Thesis on

Anaesthesia and Analgesia in certain Medical Diseases with Complications or Associated Conditions requiring Surgical Intervention

and

The Treatment of certain types of Convulsions by the Administration of some of the Newer Drugs used in Anaesthesia

presented by

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for

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This thesis has been compiled from cases personally conducted by A.K. Boyle during his term of office as resident anaesthetist to St. James' Hospital, Balham, London.

DESIDERATA

Pre-operative Investigations and Preparation

At St. James' Hospital before an anaesthetic or analgesic is administered to an indoor patient the following factors are determined as accurately as possible.

I. THE ANAESTHETIC TOLERANCE OF THE PATIENT

Determination of the patient's tolerance towards any form of anaesthesia or analgesia is based upon -

1. General Criteria:

These include,

(1) Inquiry into the past medical history especially in relation to previous anaesthesia or analgesia and the patient's reaction to it. Abnormal sensitivity, individual and/or familial to any drug or group of drugs is of special importance.

(2) Complete physical examination with special reference to the circulatory, respiratory, urinary and nervous systems.

The height and weight of the patient are recorded.

2. Special Criteria:

Certain critical tests are now applied -

(1) Moot's Index = $\frac{\text{Pulse Pressure}}{\text{Diastolic Pressure}}$ x 100 = 50 approximately in normal patients.

Moot's index provides an approximate index to the cardiac reserve. If it is below 25 or above 75 the cardiac reserve is gravely inadequate.

(2) Barach's Energy Index = (Systolic + Diastolic Blood Pressure) x Pulse Rate.

The numerals of the thousands constitute the index whose normal value is 12-18.

Barach's Energy Index provides an approximate of the circulatory reserve. If it is below 6 or above 24 the circulatory energy is gravely deficient.

(3) Henderson's Breath-Holding Test

In this test the patient, after lying absolutely quiet for five minutes, takes a moderately deep breath and holds it for as long as possible, having the lips closed and the nostrils pinched together.

Henderson's Breath-Holding Test gives an approximate measure of vital capacity. The normal subject should be able to hold his breath for some 45 seconds. A period below 10 seconds implies seriously impaired vital capacity.

(4) Read's and Yale's Formula

Indirect estimation of the basal metabolic rate may be made from

Read's Formula B.M.R. = 0.683 (P.R. + 0.9 P.P.) - 71.5.

Yale's Formula B.M.R. = P.R. + P.P. - 111.

Where P.R. represents the pulse rate per minute and P.P. the pulse pressure.

Direct estimation is always employed in thyrotoxic patients except when they are critically ill and likely to be exhausted by the procedure.

The basal metabolic rate may not give much additional help in estimating the operative risk, but it is of assistance in

gauging the approximate oxygen requirements. This is a consideration of importance where gas anaesthesia is contemplated for feverish patients and patients suffering from thyreotoxicosis.

(5) Exercise Tolerance Test

In cases of cardio-vascular disease exercise tolerance determination is essential.

It will be realised that, in many cases, the patient is so desperately ill and the operation one of such urgency, that detailed investigations in advance are impossible.

The Anaesthetic Tolerance is deduced from the maximum of information obtainable. By consideration of such information each patient is classified as of -

Ample anaesthetic tolerance.

Probably adequate anaesthetic tolerance
or
Inadequate anaesthetic tolerance.

II. THE ANAESTHETIC RISK OF THE PATIENT

From the above general and special criteria and from the nature of the proposed operation, the anaesthetic risk presented by the patient is assessed. A convenient classification is that suggested by the International Anaesthesia Research Society.

"A" Risk: Minor operation upon a healthy subject, i.e. a subject in whom all the above criteria are entirely satisfactory.

"B" Risk: Major operation upon a healthy subject, or -

An operation not dangerous to life upon an unhealthy subject, i.e. a subject in whom impaired anaesthetic tolerance is indicated by the above criteria.

"C" Risk: Serious operation upon a patient presenting some grave pathological condition.

"D" Risk: A patient in urgent danger of death from surgical disease or from some complication.

III. THE SAFEST and most SUITABLE ANAESTHETIC or ANALGESIC AGENT and TECHNIQUE

The choice of the agent and technique involves a balancing of four factors -

The Anaesthetic Tolerance and Risk presented by the patient.

The Toxicity of the Agent.

The convenience of the surgeon.

The physical reactions of the patient.

It is influenced by certain pathological factors, for example, shock and haemorrhage, grave sepsis, ketosis, diseases of the various systems, by regional factors such as cranial surgery, rhino-laryngological surgery, thoracic surgery, et cetera, and by the extremes of age.

Possible risk of fire and explosion is an important consideration in the selection of the agent and technique.

IV. THE NECESSARY PRELIMINARY PREPARATION OF THE PATIENT

The preliminary preparation of the patient - hygienic, psychic and medical - will depend upon the conditions and circumstances present in the particular case. The object of the medical treatment of the patient about to undergo an operation is to restore as completely and as rapidly as possible his resources and to provide him with any necessary or desirable preliminary medication. The pre-anaesthetic amnesic, hypnotic or narcotic drug, and the dose to be employed, are determined from a consideration of the age, sex, body weight, habits of life and state of health of the patient and of the advantages and disadvantages, indications and contra-

indications, dangers and methods of administration of the drug.

V. THE POSSIBLE ACCIDENTS of the proposed ANAESTHESIA or ANALGESIA

The prophylaxis of complications during anaesthesia or analgesia demands a knowledge of their possible occurrence and of the preventive measures to be applied, the prompt and efficient treatment of them adequate skill and facilities.

All mechanical apparatus is tested personally by the anaesthetist before use.

OBSERVATIONS during OPERATION

At intervals of five minutes throughout anaesthesia readings of -

The pulse rate and character.

The rate and character of respiration.

The systolic and diastolic blood pressures -

are recorded. The patient's colour is constantly observed.

Accurate charting places the anaesthetist in a position to assess the degree of operative shock at any stage of the operation, to inform the surgeon, if requested, whether further surgical procedures are or are not permissible, to suggest speedy completion of the operation, if changes in the patient's condition warrant it and to direct the immediate institution of such restorative measures as are necessary to combat profound shock.

In cases operated upon under local or spinal analgesia without adjuvant inhalation anaesthesia, however, a quiet comfortable patient is disturbed by frequent blood pressure readings. Sufficient information can usually be obtained by observations of his colour and of the characteristics of his pulse and respiration.

Progress notes and comments are made.

In the case of gas anaesthesia, oxygen percentage and details of rebreathing are similarly recorded.

The total quantity of the agent or agents used and the duration of the anaesthesia or analgesia are charted.

POST-OPERATIVE MANAGEMENT

Competent care of the patient after operation is of the greatest importance. Suitable prophylactic measures will avert many of the complications of anaesthesia and analgesia; proper treatment started early is extremely effective. It is essential that the anaesthetist be cognisant of all the serious sequelae which may occur and that he be thoroughly conversant with the preventive and curative therapies to be applied.

The immediate post-operative treatment of the patient suffering from such disease as diabetes mellitus and the resuscitation of the newly-born child, not infrequently falling to the lot of the anaesthetist, demand the requisite knowledge and skill.

ANAESTHETIC RECORDS

A complete record is kept of the pre-operative investigations and preparation carried out, of the observations made and restorative measures employed during operation, and of the details of post-operative management in every case. It furnishes data of great value should the patient require subsequent anaesthesia or analgesia, and provides material for statistical purposes and research.

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ANAESTHETIC RECORD.

Date. 14.2.39.

Name. J. & B

Age. 34 years.

Sex. Male.

Height. (Below 100 lbs

Weight. 1/6 register.

Physical Condition. Orthopnoic.

Voice. Emaciated.

Anaesthetic Tolerance. "Probably Adequate"

Anaesthetic Risk. "C"

Operation. Partial Resection of Rib for Right-sided Meta-pneumonic Empyema.

Preparation. Hygienic.

Premedication. Hyodermic Injection – Omnopon gr ⅓ & Hyoscine gr 1/150.

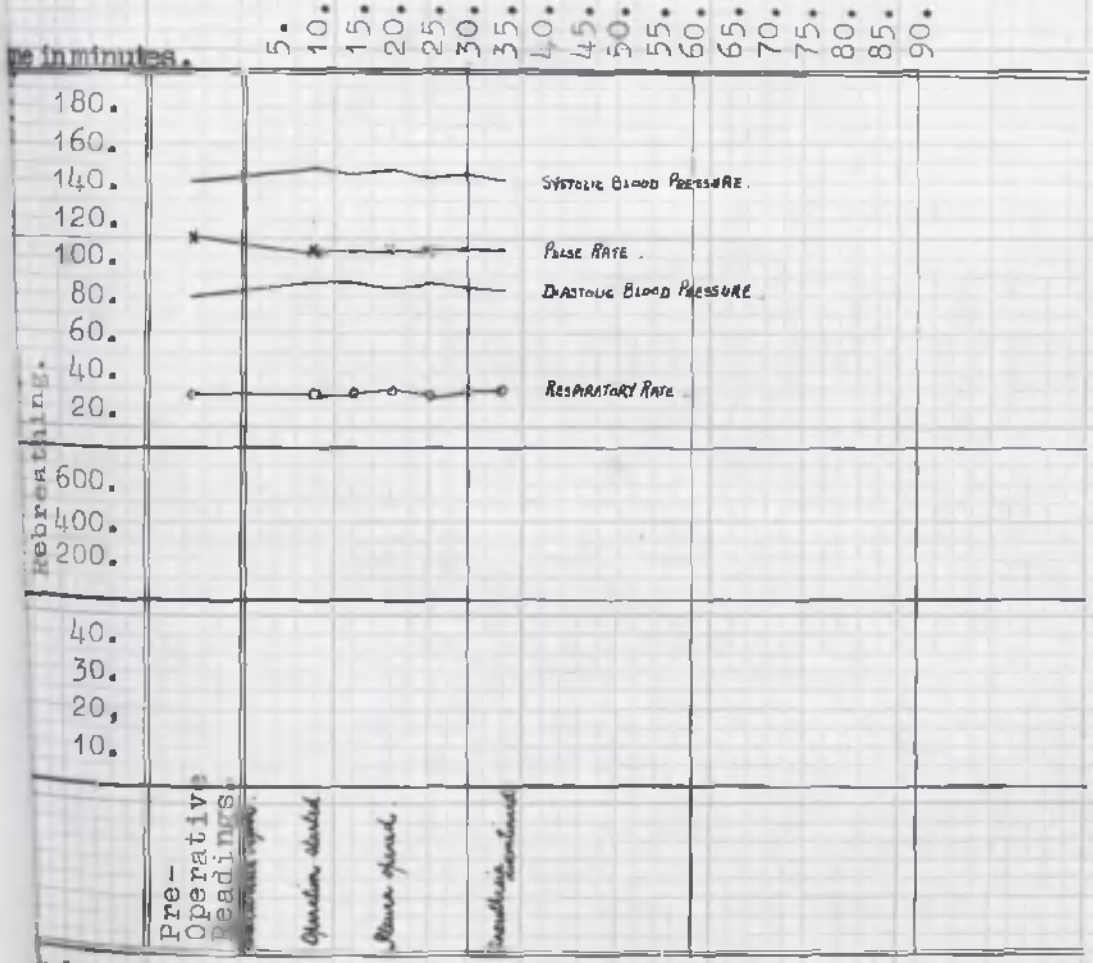
Time of Administration. 9.20 a.m.

Anaesthetic or Analgesic Agent and Technique.

Agent. Cyclopropane-Oxygen Total Quantity. 1½ gallons Cyclopropane.

Technique. Closed Circuit. Basal Oxygen Flow – 500 c.c. per minute.

Duration of Administration. (Begun. 10.5a.m.
(Discontinued. 10.40a.m.



Complications. During Anaesthesia or Analgesia. Increased Capillary Bleeding.

Post-Operative. Nil.

Result. Uneventful Recovery.

Surgeon. R.D.R.

Anaesthetist. A.K.B.

ANALYSIS of INDIVIDUAL FATALITIES

Every anaesthetic and analgesic fatality is subjected to inquiry by an appropriate committee of the medical staff. The lessons learnt are circulated among all concerned.

Autopsy findings are set down in detail.

During the period from January 1st, 1938, to February 4th, 1939, twenty-six cases of meta-pneumonic empyaema were operated upon at St. James' Hospital.

The types of operation performed were the following:

Type of Operation	Number
Intercostal drainage.	7
Partial resection of rib.	16
Intercostal drainage with subsequent partial resection of rib	3

The anaesthetic risks were classified as:

"B" Risk for intercostal drainage.

"C" Risk for partial resection of rib.

The methods of anaesthesia and analgesia employed were as follows:

Method of Anaesthesia or Analgesia	Number
Local analgesia	16
Inhalation anaesthesia	6
Intravenous anaesthesia	2
Combination of intravenous with inhalation anaesthesia	2

Mortality:

One of the patients has died. The others have entirely healed. The mortality, therefore, has been 3.84%.

LOCAL ANALGESIA
16 Cases

No	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Pre-medic.	Analgesic Agent & Technique	Complications		Result
							During Analgesia	Post-Operative	
1	2	F	Intercos. Drainage	"B"	Nil	Local Infiltrat.	Restlessness	Nil	Recovery
2	2	M	Intercos. Drainage	"B"	Nil	Local Infiltrat.	Restlessness	Nil	Subsequent rib resect. under N_2O-$O_2(C_2N_3)_2O$ Recovery
3	4	F	Intercos. Drainage	"B"	Nil	Local Infiltrat.	Restlessness	Cellulitis of post. chest wall	Death
4	4	F	Intercos. Drainage	"B"	Nil	Local Infiltrat.	Restlessness	Nil	Recovery
5	14	F	Intercos. Drainage	"B"	H.I.Omnopon gr.$\frac{1}{6}$	Local Infiltrat.	Restlessness	Nil	Recovery
6	15	F	Intercos. Drainage	"B"	H.I.Omnopon gr.$\frac{1}{6}$	Local Infiltrat.	Nil	Nil	Recovery

contd.

LOCAL ANALGESIA
16 Cases

No.	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Pre-medic.	Analgesic Agent & Technique	Complications		Result
							During Analgesia	Post-Operative	
7	32	F	Partial resec.rib	"C"	H.I.Omnopon gr.$\frac{1}{3}$ Hyoscine gr.$\frac{1}{150}$	1% Novocaine sol. Combination of local infil. and intercost. nerve block.	Nil	Nil	Recovery
8	33	F	Partial resec.rib	"C"	H.I.Omnopon gr.$\frac{1}{3}$ Hyoscine gr.$\frac{1}{150}$	Combination Local	Restlessness	Nil	Recovery
9	63	F	Partial resec.rib	"C"	H.I.Omnopon gr.$\frac{1}{3}$. Hyoscine gr.$\frac{1}{150}$	Combination Local	Nil	Cellulitis of post.-lat. wall	Recovery
10.	57	M	Partial resec.rib	"C"	H.I.Omnopon gr.$\frac{1}{3}$. Hyoscine gr.$\frac{1}{150}$	Combination Local	Nil	Nil	Recovery
11	34	M	Partial resec.rib	"C"	H.I.Omnopon gr.$\frac{1}{3}$. Hyoscine gr.$\frac{1}{150}$	Combination Local	Nil	Nil	Recovery
12	52	M	Partial resec.rib	"C"	H.I.Omnopon gr.$\frac{1}{3}$. Hyoscine gr.$\frac{1}{150}$	Combination Local	Nil	Nil	Recovery
13	47	M	Partial resec.rib	"C"	H.I.Omnopon gr.$\frac{1}{3}$. Hyoscine gr.$\frac{1}{150}$	Combination Local	Nil	Cellulitis of post.-lat.chest wall	Recovery

contd.

LOCAL ANALGESIA
16 Cases

No.	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Pre-medic.	Analgesic Agent & Technique	Complications		Result
							During Analgesia	Post-Operative	
14	55	M	Partial resec.rib	"C"	H.I.Omnopon gr.$\frac{1}{3}$. Hyoscine gr.$\frac{1}{150}$	True field block	Nil	Nil	Recovery
15	46	M	Partial resec.rib	"C"	H.I.Omnopon gr.$\frac{1}{3}$. Hyoscine gr.$\frac{1}{150}$	True field block	Nil	Nil	Recovery
16	47	M	Partial resec.rib	"C"	H.I.Omnopon gr.$\frac{1}{3}$. Hyoscine gr.$\frac{1}{150}$	True field block	Nil	Nil	Recovery

H.I. = Hypodermic Injection. All hypodermic injections were given three-quarters of an hour before operation.

N_2O = Nitrous Oxide. O_2 = Oxygen. $(C_2H_3)_2O$ = Di-vinyl ether ("Vinesthene")

INHALATION ANAESTHESIA
6 Cases

No.	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Pre-medic.	Anaesthetic Agent & Technique	Complications		Result
							During Anaesthesia	Post-Operative	
1	4	F	Intercostal Drainage	"B"	H.I. Atropine gr. $\frac{1}{150}$	N_2O-O_2-$(C_2H_3)_2O$ Partial rebreathing	Nil	Nil	Recovery
2	2	F	Partial resec. rib	"C"	H.I. Atropine gr. $\frac{1}{200}$	N_2O-O_2-$(C_2H_3)_2O$ Closed circuit tech.	Nil	Nil	Recovery
3	4	F	Partial resec. rib	"C"	H.I. Atropine gr. $\frac{1}{150}$	N_2O-O_2-$(C_2H_3)_2O$ Closed circuit tech.	Nil	Transitory vomiting	Recovery
4	37	M	Partial resec. rib	"C"	H.I. Omnopon gr. $\frac{1}{3}$. Hyoscine gr. $\frac{1}{150}$	C_3H_6-O_2 Closed Circuit tech.	Increased capillary bleeding.	Nil	Recovery
5	17	M	Partial resec. rib	"C"	H.I. Omnopon gr. $\frac{1}{3}$. Atropine gr. $\frac{1}{100}$	C_3H_6-O_2 Closed circuit tech.	Increased capillary bleeding.	Transitory nausea.	Recovery
6	5	F	Partial resec. rib	"C"	H.I. Atropine gr. $\frac{1}{100}$	C_3H_6-O_2 Closed circuit tech.	Increased capillary bleeding.	Nil	Recovery

H.I. = Hypodermic Injection. All hypodermic injections were given three-quarters of an hour before operation.

C_3H_6 = Cyclopropane. O_2 = Oxygen.

INTRAVENOUS ANAESTHESIA
2 Cases

No.	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Pre-medic.	Anaesthetic Agent and Technique	Complications		Result
							During Anaes.	Post-Operative	
1	17	M	Intercostal drain. Subsequent rib resec.	"B"	H.I. Atropine gr. $\frac{1}{100}$	Pentothal 5% Intravenous 6cc. 8cc.	Nil	Nil	Recovery
2	38	M	Intercostal drain. Subsequent rib resec.	"B"	H.I. Omnopon gr. $\frac{1}{3}$. Atropine gr. $\frac{1}{100}$	Pentothal 5% Intravenous 10 cc. 12cc.	Nil	Nil	Recovery

COMBINATION of INTRAVENOUS with INHALATION ANAESTHESIA
2 Cases

No.	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Pre-medic.	Anaesthetic Agent and Technique	Complications		Result
							During Anaes.	Post-Operative	
1	18	M	Partial resec. rib	"C"	H.I. Atropine gr. $\frac{1}{100}$	Pentothal 5% Intra. 6cc. N_2O-O_2 Inhalation Part. rebreath.	Nil	Nil	Recovery
2	47	M	Partial resec. rib	"C"	H.I. Omnopon gr. $\frac{1}{3}$. Atropine gr. $\frac{1}{100}$	Pentothal 5% Intravenous 10cc. N_2O-O_2. Inhal. Part. rebreath.	Nil	Nil	Recovery

H.I. = Hypodermic Injection. All hypodermic injections were given three-quarters of an hour before operation.

Pentothal 5% = Pentothal Sodium 5% Aqueous Solution (Abbott).
0.5 gm. Pentothal Sodium in 10 cc. sterile distilled water.

Commentary on the Methods of Anaesthesia and Analgesia employed.

LOCAL ANALGESIA:

Although a method of considerable immediate safety, and one practicable by the surgeon himself, local analgesia was unsatisfactory in children on account of their restlessness, non-cooperation and psychical instability. Subsequent infection of the chest wall, always liable to occur after preliminary paracenteses and particularly liable to complicate infiltration analgesia, was a most serious objection in both children and adults.

When an experienced anaesthetist was available general anaesthesia was preferable to local analgesia.

INHALATION ANAESTHESIA:

For intercostal thoracotomy and partial resection of rib in all patients inhalation anaesthesia with Cyclopropane-oxygen, closed circuit technique with total rebreathing and carbon dioxide absorption, was the most desirable method. Administration by means of a face-piece and retention-harness was all that was necessary. Very quiet respiration with full oxygenation was afforded; blood pressure was slightly raised. With a slow rate of flow of Cyclopropane administration during induction - 300 to 350 c.c. per minute - no untoward signs such as respiratory arrest or toxic effects on cardiac musculature were observed. Increased capillary oozing ceased with the termination of anaesthesia; occurring as it did from a small wound and for a short period it was of no moment. A hypodermic injection of atropine in the child and of Omnopon and atropine or hyoscine in the adults was given pre-operatively. Inhalation nitrous oxide-oxygen with minimal di-vinyl ether was a good substitute for Cyclopropane-oxygen. Di-vinyl ether, devoid of the toxic effect of chloroform and the respiratory irritant effect of di-ethyl ether, added in minimal quantities to the nitrous

oxide-oxygen made it possible to maintain adequate oxygenation and satisfactory anaesthesia at the same time in patients with oxygen requirements greater than normal. A closed circuit was preferred to the method of partial rebreathing. Preliminary premedication with atropine was necessary to obviate the excessive salivation consequent upon di-vinyl ether administration.

INTRAVENOUS ANAESTHESIA:

Intravenous anaesthesia with pentothal sodium, 5 per cent aqueous solution, was used in the two adult cases for intercostal drainage and subsequent partial resection of rib. Both these patients expressed a dislike of "gas". Pentothal sodium was chosen in preference to evipan sodium, the other barbiturate in common use for intravenous anaesthesia, for the following reasons: the rather smoother induction of anaesthesia and the more rapid recovery. The technique used was the single-dose method, the rate of intravenous injection not exceeding 1 c.c. in 30 seconds. Atropine was administered hypodermically three-quarters of an hour previously; the salivation not infrequently encountered in intravenous pentothal anaesthesia was thus avoided.

The end-results were very gratifying.

COMBINATION of INTRAVENOUS with INHALATION ANAESTHESIA:

Induction of anaesthesia with intravenous pentothal sodium and subsequent maintenance with inhalation nitrous oxide-oxygen proved very satisfactory for partial resection of rib in two cases, both adults. A smooth rapid induction was obtained, and the need for suboxygenation in maintaining anaesthesia with nitrous oxide-oxygen obviated.

Intravenous anaesthesia was not a method of choice for children. For adults with a dislike of gas anaesthesia, however, intravenous pentothal sodium was a good technique for intercostal drainage and for subsequent partial resection of rib, the combination of intravenous pentothal and inhalation nitrous oxide-oxygen a valuable technique for primary partial rib resection. The latter might also be used as an alternative to inhalation nitrous oxide-oxygen - minimal di-vinyl ether when cyclopropane was not available for rib resection in all adults.

In these cases the agents used for general anaesthesia were those which have been shown to cause no damage to the lungs, to be associated with rapid recovery and to have the minimum effect on metabolic processes. They provided quiet anaesthesia without materially interfering with the cough reflex. Positive pressure was, of course, unnecessary.

In the only fatal case, a female child aged 4 years, death occurred fourteen days after intercostal drainage for right sided empyaema. Paracentesis pericardii for pyo-pericardium had been performed two days before death.

Anaesthesia and Analgesia for the Surgical Complications of Peptic Ulcer

Acute gastric ulcers usually heal rapidly when appropriate medical treatment is carried out. Occasionally, however, they perforate necessitating operation.

The treatment of chronic ulcers, gastric or duodenal, in the first instance should be medical. The indications for surgical intervention may be summarised as follows :

Perforation. Perigastric abscess. Organic pyloris stenosis or hour-glass constriction which impedes stomach emptying. Suspicion of carcinoma. Intractable gastric haemorrhage from the erosion of a sclerotic artery in the floor of an ulcer. Repeated haemorrhages. Frequent relapses after efficient medical treatment. Large penetrating ulcer, demonstrable radiologically.

For the upper abdominal operations required for these complications the anaesthesia or analgesia employed should afford the best possible operating conditions and freedom from respiratory sequelae. The agents used should be as non-toxic and the methods adopted as safe as possible.

Attempts at raising the anaesthetic tolerance of the patients in advance of any surgical procedures are most desirable.

Combinations of anaesthetics and analgesics are most satisfactory for gastric surgery. A skilled anaesthetist is essential.

The combination of spinal analgesia with inhalation anaesthesia, using percaine 1:1500, hyperbaric solution and nitrous oxide-oxygen with minimal di-vinyl ether is ideal. Spinal block up to T.3 or T.4 provides perfect operating conditions - absolute muscular relaxation, minimal abdominal respiratory movement and contracted intestines - even in the most muscular subjects. It affords also protection from "reflex" shock, a most important consideration in long, difficult and shock-producing gastrectomies.

The patients are given an adequate dose of omnopon-hyoscine subcutaneously three-quarters of an hour before going to the operating theatre and are left undisturbed in a quiet room. A modified Fowler's position is desirable during this period in perforation cases. Post-operative apprehension is thus allayed. The general condition of patients with perforated ulcers is much improved. As a prophylactic against the circulatory depression associated with high-block spinal analgesia, one grain of ephedrine is administered intramuscularly at the completion of the subarachnoid injection of percaine solution. To avoid psychic strain and the "vago-traction-nausea" reflex (nausea resulting from traction on the stomach) during operation consciousness is abolished with nitrous oxide-oxygen. Very small quantities of vinesthene are added to permit a high percentage of oxygen with the nitrous oxide and to ensure steady maintenance over a considerable period, if necessary. The partial rebreathing employed guards against profound respiratory depression and maintains blood pressure.

When spinal analgesia is contra-indicated, avertin basal narcosis combined with endotracheal inhalation nitrous oxide-oxygen, closed circuit technique, di-ethyl ether as an adjuvant and abdominal field block with one-half percent novocaine solution carried out by the surgeon when the patient is under the general anaesthesia is most suitable for lengthy operations. The total effects of these various agents in simultaneous exhibition produce adequate depth without it being necessary to use any one of them in such quantity or concentration that harmful effects may result. With this technique the endotracheal route for the administration of the inhalation anaesthetics is all important. It assures patency of the airways throughout; partial respiratory obstruction with laboured breathing,

so common in light anaesthesia with nitrous oxide-oxygen-di-ethyl ether when a powerful upper abdominal is stimulated cannot occur. The anaesthesia is under definite control at all times. The advantages of the closed circuit principle are economy of use of agents, very quiet respiration with minimal abdominal movement, conservation of body heat and moisture, and prevention of mucous surface dessication. In patients with perforations which may require more than mere suturing this method is extremely satisfactory, omnopon-hyoscine hypnosis being substituted for avertin basal narcosis.

For bad risk subjects in whom the shortest procedures only are proposed - simple suturing of a perforation, rapid gastro-jejunostomy - inhalation anaesthesia with cyclopropane-oxygen, closed circuit, combined with local analgesia is the most valuable method. It gives good surgical access and thus enables the surgeon to perform his operation efficiently and expeditiously. Field block of the abdominal wall by providing a local muscular relaxation avoids any need for "pushing" the cyclopropane anaesthesia and so obviates the risks of respiratory arrest and toxic effects on the heart muscle. Increased capillary oozing is of little moment when it occurs only over a short period.

Light premedication with omnopon, one-third of a grain, and atropine, one-hundredth of a grain given hypodermically three-quarters of an hour before operation, is necessary.

The well marked reduction in mortality from gastric operations, revealed by a study of the statistics for the last three years, is consistent with the opinion formed, from clinical observation, of the value of the combinations of anaesthetics and analgesics described.

Anaesthesia and Analgesia for the Surgical Complications of Diabetes Mellitus

At St. James' Hospital, from November 1937 to February 1939, twenty-one patients suffering from diabetes mellitus were operated upon for some complication of the diabetic state.

The following is a convenient classification of the complications encountered and the operations performed.

		Number of Cases
Gangrene of leg	Amputation	5
Carbuncle	Excision	5
Abscess	Incision and drainage	4
Cataract	Extraction	4
Gall stones	Cholecystectomy	3

There were no deaths.

AMPUTATION of LEG for GANGRENE
5 Cases

No.	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Premedic.	Agents and Techniques	Complications: During Anaes.	Complications: Post-Operat.	Result
1	53	F	Amp. of left leg	"C"	H.I.Omnopon gr.1/3. Hyoscine gr. 1/150.	Percaine 1:1500. Spin.anal. N_2O-O_2-$(C_2H_3)_2O$ Inhal.anaes.	Nil	Nil	Recovery
2	65	M	Amp. of right leg	"C"	H.I.Omnopon gr.1/3 Hyoscine gr.1/150	Percaine 1:1500 Spin.anal. N_2O-O_2-$(C_2H_3)_2O$ Inhal.anaes.	Nil	Nil	Recovery
3	62	F	Amp. of left leg	"C"	H.I.Omnopon gr.1/3 Atropine gr.1/100	C_3H_6-O_2 Inhalation Closed circ. technique.	Inc.capillary bleeding	Nil	Recovery
4	68	F	Amp. of right leg	"C"	H.I.Omnopon gr.1/6 Atropine gr.1/100	C_3H_6-O_2 Inhalation. Closed circ. technique.	Inc.capillary bleeding	Nil	Recovery
5	52	F	Amp. of right leg	"C"	H.I.Omnopon gr.1/3 Hyoscine gr.1/150	C_3H_6-O_2 Inhalation. Closed circ. technique.	Inc.capillary bleeding	Nil	Recovery

H.I. = Hypodermic Injection. All hypodermic injections were given $\frac{3}{4}$ hour before operation.
Percaine 1:1500 = Percaine 1:1500 in 0.5% saline (specific gravity 1.00345 at 15°C.).
Hypobaric percaine solution of Howard Jones.
N_2O = Nitrous oxide. O_2 = Oxygen. $(C_2H_3)_2O$ = Di-vinyl ether ("Vinesthene")
C_3H_6 = Cyclopropane.

EXCISION of CARBUNCLE
5 Cases

No.	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Premedic.	Agents and Techniques	Complications		Result
							During Anaes.	Post-Operat.	
1	50	F	Excision of carb. neck	"B"	H.I.Omnopon gr.1/3 Atropine gr.1/100	Pentothal 5% Intravenous 10c.c.	Nil	Nil	Recovery
2	46	M	Excision of carb. neck	"B"	H.I.Omnopon gr.1/3 Atropine gr.1/100	Pentothal 5% Intravenous 10c.c.	Nil	Nil	Recovery
3	48	M	Excision of carb. neck	"B"	H.I.Omnopon gr.1/3 Atropine gr.1/100	Pentothal 5% Intravenous 10c.c.	Nil	Nil	Recovery
4	66	M	Excision of carb. neck	"B"	H.I.Omnopon gr.1/6 Atropine gr.1/100	Pentothal 5% Intravenous 8c.c.	Nil	Nil	Recovery
5	68	M	Excision of carb. neck	"B"	H.I.Omnopon gr.1/6 Atropine gr.1/100	Pentothal 5% Intravenous 8c.c.	Nil	Nil	Recovery

H.I. = Hypodermic injection. All hypodermic injections were given $\frac{3}{4}$ hour before operation.

Pentothal 5% = Pentothal sodium 5% aqueous solution (Abbott)
0.5 gm. Pentothal sodium in 10c.c. sterile distilled water.

4 Cases

No.	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Premedic.	Agent and Technique	Complications		Result
							During Anaes.	Post-Operat.	
1	49	F	Incision & drainage abscess rt. thigh	"B"	H.I.Omnopon gr. 1/3 Atropine gr. 1/100	Pentothal 5% Intravenous 10c.c.	Nil	Nil	Recovery
2	60	M	Incision & drainage abscess rt. thigh	"B"	H.I.Omnopon gr. 1/3 Atropine gr. 1/100	Pentothal 5% Intravenous 8c.c.	Nil	Nil	Recovery
3	54	M	Incision & drainage abscess rt. thigh	"B"	H.I.Omnopon gr. 1/3 Atropine gr. 1/100	Pentothal 5% Intravenous 9c.c.	Nil	Nil	Recovery
4	52	M	Incision & drainage abscess lt. thigh	"B"	H.I.Omnopon gr. 1/3 Atropine gr. 1/100	Pentothal 5% Intravenous 9c.c.	Nil	Nil	Recovery

H.I. = Hypodermic Injection. All hypodermic injections were given $\frac{3}{4}$ hour before operation.

Pentothal 5% = Pentothal sodium 5% aqueous solution.

EXTRACTION of CATARACT
4 Cases

No.	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Premedic.	Analgesic Agent and Technique	Complications		Result
							During Anal.	Post-Operat.	
1	70	F	Ext.cataract left eye	"B"	H.I.Omnopon gr. 1/6	Percaine 1% Local instill. Percaine 1:1000 1c.c. Ciliary ganglion block.	Nil	Nil	Recovery
2	63	F	Ext.cataract left eye	"B"	H.I.Omnopon gr. 1/3	Percaine 1% Local instill. Percaine 1:1000 1c.c. Ciliary ganglion block.	Nil	Nil	Recovery
3	65	F	Ext.cataract right eye	"B"	H.I.Omnopon gr. 1/3	Percaine 1% Local instill. Percaine 1:1000 1c.c. Ciliary ganglion block.	Nil	Nil	Recovery
4	68	M	Ext.cataract left eye	"B"	H.I.Omnopon gr. 1/6	Percaine 1% Local instill. Percaine 1:1000 1c.c. Ciliary ganglion block	Nil	Nil	Recovery

H.I. = Hypodermic injection. All hypodermic injections were given $\frac{3}{4}$ hour before operation.

Percaine 1% = Percaine 1% with adrenaline 1:200,000.

Percaine 1:1000 = Percaine 1:1000 in physiological saline.

CHOLECYSTECTOMY FOR GALL STONES
3 Cases

No.	Age in Yrs.	Sex	Operation	Anaes. Risk	Prelimin. Premedic.	Analgesic Agent and Technique	Complications		Result
							During Anal.	Post-Oper.	
1	48	F	Cholecyst-ectomy	"C"	H.I.Omnopon gr.1/3 Hyoscine gr.1/150	Percaine 1:1500 Spinal analgesia	Nil	Nil	Recovery
2	48	F	Cholecyst-ectomy	"C"	H.I.Omnopon gr.1/3 Hyoscine gr.1/150	Percaine 1:1500 Spinal analgesia	Nil	Nil	Recovery
3	44	F	Cholecyst-ectomy	"C"	H.I.Omnopon gr.1/3 Hyoscine gr.1/150	Percaine 1:1500 Spinal analgesia	Nausea, during visceral traction	Vomit-ing Keton-uria	Recovery

H.I. = Hypodermic Injection. All hypodermic injections were given $\frac{3}{4}$ hour before operation.

Percaine 1:1500, Hypodermic percaine solution of Howard Jones.

The Management of the Diabetic Surgical Cases presented.

Each patient was an individual problem. A general outline only, can be given of the preliminary preparation and post-operative treatment adopted.

In the cases of gangrene and infections (carbuncle and abscess) recorded, the patients were known diabetics whose disease had previously been controlled by diet and insulin. The development of gangrene and the occurrence of infection disturbed the balance - the clinical features of thirst and polyuria and the chemical signs of hyperglycaemia, glycosuria and ketonuria shown by the patients indicates clearly that the diabetes was out of control. Time was available for the pre-operative re-establishment of control and for the adoption of a simple and easily assimilable diet of adequate caloric value and with a carbohydrate content of at least 100 grammes. Insulin was given at frequent intervals (every four hours) in sufficient dosage to completely abolish ketonuria and to reduce hyperglycaemia and glycosuria to a minimum. As a prophylactic against operation and post-operative dehydration abundant fluids were administered.

All operations were performed at or about midday. Breakfast and insulin on the morning of operation were omitted. Glucose, grammes 50 by mouth, preceded by insulin units 25 subcutaneously given twenty minutes earlier, was administered three hours before anaesthesia. Post-operatively, during the remainder of the day of operation, the patients were given milk, 6 ounces every two hours - four feeds. Two drachms of glucose were added to the second and fourth milk feeds, and insulin was injected twenty minutes before them. The urine was tested every two hours and, ketonuria being absent, the dose of insulin preceding the milk-glucose feeds determined

as follows :

Red	Orange	Yellow	Yellow-green
20	15	10	5

the numerator representing the results of the Benedict tests and the denominator the dosage of insulin.

It was possible the next morning to return to the same details of management as before operation. Abatement of the need for insulin, synchronous with recovery, was demonstrated by repeated chemical examinations of the blood and urine.

Recovery complete, final adjustments of diet and insulin were made, and the patients observed for seven days before discharge to the outdoor diabetic clinic.

In the diabetic patients undergoing cataract extractions, performed under local analgesia, pre-operation stabilisation of diet and insulin was undertaken and an adequate fluid intake assured. Midday was the time of operation in these cases, and on the morning of operation, breakfast being withheld, the usual dose of insulin plus 10 units more was given succeeded in twenty minutes by glucose, grammes 2 for each unit of insulin, per os, three hours before analgesia. After operation alternate milk and milk-glucose feeds at two-hourly intervals and insulin, dosage (in the absence of ketonuria) according to the colour scheme, before the two milk-glucose feeds, were given during the rest of the day of operation. The patients were able to resume their pre-operatively stabilised diet and insulin the next morning. Routine urine examinations and blood sugar estimations were continued throughout the period of indoor treatment and supervision maintained at the outdoor clinic for diabetes.

The diabetics whose disease was complicated by gall stones were prepared for cholecystectomy by the provision of a generous diet in soft and simple

form, adequate insulin and abundant fluids. The operation having been 'fixed' for noon on a particular day, glucose by mouth grammes 50, preceded by insulin subcutaneously units 25, was administered at 9 a.m. on the day of operation, the usual breakfast and insulin being omitted.

With the exception of one case the post-operative management was as follows: During the remainder of the day of operation alternate milk and milk-glucose feeds and insulin before the milk-glucose feeds in accordance with the results of the Benedict tests were given. Next morning the diet which would be given to similar non-diabetic patients was begun. Until such time as the patients were able to take their pre-operation level of carbohydrate by mouth any deficiency below this total amount was made good as glucose. Insulin was prescribed in sufficient dosage to allow of the utilisation of the post-operative diet and adjuvant glucose. Thereafter a gradual resumption of the patients' customary diabetic diets was made and the insulin requirements modified accordingly. Control and transition were effected throughout by regular examinations of the urine and estimations of the blood-sugar.

Post-operative vomiting and ketosis were encountered in one gall bladder case. The administration of an abundance of fluid and of an adequate supply of carbohydrate was assured by rectal glucose-saline, 50 grammes of glucose in 1 litre of normal saline, and 40 units of insulin were given subcutaneously. With the urine ketone-free next morning, control similar to that already described for the other cholecystectomy cases was practicable.

Commentary on the Methods of Anaesthesia and Analgesia employed.

LOCAL ANALGESIA

Cataract extractions were performed under local analgesia, a combination of surface with nerve-block analgesia carried out with all the precautions of modern asepsis. The patients had had omnopon hypodermically, 1/6th to 1/3rd of a grain, three-quarters of an hour before coming to the operating theatre. The instillation of a few drops of percaine 1 percent solution into the conjunctival sac was followed by the retrobulbar injection of 1 c.c. of 1:1000 percaine solution around the ciliary ganglion.

The risk of infection was negligible in the absence of sepsis in the neighbourhood. Percaine was chosen in preference to cocaine for the surface analgesia because of its more prolonged action and freedom from any concomitant toxic or psychological effects.

This simple technique yielded excellent results - a quiescent patient, adequate analgesia and minimal post-operative interference with metabolism.

SPINAL ANALGESIA

Subarachnoid spinal block was employed in two of the cases of amputation of leg and in the three cases of cholecystectomy. In all five, Etherington Wilson's modification of the Howard Jones technique, using 1:1500 hypobaric percaine solution, was adopted.

Three-quarters of an hour before operation the preliminary sedatives were given and the patients had their eyes lightly bandaged and their ears plugged with cotton wool. The volumes of percaine solution injected, the post-injection 'sitting up' periods allowed, and the levels of analgesia attained were the following:

	Volume of Percaine Solution	Sitting-up Period	Level of Spinal Block
Amputation of leg	8 c.c.	30 seconds	Up to T.12
Cholecystectomy	10 c.c.	50 seconds	Up to T.4

Ephedrine grains 1 administered intramuscularly at the conclusion of the subarachnoid injection proved its value as a prophylactic against circulatory depression.

In the patients undergoing amputation of leg abolition of consciousness, considered desirable, was obtained with inhalation nitrous oxide-oxygen, minimal quantities of di-vinyl ether being added to avoid any need for suboxygenation. Of those operated upon for gall stones, the first and second slept throughout the operation. The third patient even though disturbed by nausea, consequent upon visceral traction during a difficult operation, refused inhalation anaesthesia. Spinal analgesia, selected for its slight effect on metabolic processes, gave a very good result in the amputation cases. In the cholecystectomy cases high spinal block provided the best possible operating conditions - flaccid abdominal wall, quiet breathing and contracted intestines. With no absolute contra-indications to its use in these patients, it was the method of choice.

Inhalation anaesthesia with nitrous oxide-oxygen supplemented with minimal di-vinyl ether would have obviated the "vago-traction-nausea" reflex and doubtlessly have avoided the post-operative vomiting and ketosis met with in the third cholecystectomy case.

INHALATION ANAESTHESIA

Inhalation cyclopropane-oxygen anaesthesia, closed circuit technique with total rebreathing and carbon dioxide absorption was used for amputation of leg on three occasions.

In the first of these patients the use of spinal analgesia was precluded by sepsis in the region of the proposed lumbar puncture. Inhalation anaesthesia was necessary; cyclopropane-oxygen was preferred. Occurring over a short period the increased capillary bleeding associated with cyclopropane administration gave no cause whatever for concern. The excellent end result obtained in this case was repeated in the other two diabetics requiring amputation.

INTRAVENOUS ANAESTHESIA

For the excision of carbuncles and the incision and drainage of abscesses intravenous anaesthesia with pentothal sodium, 5 percent aqueous solution, preceded by omnopon and atropine administered hypodermically, gave a smooth induction, adequate anaesthesia and a rapid recovery. The absence of post-anaesthetic nausea and vomiting was particularly advantageous.

The effects on carbohydrate metabolism and on the reaction of the blood were almost negligible. The single-dose method was all that was required.

The anaesthetic and analgesic agents employed in the series of surgical diabetic cases presented were those known to have the minimum effect on the hydrogen-ion concentration of the blood and on the blood sugar. The use of chloroform, condemned by trustworthy authorities, was excluded. Di-ethyl ether was avoided.

Anaesthesia and Analgesia for the Elimination of Foci of Infection

In his search for primary foci during the treatment of diseases, such as rheumatism in its various forms, peptic ulcer and focal nephritis, in which non-specific infection plays a part, the physician can often find ample evidence, naked eye, bacteriological and radiological, to convict the tonsils and adenoids, the accessory nasal sinuses and the teeth. He directs that these sources of infection be eradicated. The methods of anaesthesia and analgesia used at St. James' Hospital for the surgical procedures involved will be described. Adequate preparation and the administration of any necessary or desirable preliminary medication is practical in patients under treatment in the medical wards.

TONSILLECTOMY and ADENOIDECTOMY

When performed, guillotine enucleation of tonsils and curettage of adenoids in children is carried out under the single-dose ethyl chloride or ethyl chloride-diethyl ether methods. Dissection tonsillectomy demands quiet anaesthesia with relaxed muscles for an indefinite period. An active cough reflex is essential at the conclusion of the operation. The technique adopted is as follows :

One hour before operation a hypodermic injection of atropine, dose according to age, is given together with paraldehyde per rectum, 1 drachm per stone of body weight as a 10 percent solution in normal saline, in nervous children. Paraldehyde, however, is contra-indicated in cases of nephritis.

Anaesthesia is induced with the ethyl chloride-di-ethyl ether sequence and with the patient in the "thyroid position" is maintained by the insufflation of di-ethyl ether vapour through the metal pipe on the tongue depressor of the Boyle-Davis gag. The gag is held in position with an adjustable 'jack'. The adenoids are curetted after the tonsils have been removed. In all adults the tonsils are enucleated by dissection. Local analgesia has not found favour. The increased risk of deep cervical infection after operation is a serious objection to its use. Endotracheal nitrous oxide-oxygen-di-ethyl ether inhalation anaesthesia, transnasal intubation with a wide-bore Magill tracheal tube and a pharyngeal pack of gauze is preferred to the endopharyngeal insufflation method. An adequate dose of omnopon and atropine is given three-quarters of an hour previously. The tracheal tube is removed when, almost immediately the operation is over, the cough reflex has returned.

OPERATIONS on the ACCESSORY NASAL SINUSES

Intranasal drainage of the accessory sinuses in adults is performed under local analgesia. The following is a brief description of the technique used:

Three-quarters of an hour before operation the patient is given an adequate dose of omnopon-hyoscine. Half an hour before operation the local analgesia is undertaken; the whole procedure a combination of surface with nerve block analgesia takes about ten minutes. The nostrils are first purified with 2 percent mercurochrome, and the mucous surfaces of the nasal fossae are then painted over with percaine, 2 percent solution, with adrenalin. Care is necessary to prevent any of the solution from trickling down into the pharynx. The roof of the nose in the region of the cribriform plate is avoided. Sluder's method of nerve blocking is employed at the conclusion of the surface application. Two long and two short silver wire probes are used. They are tipped with wool which is then soaked in the percaine-adrenalin solution. The two short ones are passed up as far forwards and as high up as possible to lie at the roof of the nose near the point of entrance of the nasal nerve and kept in position for two minutes. The long ones are slipped backwards and obliquely upwards until they are felt to impinge on the anterior wall of the sphenoid sinus; analgesia from block of the spheno-palatine ganglion and its branches results within two minutes.

The patient is ready for operation after a lapse of twenty minutes. Providing care is taken to avoid trauma, there is no risk of introducing infection into the deeper tissues from the surface with this technique.

In adults when general anaesthesia is requested and for all children endotracheal inhalation anaesthesia with nitrous oxide-oxygen-di-ethyl ether

is used. A Magill tube is introduced through the mouth under direct laryngoscopy. The entrance of blood into the larynx and trachea is prevented during operation by packing the pharynx with gauze soaked in liquid paraffin and after operation by a brisk cough reflex. By the preliminary administration of a hypodermic injection of pituitrin (which drug has been shown to decrease the coagulation time of the blood), by the preliminary application by painting or spraying of percaine adrenalin solution to the nasal mucosa and by the adoption of the endotracheal method which ensures a perfectly free airway throughout, excessive haemorrhage, the former bugbear of inhalation anaesthesia for intra-tracheal surgery, is obviated.

Extensive operations on the nasal sinuses are carried out under inhalation anaesthesia, endotracheal administration.

DENTAL EXTRACTIONS

For children, inhalation anaesthesia with di-vinyl ether is the method of choice. Using Goldman's closed inhaler, 3 c.c. "Vinesthene" (the proprietary preparation) from an ampoule is the average amount for a single-dose technique. This provides adequate anaesthesia for six or eight extractions. The outstanding advantages of this method are safety, rapidity of induction and recovery, absence of nausea and vomiting and of toxic effects on the bodily organs and functions after administration. A dental prop or a Mason's gag is inserted in the mouth before the induction of anaesthesia. A gauze pack placed behind the tongue when induction is complete is a wise precaution against the inhalation of foreign bodies.

Dental extractions in adults are performed under nasal nitrous oxide-oxygen. An intermittent flow apparatus is ideal. Before every administration a prop is inserted. After anaesthesia is established a properly designed and suitably placed mouth-pack prevents the aspiration of debris, the inspiration of air and the escape of 'gas'. Adults who dislike nitrous oxide are given intravenous anaesthesia with pentothal sodium, 5 percent aqueous solution. Preceded by omnopon, 1/3rd of a grain, and atropine, 1/100th of a grain, doses up to 10 c.c. Secure quiet anaesthesia with muscular relaxation for periods up to fifteen minutes. The cough reflex is not materially interfered with. Recovery is less rapid than after nitrous oxide-oxygen but this is no great disadvantage in indoor patients. The precautions necessary are a recumbent position of the patient, the insertion of a prop or gag before the intravenous injection and the use of a mouth-pack during operation. When prolonged anaesthesia is anticipated endotracheal nitrous oxide-oxygen-di-ethyl ether is employed. The Magill

tube is introduced through the nose.

Local analgesia is inadvisable in children. In adults for multiple extractions the only safe method in the presence of frank sepsis, nerve-block analgesia, demands an exact anatomical knowledge, considerable practice and sufficient time for the successful blocking of the required nerves in the various fossae and foramina.

The Treatment of Certain Types of Convulsions by the Administration of some of the Newer Drugs used in Anaesthesia

The administration of avertin per rectum for the control of the reflex spasms of tetanus has been described on several occasions. At St. James' Hospital, during the period from January 1st to December 31st, 1938, three cases of tetanus in children were treated with antitoxin and avertin with success. The dose of avertin required was the full basal narcotic dose of 0.1 gramme avertin per kilogramme of bodyweight; a smaller dose was inefficient. This was repeated as often as necessary, thrice during the twenty-four hours if need be, to avoid recurrence of the spasms. There was less tendency for a 3 percent solution in distilled water to be returned than the $2\frac{1}{2}$ percent solution usually recommended.

The first rectal injection was administered under chloroform anaesthesia in all three cases. All the enemata were given with the patients lying on their left sides to aid retention. This position was maintained after completion of the injections. There was then little risk of respiratory obstruction from falling back of the tongue as the narcosis deepened and the jaw relaxed. As an additional precaution the nursing staff was apprised of this possibility.

To these children, given abundant fluids and liberal supplies of glucose, avertin appeared to have an extremely low toxicity. In one girl twenty-five consecutive administrations produced no obvious ill-effects. Repeated examinations of the urine for the presence of albumen, sugar and ketones proved negative.

With fresh properly prepared solutions administered at body temperature no local irritant effects were observed.

AVERTIN DOSAGE

Case I

A.McG. Female Aged 12 years Weight 32 kilogrammes

Day of Disease from Admission	No. of Doses	Grammes Avertin per dose	Total Avertin in 24 hrs. In Grms.	Percentage Solution in Distilled Water
2	3	1st dose 2.6 2nd " 2.6 3rd " 3.2	8.4	2½
3	3	1st dose 3.2 2nd " 2.1[X] 3rd " 3.2	8.5	2½
4	3	1st dose 2.1[X] 2nd " 3.2 3rd " 3.2	8.5	2½
5	3	1st dose 3.2 2nd " 2.1[X] 3rd " 2.1[X]	7.4	2½
6	2	3.2	6.4	3
7	2	3.2	6.4	3
8	2	3.2	6.4	3
9	1	3.2	3.2	3
10	1	3.2	3.2	3

In 9 days: Doses 20. Avertin 58.4 grammes.

[X]One-third of total injection returned.

CASE II

M.W. Female Aged 13 years Weight 38 kilogrammes

Day of Disease from Admission	No. of Doses	Grammes Avertin per dose	Total Avertin in 24 hours. In Grms.	Percentage Solution in Distilled Water
1	1	3.8	3.8	3
2	3	3.8	11.4	3
3	2	3.8	7.6	3
4	2	3.8	7.6	3
5	2	3.8	7.6	3
6	3	1st Dose 2.5 2nd " 3.8 3rd " 3.8	10.1	$2\frac{1}{2}$ x 3 3
7	3	3.8	11.4	3
8	2	3.8	7.6	3
9	3	3.8	11.4	3
10	2	3.8	7.6	3
11	1	3.8	3.8	3
12	1	3.8	3.8	3

In 12 days: Doses 25. Avertin 93.7 grammes.

x $2\frac{1}{2}$ percent solution of avertin dispensed in mistake for 3 percent solution.

One-third of total injection returned.

CASE III

J.C. Male Aged 10 years Weight 29 kilogrammes

Day of Disease from Admission	No. of Doses	Grammes Avertin per dose	Total Avertin in 24 hours. In Grms.	Percentage Solution in Distilled Water
2	2	2.9	5.8	3
3	2	2.9	5.8	3
4	3	2.9	8.7	3
5	2	2.9	5.8	3
6	3	2.9	8.7	3
7	2	2.9	5.8	3
8	2	2.9	5.8	3
9	2	2.9	5.8	3
10	2	2.9	5.8	3
11	1	2.9	2.9	3

In 10 days: Doses 21. Avertin 60.9 grammes.

Avertin narcosis undoubtedly contributed in no small measure to the successful treatment of these severe cases of tetanus. It enabled antitoxin administration, dressing of wounds, nasal feeding and general nursing to be carried out without the precipitation of reflex spasms.

Here are recorded two cases of convulsions under inhalation anaesthesia with nitrous oxide - oxygen - di-ethyl ether controlled by the intravenous injection of evipan sodium in 10 percent aqueous solution.

The convulsions were not the anoxaemic spasms of gas anaesthesia but the epileptiform seizures which have been described many times under the misnomer of "ether convulsions".

They occurred in patients with no history, family or personal, of convulsions.

CASE I

J.N. Male. Aged 19 years. Electrician.

Admitted: 6.10.38.

Complaint: Abdominal pain, nausea and vomiting. Vomited twice before admission.

Duration: 24 hours.

History: No family history of epilepsy.

No personal history of convulsions. No previous anaesthesia.

Physical Examination:

On admission -

General condition: Well nourished, well developed, intelligent young man.

Temperature 101.4°F. Pulse rate - 112 per minute.

Respiratory rate - 24 per minute. Blood pressure 118/70.

Alimentary system: Tongue furred. Rigidity and tenderness on pressure in right iliac fossa.

Urinary system: Urine: Specific gravity 1022. Acid reaction. Slight albuminuria. No sugar or ketones present.

Circulatory system: Heart $\frac{III}{1/3_2}$ Heart sounds normal. No murmurs.

Respiratory system: No apparent disease.

Nervous and locomotory systems: No apparent disease.

Diagnosis: Acute appendicitis.

Anaesthetic risk: "B".

Operation: 6.10.38. Appendicectomy. Retrocolic gangrenous appendix.

Anaesthesia: Premedication - hypodermic injection, morphine gr. 1/6th and atropine gr. 1/100th, given $\frac{3}{4}$ hour before operation.

Agent and technique - inhalation nitrous oxide - oxygen - di-ethyl ether.

Administration by means of face-piece and retention-harness. Hot water jacket round the ether bottle of the nitrous oxide-oxygen apparatus.

Hirsch airway. Small quantity of carbon dioxide added to anaesthetic mixture during induction.

Convulsions: Onset: Time: 30 minutes after commencement of anaesthesia, during delivery of appendix.

Mode: Muscular twitching about the face.

Progress: Rapid spread of spasms to other muscles until whole body involved in powerful spasmodic movements. Jerky respiration with laryngeal stridor and increasing cyanosis.

Additional observations:

Pupils and eye reflexes those of 1st plane, 3rd stage (surgical) anaesthesia.

Skin dry and hot.

Theatre temperature 79°F. Humidity reading, "high".

CASE II

A.B. Male. Aged 5 years. Schoolboy.

Admitted: 23.11.38.

Complaint: Abdominal pain, nausea and vomiting.

Duration: 60 hours.

History: No family history of epilepsy.

Child has never suffered from convulsions.

No previous anaesthesia.

Physical Examination:

On admission:

General condition: Well nourished boy. Ill and toxic-looking.

Temperature 102.3°F. Pulse rate - 126 per minute.

Respiratory rate - 30 per minute.

Alimentary system: Generalised abdominal rigidity and tenderness on pressure.

Urinary system: Urine: specific gravity 1018. Acid reaction.

Trace of albumen. No sugar or ketones present.

Circulatory system: Heart $\frac{III}{1/3\frac{1}{2}}$ Heart sounds normal. No murmurs.

Respiratory system: Poor air entry - both bases.

Nervous and locomotory systems: No apparent disease.

Diagnosis: Acute appendicitis with general peritonitis.

Anaesthetic risk: "C".

Operation: 23.11.38. Appendicectomy with drainage. Appendix gangrenous and perforated. General peritonitis.

Anaesthesia: Premedication: Hypodermic injection, atropine gr. 1/150th, given $\frac{3}{4}$ hour before operation.

Agent and technique: Inhalation nitrous oxide-oxygen-di-ethyl ether.

Administration by means of face-piece and retention-harness. Hirsch airway.

Hot water jacket round ether bottle of nitrous oxide-oxygen apparatus.

No carbon dioxide used prior to the onset of convulsions.

Convulsions: Onset: Time: 25 minutes after commencement of anaesthesia.

During delivery of appendix.

Mode: Twitching of facial muscles.

Progress: Whole body soon involved in rhythmic spasms.

Jerky ineffectual breathing with rapidly increasing cyanosis.

Additional Observations:

Signs of anaesthesia at onset of convulsions these of 1st plane surgical anaesthesia.

Skin dry and burning. No perspiration whatever.

Theatre temperature 80°F. Humidity reading - "high".

TREATMENT

In both cases treatment, in the first instance, was undertaken by the House Physician administering the anaesthetic. Ether administration had been discontinued, the face-piece removed, the patency of the airways verified and the patient's head raised high before my arrival in the operating theatre. A 10 percent carbon dioxide 90 percent oxygen mixture was being insufflated endopharyngeally through the metal pipe of the Hirsch artificial airway in an attempt to combat the cyanosis which had developed with the onset of the generalised epileptiform movements. The surgeon was attempting to complete the operation, with all possible speed, in a convulsing patient. The further treatment was as follows :-

Case I

At my request the surgical manipulations were temporarily suspended. Calcium "Sandoz", 10 c.c., 10 percent was given into a vein in the left arm without improvement. Evipan sodium, 3.5c.c., in 10 percent aqueous solution was then administered intravenously at the rate of 1 c.c. in fifteen seconds. The convulsions promptly ceased. The patient was now in the profound 3rd plane of 3rd stage (surgical) anaesthesia. His head was lowered, the carbon dioxide-oxygen insufflation stopped, the pharyngeal airway removed, a wide-bore Magill endotracheal tube passed through the mouth under direct vision and inhalation nitrous oxide-oxygen (18 percent oxygen) started. The operation was resumed and finished, chloroform being added to the nitrous oxide-oxygen in quantities sufficient to maintain anaesthesia in the normal 2nd plane. The convulsions did not recur.

The seizures controlled, the patient's temperature was taken per rectum and his pulse rate counted. The readings were: 105°F. and 142 per minute. The theatre fan was started and kept going throughout the remainder of the

operation. He was returned to the ward with a rectal temperature of 102.4°F. and a pulse rate of 130 per minute, specific instructions having been given to the nursing staff to keep him cool. An hour later his temperature was 101.6°F, and his pulse rate 124. Within another hour his temperature had fallen to 101°F., and his pulse rate to 116.

Next morning, with a temperature of 100.2°F. and a pulse rate of 110, he looked as well as any patient might after the removal of a gangrenous appendix the night before.

Case II

The operation was abandoned for a short time. An intravenous injection of 5 c.c. calcium "Sandoz" was given with no effect whatever. Evipan sodium solution, 1.5 c.c., of 10 percent, was given intravenously and immediately arrested the convulsions. The signs of anaesthesia at the conclusion of the evipan administration were those of the deep 3rd plane with the neuro-muscular mechanism markedly depressed. Inhalation nitrous oxide oxygen (18 percent oxygen) through an endotracheal tube, introduced transorally under direct laryngoscopy, with the addition of minimal quantities of chloroform, maintained anaesthesia in the desired 2nd plane. With the excellent operating conditions thus provided it was possible to complete the appendicectomy in the shortest possible time. There was no recurrence of the convulsions.

Readings of the rectal temperature and of the pulse rate can be conveniently summarised thus :-

	Rectal Temperature Degrees Fahrenheit	Pulse Rate Beats per Minute
Convulsions controlled.	106	150
Before leaving theatre.	103	140
1 hour after return to ward.	102.3	136
2 hours after " "	101.7	125
12 hours after " "	101	120

The theatre fan had been set going as soon as the convulsions had been controlled and the patient kept cool on his return to the ward.

Both patients were ultimately discharged from hospital with their wounds 'healed and sound'. After a suitable stay in a convalescent home, the young adult was able to resume his work, the schoolboy to go back to school.

Two further observations are worthy of note:

The first and second urine passed after operation was acid in reaction in both instances.

The ether remaining in the bottle of the nitrous oxide-oxygen apparatus after the anaesthesiae complicated by convulsions was deliberately used the next day for appendicectomy in non-pyrexial adults to whom atropine, 1/100th of a grain by hypodermic injection, had been given pre-operatively. With almost identical atmospheric conditions in the operating theatre, with the water jacket of the ether bottle filled with hot water, with a little carbon dioxide added to the anaesthetic mixture during induction, and with brief periods of cyanosis permitted during administration, these operations were carried out under 2nd plane surgical anaesthesia with no occurrence of twitching.

The enigma of "Ether Convulsions" remains unsolved. The various conflicting hypotheses - idiosyncrasy, convulsant factor in di-ethyl ether, atropine poisoning, excessively deep or prolonged anaesthesia, incomplete anaesthesia, anoxia, hyperoxygenation, rapid increase in blood carbon dioxide, acapnia, congestion of the Rolandic area of the cerebral cortex, diminution in the physiologically active fraction of the serum-calcium, septic toxaemia, hyperthermia - are well known. The abundant literature needs no further review or analysis.

In the cases I have described, epileptiform seizures began in 1st plane, 3rd stage anaesthesia with inhalation nitrous oxide - oxygen - di-ethyl ether and were abolished by immediately deepening the anaesthesia with the administration, intravenously, of evipan sodium. Both patients were pyrexial and toxaemic.

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