

disregarded by modern surgeons. Of the remedies recommended there are few which have survived to the present day. Diacodium, or syrup of poppies, was a remedy held in great repute by Sydenham, who, in his account of the epidemic disease from 1675 to 1680, says—"Though I have used liquid laudanum for many years with good success, yet I think diacodium is to be preferred before it." In regard to the other remedies, most of them have fallen into disuse by the profession, but some of them, such as mallow, comfrey, etc., are still held in great repute as domestic remedies.

THE USE OF ETHYL CHLORIDE AS A GENERAL ANÆSTHETIC.

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ETHYL CHLORIDE has for many years been known to the profession as a local anæsthetic agent, under its own and various proprietary names, such as "Anestile."

During the past few years, however, it has come before us in a new guise, namely, that of a general anæsthetic, and in this country more particularly during the past twelve months. As far back as 1851, Snow used it to some extent for general anæsthesia; Heyfelder⁽¹⁾ about the same date, and later, Sir B. W. Richardson⁽²⁾ and Clover experimented with it, the last-named anæsthetist recording a series of cases.

Why its use was then abandoned is difficult to say, but it seems to have shared the disrepute and desuetude of the once much-vaunted dichloride of ethidene⁽³⁾ (a very unstable compound), and it fell to the dental profession, to members of which we owe at least two other valuable anæsthetics,¹ to further experiment with and ascertain the properties of chlorethyl, and to lay the merits of this anæsthetic before the dental and surgical profession at large.

In 1895-96, Carlson⁽⁴⁾, Director of the Dental Institute, Gothenburg, showed that in certain cases, where local anæsthesia of the gums was produced for tooth extraction, the patient became quite unconscious, and he rightly concluded that this was due to inhalation of the vaporised drug. Then Thiesing⁽⁵⁾ and Billeter purposely used it as a general anæsthetic—by inhalation—and obtained good results. Soulier of Lyons and Lotheissen⁽⁶⁾ of Innspruck, and other surgeons, followed suit, and during the next two years several thousand cases were recorded and favourably commented on in the continental dental and surgical journals. The anæsthetic was loyally used in the clinic of v. Hacker at

¹ Horace Wells, Nitrous Oxide; W. T. Morton, Ether.

Innsbruck, and extensive operations rendered painless by means of it.

Gastrostomies, colostomies, herniotomies, tenotomies, operations for piles, and fistula ani, and cancer of the breast, were performed, and fractures and dislocations reduced.

In July 1892, Wood and Cerna (7) of Pennsylvania published conclusions which they came to in regard to the physiological action of the drug, from experiments on animals, and, among other things, stated that the blood pressure was lowered and pulse slowed.

This conclusion was later shown to be erroneous by Ruegg of Basle, who, while admitting that primarily, and especially on the application of a dilute vapour of chloethyl, some widening of the vascular calibre occurred, occasioning a slight fall of blood pressure, but increase of vapour strength, immediately counteracted by increase of the heart's action.

We know that much the same occurs with chloroform, and that a further fall of blood pressure only occurs when toxic doses are given, or from secondary causes.

In 1901-3, Dr. W. J. M'Cardie (8) published several very interesting articles and translations in the English medical journals drawing attention to the value of the anæsthetic. During the past year demonstrations given throughout the kingdom by those interested in "Somnoforme" have drawn much attention to the "volatile anæsthetics," and increased the use of ethyl chloride especially.

Physiological action.—Ethyl chloride causes quickening and deepening of the respirations, with at first slight decrease and then increase of the cardiac pulsations; arterial pressure is raised, and the normal vascular tone stimulated during narcosis. The sphygmographic tracing below shows the change very markedly.

The patient's colour improves from the vasomotor dilatation, and sweating is sometimes noticed.

A slight rash is occasionally seen to appear on the upper part of the body, similar to the rash caused by ether inhalation in certain patients. If an adequate amount of air be not admitted, during the course of the narcosis, the arterial pressure will soon fall, and respiration and then circulation become arrested.

The kidneys are practically unaffected by ethyl chloride, although on two occasions a very slight amount of albumin was found in patient's urine; but in each case it was quite transient.

In some of the Paris hospitals, jaundice has been found to occur in a small number of cases.

Ethyl chloride is absorbed and eliminated with extraordinary rapidity, and this is a great factor for safety. There is practically no possibility of a cumulative effect. The first symptom of overdose is respiratory spasm, and followed by arrest. The slowing or cessation of breathing results in decrease or cessation of absorption,

while the commencement of artificial respiration brings back the patient to the normal.

Chemical characters of ethyl chloride, or E. dichloride, also known as "Chlorethyl," "Salzather" (Germany).—The chemical formula is C_2H_5Cl .

It is a colourless, highly volatile liquid, with a sweetish taste, and not unpleasant but rather penetrating odour, suggestive of Roman hyacinths. It evaporates at ordinary temperatures without residue. It is very combustible, and burns with a green flame, setting free hydrochloric acid.

It keeps well, and has no tendency to undergo decomposition or chemical change.

Inhalers.—There are many varieties of inhalers for this drug now on the market. More than one of them is termed "The Ideal," but I cannot say I think that happy stage has yet been reached.

What is needed, in brief, is a face-piece, a 1-gallon rubber bag (preferably with a fairly wide mouth, and so capable of inversion), and an angle junction tube for the two, with some aperture or means of getting the desired quantity of the anæsthetic into the bag. To any one familiar with Clover's and Ormsby's inhaler, some such arrangement will readily suggest itself.¹ Ethyl chloride was at first given on folded linen or lint, and this is still the best way to produce a light but sufficient anæsthesia in patients with enlarged thyroid, or suffering from some respiratory disability. But to produce good anæsthesia quickly, and avoid a stage of excitement, complete air exclusion, involving the use of a bag, is necessary.

When using any cotton or linen fabric, it is best to spray the desired dose into a small thick test tube, and then pour it on to the cloth at once, as, if the drug is only gradually sprayed on, freezing is apt to occur.

Ethyl chloride has no action on rubber fabrics, or on celluloid, and face-pieces are best when partially made of the latter.

When a rubber bag has been used, it should be inverted and washed before the next anæsthesia.

The dose.—The dose of ethyl chloride is a variable quantity, varying with the patient, the nature of the operation, and the length of anæsthesia required.

It will be seldom necessary to employ more than 10 c.c., and seldom possible to use less than 3 c.c.; but with this latter amount, properly administered, an anæsthesia of seventy to ninety or more seconds can be obtained even in adult patients. With young children, one and a half to two and a half minutes can be reckoned on. If the administrator fails to get anæsthesia with such an amount, in seventy to ninety seconds, it is due far more

¹ A convenient form of inhaler was described by me in *Lancet*, London, July 15. I have never failed to anæsthetise a patient with this.

probably to air being unknowingly admitted rather than to an insufficient dose.

The rapidity with which anæsthesia is induced in some cases is very remarkable, and even startling. If the patient takes deep breaths from the start, consciousness is sometimes lost after the first three or four breaths, stertor commences, and the patient is ready for the knife in twenty-five to thirty seconds.

M'Cardie finds *the average time of induction to be 50.9 seconds, and the average length of anæsthesia 71.3 seconds.*

In my own practice, I have found the average of induction a few seconds longer, but the duration of anæsthesia has been correspondingly long.

My longest period of available anæsthesia, after complete removal of the inhaler, was five minutes (see Case 2).

After-effects.—Headache and nausea, or vomiting, are the most common. Anything further is extremely rare, and any faintness or syncopal tendency, which is ever seen, is probably more due to loss of blood, or *vertigo a stomacho*, than any action of the anæsthetic on the cardio-vascular system.

Of patients anæsthetised for short dental extractions during the early part of the day—from 10 to 2 o'clock—I find not more than about 1 in 20 suffers from sickness. Patients anæsthetised in the afternoon seldom do so well as those narcotised early in the day. Sickness is more common where the anæsthetic has been pushed, or where some blood has been swallowed. There are some types of patients who are frequently sick or upset after any anæsthetic, namely, people suffering from chronic digestive disorder, and schoolboys who eat questionable articles of diet at odd times.

An interval of two, and, if possible, three or four hours, is desirable between the last meal and the taking of the anæsthetic. Sickness does not recur, at most, in more than 30 per cent. of cases, and this is considerably less than we see after chloroform or ether. If troublesome, the patient should be directed to lie down in the supine position, and albumin-water, or chloretone (10 grs.), administered, while toilet vinegar, sniffed at, is refreshing. Headache, if it occur, generally passes off soon, but if not, is best treated with a cup of tea or some antikamnia, 5 to 10 grs.

Both during the early stage of anæsthesia and the recovery stage, the thoughts or dreams of patients are not infrequently of an erotic nature, and this may lead to complications. The same, of course, is known to occur with nitrous oxide.

A few Cases taken from my Notebook.

CASE 1. — Male, æt. 27. — Eight teeth extracted. 6 c.c. ethyl chloride used. Induction, 60 seconds. Anæsthesia, 60 seconds. No vomiting, etc.

CASE 2.—Female, æt. 19.—Twenty-five teeth extracted. 7 c.c. used. One inhalation only. Induction, 65 seconds. Anæsthesia, 5 minutes. No after sickness or trouble. Patient, a thin, anæmic girl. Complete anæsthesia throughout.

CASE 3.—Female, æt. 22.—Seven teeth extracted. 7 c.c. used. Induction, 45 seconds. Anæsthesia, 75 seconds.

CASE 4.—Male, æt. 12.—Five teeth extracted. 8 c.c. used. Induction, 75 seconds. Anæsthesia, $2\frac{1}{2}$ minutes. Patient, a bright school-boy. "Feel very wobbly." No sickness.

CASE 5.—Female, æt. 40.—Two extractions. 5 c.c. used. Induction, 60 seconds. Anæsthesia, $1\frac{1}{2}$ minute. Woke up weeping, but "No pain."

CASE 6.—Female, æt. 40.—Six extractions. 6 c.c. used. Induction, 75 seconds. Anæsthesia, $1\frac{1}{2}$ minute. "So grateful." No sickness.

CASE 7.—Female, æt. 35.—One extraction (difficult). 7 c.c. used. Induction, $1\frac{1}{2}$ minute. Anæsthesia, 2 minutes. Profuse vomiting. Time, 5.30 P.M. Heavy lunch at 2.30; railway journey.

CASE 8.—Male, æt. 8.—Circumcision. 12 c.c. administered. Induction, 65 seconds. Anæsthesia kept up for 15 minutes. On awaking, some slight retching of frothy mucus. Asked where he was, tried to say "Royal-Infirmiry-Edinburgh" all in one word; and subsequently told the house surgeon that he rather liked it. Time, 7.30. Had tea at 5 P.M.

CASE 9.—Female, æt. 36.—Bimanual examination, etc. Used 10 c.c. ethyl chloride. Induction, 70 seconds. Anæsthesia, $2\frac{1}{2}$ minutes. Complete abdominal relaxation. As patient was leaving for country in an hour, she was anxious not to run any risk of vomiting, etc.

CASE 10.—Female, æt. 19.—"Wen" on the scalp. 15 c.c. ethyl chloride used. Induction, 65 seconds. Anæsthesia, 15 minutes. No change of colour. Good, quiet anæsthesia, with slight stertor at commencement. The patient woke up quite bright, had a very slight attack of retching, and in a few minutes walked back to bed.

CASE 11.—Female, æt. 14.—Tuberculous glands. 7 c.c. ethyl chloride used intermittently. Induction, 55 seconds. Anæsthesia, 10 minutes. Good, quiet anæsthesia. No sickness.

CASE 12.—Male, æt. 39.—Fibroma. Ethyl chloride, 20 c.c., used intermittently. Induction, 80 seconds. Anæsthesia, 15 minutes. Patient, a tall, powerfully-built man. After 4 minutes, turned dusky and cyanosed. Respiratory hesitancy. Face turned on side, and tongue traction carried out rhythmically. Stertorous breathing and cyanosis disappeared, and patient did well to the end. No vomiting. Very drowsy after.

CASE 13.—Male, æt. 40.—Incision of inflamed arm. Patient was suffering from pneumonia at the time, and temperature $102^{\circ}.7$. 8 to 10 c.c. administered on a handkerchief, rapidly, made him fully unconscious, and the highly inflamed parts were incised and explored quite painlessly. No ill effects.

CASE 14.—Male, æt. 5.—Adenoids and tonsils. 10 c.c. ethyl

chloride used (on Breuer's mask).¹ Induction, 45 seconds. Anæsthesia, 1.45 minute. A little struggling. No crying.

CASE 15.—Male, æt. 7.—Adenoids. Used 8 c.c. ethyl chloride. Induction, 75 seconds. Anæsthesia, 2½ minutes. A little struggling and crying. Pupils dilated.

CASE 16.—Male, æt. 6.—Adenoids. Used 7 c.c. ethyl chloride. Induction, 65 seconds. Anæsthesia, 90 seconds. Ample time, and very good anæsthesia. Used mouth prop and Doyen's gag.

CASE 17.—Female, æt. 85.—Seven dental extractions. 8 c.c. ethyl chloride used. Induction, 60 seconds. Anæsthesia, 1½ minute. Patient awoke very fresh. No vomiting or discomfort.

The death-rate under ethyl chloride.—Patients seem to vary a great deal as to their susceptibility to the vapour. Alcoholics and those addicted to cocaine and morphia require a great deal of the anæsthetic, and are scarcely affected except by a strong vapour. On the other hand, those who are anæmic, and weakened by disease, are frequently very soon influenced, and as small a dose as 3 c.c. has been followed by violent tonic spasms, opisthotonos, and cyanosis. Any toxic effect of the drug seems to make itself first felt in the patient's respiratory system. The action there seems to be supplemented by the onset of muscular spasm, which most frequently commences in the masseter, but may spread to the muscles of the tongue, larynx, and thorax. The cyanosis is much accentuated, if not primarily caused, in many cases, by this spasm of muscles at the base of the tongue; this spasm, and also laryngeal spasm, can readily be relieved by tongue traction, supplemented by artificial respiration for a few moments in some cases. The appearance of the patient is extremely unpleasant, and very similar to that of a person deeply under the influence of nitrous oxide. With this anæsthetic clonic spasm is usually seen, however, but the retraction of the head and opisthotonos is very similar. The patient's face looks very swollen, the eyes usually open, pupils dilated and fixed, while the pulse usually beats quite well.

Seitz (⁹) of Constanz, a dental surgeon, has gone very carefully into the question of safety. He has collected an account of over 16,000 cases, with only one death recorded. This occurred at Innsbruck in 1899. The patient was a labourer, æt. 41, and died of respiratory syncope, apparently. At the necropsy, he was found to have an enlarged and fatty heart and sclerosed coronary arteries. No other case has actually been published, except that of a child, æt. 1¾ year, suffering from diphtheritic croup, who died during a tracheotomy. There is no record of a death during a dental operation.

There have been many cases recorded in which asphyxial symptoms have appeared and been promptly relieved by suitable treatment.

¹ Breuer's mask has no bag attached, and is a poor inhaler.

Comparing ethyl chloride with other anæsthetics, we find—

Ethyl chloride	1 to 16,000
„ bromide	1 „ 4,000
Ether	1 „ 12,000
Chloroform	1 „ 2,000
Nitrous oxide	Impossible to calculate.

That is to say, that while nitrous oxide is unquestionably the most safe anæsthetic, ethyl chloride comes next, before even ether. The difference is rather greater than appears from the figures found, for ethyl chloride can be given with satisfaction to many patients when it would be unwise, if not impossible, to properly anæsthetise with ether.

The field open for ethyl chloride anæsthesia.—Ethyl chloride is primarily best adapted to the requirements of the dental surgeon, and promises, in time, to largely displace laughing gas as a routine anæsthetic; but its appearance also renders the field of CHCl_3 more limited, and its administration for dental extractions even more unjustifiable than it was before. With ethyl chloride alone, supplemented by ether, in the very longest cases, any dental operation can be faced with confidence, provided the person in charge of the anæsthetic has had a reasonable amount of experience in the use of it.

For operations in the mouth and nose, of short duration, such as the removal of adenoids and tonsils, polypi and spurs on the septum, ethyl chloride is admirably adapted.

The patient may be safely placed in the sitting posture, if the surgeon prefers it; and the rapid recovery of consciousness, which may be timed and regulated to a few seconds, when one is experienced, greatly adds to the safety, from the patient being able to assist in the keeping the respiratory passages free by coughing freely, etc. I almost invariably use this anæsthetic for such cases now, and find there is plenty of time afforded, as by increasing the dose, and length of inhalation, one can vary the duration of anæsthesia according to the probable requirements of the case. The use of chlorethyl in operative throat work is increasing rapidly, and Mr. F. H. Marsh (¹⁰), in the Ingleby Lectures of last year, expresses his approval of it from the surgeon's point of view.

But, apart from special surgery, there is a wide field in general surgery for the employment of chlorethyl.

That deaths under chloroform most frequently occur in the early struggling stage, is well known. By using chlorethyl prior to the inhalation of chloroform, the patient is rendered unconscious with extreme rapidity—in fifteen to twenty seconds—and struggling is readily avoided. In France, where chloroform appears to be very popular still, this practice is now very largely adopted, both at the Paris and other medical centres.

Again, even the advocates of ether will admit its pungency and unpleasantness as an inhalant; and the patient may be saved¹ from this by the preliminary use of ethyl chloride, just as nitrous oxide has been used for many years.

Sir Frederick Treves⁽¹¹⁾ has well remarked that, "To lie on a table, and breathe in a subtle vapour that will soon plunge the anxious brain and throbbing personality into an outer and uncertain darkness, is no slight ordeal!" Ethyl chloride reduces this ordeal to a minimum.

For use in tenotomies, opening of abscesses, scraping of lupus, painful dressings, and probing for bullets, it is well adapted, used alone.

Patients in an advanced stage of inanition, on whom gastrostomy requires to be performed, and when it is desirable to feed immediately after the operation is complete, are usually provided with local anæsthesia only in order to avoid after-sickness. Individuals vary immensely in their capacity for stoical endurance in such circumstances, but I have, from time to time, watched such operations in hospital, and remarked signs of unmistakable agony at certain stages, sometimes audibly expressed. By an initial inhalation of ethyl chloride for the skin incision, and the maintenance of a very light anæsthesia afterwards, deepened if necessary, such infliction of pain may be avoided, and the patient yet be fed, with safety, immediately on return to bed.

Again, for cases of goitre, and patients who are extremely debilitated, whom one would wish only to render subconscious, and ensure their rapid awakening if need be, the volatility and rapid elimination of chlorethyl recommends itself as specially adapted.

Young children take ethyl chloride remarkably well, and so do old people.

With nitrous oxide the first class of patients are prone to cyanosis and excessive jactitation, while in the latter it is less desirable for other reasons.

Varieties of ethyl chloride on the market.—When general anæsthesia was first produced by this anæsthetic, it was produced, as already stated, by means of the ordinary preparation used for local anæsthesia; but, of course, it was obvious, if the drug was to be inhaled more or less indiscriminately, greater care was called for in its preparation, and a purer description was produced.

A brand which early obtained great popularity is that known as "Kelene." It is evidently well and carefully prepared, and pure, and has been very largely used on the Continent. Henning's "ether chloratus" appears to find favour in Germany. The original makers of "Anæstile" produce an ethyl chloride for general anæsthesia which I have used with satisfaction. Their

¹ Koch has used the less preferable ethyl bromide in this manner for ten years. See article, *Lancet*, London, September 12, 1903, by Dr. Huggard.

preparation "Narcotile," which they say is bichloride of methyl-ethylene, is also excellent, but I do not find it superior to ethyl chloride.

During the past year much has been written and said about a preparation known as "Somnoforme." I have also used this, and seen it used by its introducer, Dr. Rolland of the Bordeaux Dental School. The results have been excellent, but again in no way superior to those obtained with ethyl chloride.

"Somnoforme" is simply a mechanical mixture of the following composition:—

Ethyl chloride	60 per cent.
Methyl chloride	36 "
Ethyl bromide	4 "

The methyl chloride has been added with the idea of its inducing anæsthesia more rapidly than ethyl chloride alone, and the bromide is supposed to prolong the period of available analgesia and anæsthesia. Whether this is so or not I cannot say, but the mixture is open to one serious objection at any rate, and that is, it is unstable. If a bottle is half empty, and allowed to stand, the more volatile methyl chloride seems to dissipate itself, and a more concentrated mixture of ethyl chloride and bromide is left. The bromide may further decompose, and give off free bromine, and then we find clinically that patients anæsthetised with such "remainders" are prone to suffer from sickness and headache, which may be severe. This constitutes a serious drawback, and I cannot say I have seen or heard of any compensating advantage. "Somnoforme" is stored in green glass phials, by no means so convenient as the ordinary ethyl chloride trigger-stoppered flasks, and, moreover, apt to leak.

There is something in the name which appears to attract the attention of certain individuals more than plain ethyl chloride. The unknown is often more interesting and attractive than what we are familiar with. A medical man came to me recently to ask about "Somnoforme," as he proposed to try it, and he said his local chemist had offered to make him up some, as he had got hold of the formula!

In conclusion, I think there is no possible advantage, but the reverse, in using proprietary preparations and mixtures; a brand of pure chloride of ethyl, manufactured by a chemical firm of repute, is all that is needed to obtain good results, provided the administration is properly conducted.

General conclusions in regard to ethyl chloride.—

1. It is very rapid in action, and pleasant to inhale.
2. The duration of anæsthesia compares very favourably with that afforded by nitrous oxide.
3. It causes no change of colour, or cyanosis, under normal conditions.

4. The administration is very simple in technique.

5. Its lower rate of mortality, more agreeable odour, and method of administering, and the possibility of repeating the dose and continuing the anæsthesia, make it greatly preferable to ethyl bromide, which cannot be safely re-administered at one sitting.

6. The after-effects are slight, if there are any.

7. It is by no means expensive, but cheaper than nitrous oxide.

8. It is especially useful when the patient is very young, very old, or anæmic.

9. It is extremely portable—a flask with sufficient for ten to twelve cases being readily carried in the breast-pocket.

10. It is much safer than chloroform, as safe as ether, and much better adapted for brief operations than either.

New anæsthetics are like a new horse, and one is inclined at first to go very gently with them. When I first began to try ethyl chloride, about three years ago, I used it "with fear and trembling"; but though familiarity has not bred contempt, I now use it with confidence, as a tried friend. I have personally administered it in over 300 cases, and I have had no reason to regret doing so. One or two patients have given some trouble, from the onset of marked spasms and cyanosis; but as we not unfrequently experience both when using nitrous oxide, if one is accustomed to that anæsthetic, these symptoms are not so disconcerting. I am convinced ethyl chloride is an anæsthetic which needs great care and watchfulness in its administration; and the great rapidity of the onset of anæsthesia is calculated to catch the uninitiated and inexperienced napping. But, bearing in mind the rapid elimination, and the fact that, when trouble has occurred, it has always been of an asphyxial and not syncopal character, one realises there is a fair margin of safety. And if we do meet with difficulty, as we are practically bound to from time to time whatever anæsthetic we are giving, a cool head, and the precise and methodical carrying out of the usual restorative measures, are in all probability all that will be necessary to bring about the happiest results.

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