able to go home, preferably with attendance. If, however, more than the minimum dose has been injected a longer period must be allowed for recovery, and it will be necessary to have a friend to see him home safely.

Technique

The first 2.5 or 3 c.cm. is injected fairly quickly (five to ten seconds), and a pause of about thirty seconds (which is the normal time for the complete circulation of the blood) is then allowed. At the end of this time unconsciousness usually takes place. If not, a further 2 to 3 c.cm. is injected, and the minor operation is performed. The patient regains consciousness almost as quickly as he went under. If the injection is steadily continued after the first 2 or 3 c.cm. without any pause, a further 3 or 4 c.cm. will be injected before unconsciousness supervenes. This means that the patient gets double, or more than double, the minimum dose; unconsciousness lasts from ten to twenty minutes, a longer time is needed in the recumbent position for recovery, and the patient is more apt to pass into a sort of drunken state, and for a longer period, than if a smaller dose had been used.

EVIPAN ANAESTHESIA WITH PREMEDICATION

For in-patients evipan may be combined with premedication, so that before the patient is removed to the theatre complete oblivion, or at any rate somnolence, is produced to eliminate all psychic shock, permit any necessary preparations for the operation to be made without the patient's knowledge, and provide a peaceful sleep for some hours afterwards.

In order to ensure successful anaesthesia with evipan I use my routine premedication method of omnopon and scopolamine. This produces a satisfactory state of somnolence. The Hoffman-La Roche preparation, containing omnopon 2/3 grain and scopolamine 1/150 grain, I

have found most reliable for all patients between the ages of 16 and 70. Half this dose may be given to a large child or elder person. The preparation contains the laevorotatory scopolamine, which is the sedative alkaloid of hyoscyne, and does not include the stimulating dextrorotatory alkaloid. The injection is given one hour before the operation. The patient is then left quietly in a darkened room, or with a bandage round his eyes, in order to encourage sleep. The majority of patients are quite unconscious by the time they reach the theatre. Among private patients, when this state of affairs has been promised and is not attained, an injection of evipan is given one hour after the premedication, with the patient still in bed. He is then transported to the operating table, and a further injection of evipan is given for all but short operations.

DOSAGE AND GENERAL INDICATIONS

For minor operations upon in-patients a full dose of evipan (1 gram dissolved in 10.5 c.cm. sterile water) may be given without premedication, or combined with omnopon and scopolamine, one hour before. Evipan is without doubt very useful in cases of manipulation of the back, shoulder, knee-joints, or ankle-joints; complete relaxation is obtained, especially if omnopon and scopolamine have been given previously. For major operations, as I have already said, evipan may be used as a total, as well as a basal, anaesthetic. When used as a total anaesthetic the full dose may be repeated as often as required during the operation. For a strong, healthy young adult it has often been found necessary to repeat the full dose within a few minutes. But in younger and older patients it seldom becomes necessary under twenty to thirty minutes. The maximum number of times I have repeated the injection has been four, over a period of two hours.

As already stated, evipan may be used as a basal narcotic, preferably after omnopon and scopolamine; it may be given to render the patient unconscious before being taken from his bed, or for the injection of a spinal analgesic, or for the passage of an endotracheal tube. As a subsequent inhalation anaesthetic, nothing should be given but nitrous oxide and oxygen, the use of either chloroform or ether being avoided, these drugs not only being dangerous in themselves, but notoriously more so in combination with barbiturates. For example, for such operations as gastrectomy, cholecystectomy, hysterectomy, rectectomy, etc., evipan is frequently used after the premedication, a spinal anaesthetic then being administered; and later, in order to maintain unconsciousness throughout the whole period of operation, the dose of evipan is repeated or anaesthesia is continued with nitrous oxide and oxygen by means of the McKesson apparatus. Where a closure of the upper air passages is indicated, anaesthesia should be produced with evipan, and the intratracheal tube passed transnasally, anaesthesia being continued if and when necessary with more evipan or with N_2O and O_2 .

CONTRAINDICATIONS OF EVIPAN

There are certain contraindications to the use of evipan. It is metabolized in the liver very rapidly, and any gross disease of this organ, or the presence of jaundice, should definitely preclude its employment. General feebleness of the patient and low blood pressure, or low Moot-McKesson ratio, are also contraindications, because evipan does cause a definite, though temporary, fall in blood pressure. Again, it is felt that the upright position is another contraindication to the use of large doses of the drug, on account of this sudden fall in blood pressure.

It is therefore advisable that for dental extractions, etc., the patient should be lying down and not upright. (Lack of available space only applies to institutions where large numbers of cases are to be dealt with, and where sufficient room is not available to allow all patients to recover sufficiently to be able to proceed home. This question does not arise in the in-patient department.) Lastly, it is not advisable to give evipan to patients who have already had other barbiturates as premedication. Slow recovery and prolonged depression of respiration and blood pressure have only occurred in patients who have been given nembutal previously.

SOME DANGERS AND DIFFICULTIES

The Jaw.—In from fifteen to twenty-five seconds after the administration of evipan the patient is completely unconscious, and the first phenomenon to be observed is the dropping of the jaw. An attendant should always be present to see that this is not allowed to happen, and to maintain an adequate airway. Dropping of the jaw may be partly avoided by the patient's head being to one side, and the jaw is more easily supported if the patient has a small dental prop between his teeth. The airway is always completely maintained if a rubber (Phillips's) airway is inserted into the pharynx immediately unconsciousness takes place. It cannot be too strongly emphasized that the danger of allowing the jaw to fall and the tongue to drop back, thereby causing obstruction of the air passage, is a most serious one, and must never be allowed to occur. Evipan should therefore only be administered single-handed in the most unusual circumstances.

Blood Pressure.—A fall of some 20 per cent. or even more in the blood pressure always occurs. This is both systolic and diastolic. In my experience it has produced no deleterious immediate effects or after-effects, but I have not used evipan for patients with a low blood pressure, as trouble can be expected, especially if old and feeble persons are anaesthetized in the sitting posture.

Respiration.—A similar depression of respiration occurs, but again this is very transient, and provided the airway is maintained should cause no alarm.

Restlessness and Twitchings.—Slight involuntary movements and tremors occasionally take place. These are never gross, but are a little disconcerting to the beginner working with evipan. They very seldom happen if the premedication described above has been given beforehand, and they are readily overcome by a further injection of from 5 to 10 c.cm. of evipan.

Signs of Drunkenness.—Patients who have been given more than the minimum dose and allowed to go home when they had apparently recovered have been known to exhibit signs of drunkenness in the street. If more than 3 c.cm. have been given, ample time must be allowed for recovery to take place, and a comrade should see the patient home.

After-effects.—I have had no deaths following the use of evipan in over 1,000 cases. Careless nursing and failure to maintain an airway after the patient's return to bed have given me some minutes' anxiety in a few cases in my earlier experience. No pathological process appears to have been aggravated, though restlessness has been very marked in some dozen instances—all, I think, in the highly strung type. A definite though very small proportion of patients are found to vomit after the use of any opium derivative. I feel that the very small proportion, about 1 per cent., of patients who have vomited after evipan is not greater than the proportion who vomit after the use of an opiate alone. No case that has

had evipan alone—that is, without premedication—has vomited.

Antidotes.—The antidotes for evipan do not differ from those for any other form of general anaesthetic, nor are they more often needed. During collapse coramine is by far the most reliable drug for general purposes, but it must be used liberally; 5 c.cm. should be the average dose, and 10 c.cm. may be given quite readily for any general collapse. Recently I have been trying the effect of icoral and picrotoxin, which appear to be even more potent general stimulants than coramine. For simple respiratory failure from whatever cause alfalobeline is the only drug causing direct respiratory stimulation. A dose of 3/20 grain, or even twice that amount, may be given intravenously for rapid action, or, for slow action, subcutaneously. The other direct respiratory stimulant is carbon dioxide. It should be given, if possible, under pressure, in a mixture consisting of 7.5 per cent. carbon dioxide with oxygen. Cylinders of these gases in the above proportions should be in every operation room and every recovery room. Incidentally, they should be carried on every fire-engine, and found in every first-aid box—especially on river banks and in lifeboats. I regret to say that there are, as yet, very few doctors' surgeries or nursing homes which have them.

Conclusions

I believe the best modern anaesthetic to be nitrous oxide and oxygen, which is administered most successfully by the McKesson apparatus, without the use of ether or chloroform, and which is best preceded by omnopon and scopolamine as premedication. Where it is essential that no drop in blood pressure should occur, nitrous oxide and oxygen is the general anaesthetic of choice. Similarly, where instantaneous recovery is desirable it is extremely valuable. This form of anaesthesia allows full premedication, so ensuring a complete absence of psychic shock; it is not followed by vomiting, and it does not aggravate any pathological condition present.

Surgical cases of already established pulmonary disease can be dealt with without any form of inhalation anaesthesia, and for many of these evipan has proved ideal. No expensive or heavy apparatus is required, though it is strongly advisable always to have at hand a positive pressure apparatus for the administration of CO₂ and O₂, or nitrous oxide and oxygen. It must be remembered that, except in a few centres, it is difficult to get a good nitrous-oxide-oxygen anaesthesia, or even to avoid ether or chloroform. Chloroform, I believe, should never be used at all, and ether only in extraordinarily rare circumstances.

The council of the Royal Sanitary Institute, London, has decided to offer for award annually a challenge shield for the best celebration of Health Week in the Empire, outside the British Isles. In view of the great interest which was taken by the late Professor Bostock Hill in the Health Week movement from the date of its inception, the challenge shield will be known as the "Bostock Hill Memorial." The date fixed for Health Week this year is October 7th to 13th, and over-seas centres wishing to enter the competition for the shield must submit, by December 31st, 1934, full programmes and reports of any celebration held.

The Istituto Ortopedico Rizzoli in Bologna announces a competition for the prize Umberto I for the best orthopaedic work or invention. This prize of 3,500 lire will be awarded according to the decision of the Provincial Council. Italian and foreign doctors may take part in the competition, which closes on December 31st, 1934. Copies of the regulations may be had from the president of the Rizzoli Institute. Bologna.