PRACTICAL ANÆSTHETICS

J. ROSS MACKENZIE

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FOR STUDENTS, HOSPITAL RESIDENTS AND PRACTITIONERS

BY

J. ROSS MACKENZIE

M.D., D.A. (R.C.P.& S.Eng.)

LECTURER ON ANÆSTHETICS, UNIVERSITY OF ABERDEEN; SENIOR ANÆSTHETIST, ROYAL INFIRMARY, ABERDEEN, AND ROYAL ABERDEEN HOSPITAL FOR SICK CHILDREN; CONSULTING ANÆSTHETIST, EMERGENCY MEDICAL SERVICE

WITH A FOREWORD BY

W. C. WILSON

M.B., Ch.B., F.R.C.S.E.

REGIUS PROFESSOR OF SURGERY, UNIVERSITY OF ABERDEEN

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FOREWORD

ANÆSTHESIA in the hospitals of this country, certainly the teaching school hospitals and probably all large hospitals, has become, or will shortly become, a separate medical speciality. The hospital anæsthetist, specially trained and qualified, gives full-time service to the practice and study of the speciality. This development is to be welcomed inasmuch as it raises the standard and status of anæsthetic practice, which yearly attracts an increasing number of competent young men and women who may be expected to contribute to the knowledge of human physiology and pharmacology. Nevertheless the general practitioner is still required to administer anæsthetics on many occasions and the medical student must learn the simple methods.

This handbook of anæsthetics by Dr. Ross Mackenzie should prove a most useful guide to the student and greatly facilitate the task of the anæsthetist in teaching and of the student in learning the art of anæsthesia. With its strong emphasis on practical considerations the book will certainly appeal to the general practitioner in need of practical guidance. The part-time anæsthetist in smaller hospitals will also find much of interest and value in a book which is based on a long and extensive experience of a considerable variety of anæsthetic agents and methods.

W. C. WILSON.

MEDICAL SCHOOL,
UNIVERSITY OF ABERDEEN.

PREFACE

THIS manual of anæsthetics is intended to form a foundation on which the medical student and the medical or surgical hospital resident may build the practice of anæsthesia and analgesia and as a guide to the practitioner or the occasional anæsthetist, who desires to know the type of anæsthesia best suited to his patient in various circumstances. The practical aspect of the subject has predominated in the descriptions of the anæsthetic agents and the methods of their administration.

The regulations for the Diploma in Anæsthetics, along with a summary of the subjects of the examination and a list of books bearing directly on these subjects, have been included in the final chapter.

It is a pleasant duty to express my gratitude to Professor W. C. Wilson for writing a Foreword to this manual and for his invaluable help and criticism in its preparation. It has, too, been my good fortune to have had associated with me, in the teaching of anæsthetics to medical students, Hospital Residents and Practitioners, indefatigable workers such as

Albert Christie, M.A., M.B., Ch.B., D.A., Anæsthetist, Victoria Infirmary, Glasgow,

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Miss Maeve Cronin, M.B., Ch.B., D.A., Resident Anæsthetists, Royal Infirmary, Aberdeen,

each of whom has read the typescript and has made suggestions which are incorporated in the text.

To the teaching of Drs. Gwathmey of New York, Wesley Bourne of Montreal, Clement of Toledo, Ohio, Ivan W. Magill, C. Langton Hewer, J. Blomfield, Victor Goldman of London, and the late H. P. Fairlie of Glasgow, I am deeply indebted: their work and personalities have been a continuing source of inspiration to me.

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J. ROSS MACKENZIE.

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CONTENTS

CHAPTER I

THE PREPARATION OF THE PATIENT

THE preparation of a patient for an anæsthetic and an operation demands the careful consideration of the anæsthetist because on its thoroughness may frequently depend—

(*a*) The safety and efficiency of the anæsthesia.
(*b*) The resistance of the patient to surgical trauma.
(*c*) The absence of post-anæsthetic complications.
(*d*) The nature and the duration of the convalescence.

Examination of Patient

In order to evaluate the anæsthetic and surgical risk the anæsthetist should examine the patient at least 12 to 24 hours before the operation and note the temperature, the pulse and respiratory rate, and any abnormality of the respiratory and the cardio-vascular systems. The systolic and diastolic blood pressures and the pulse pressure should be considered, and the urine examined for albumin, sugar, blood and pus. If there is any clinical evidence of anæmia the condition of the blood must be investigated regarding the red cell count, the percentage of hæmoglobin and the coagulation time.

A rapid and useful estimate of the physical condition of a patient before and during an operation may be derived from the application of the following formulæ :

Moots' Index of operability is a formula for assessing the cardiovascular stability of the patient. It states that the pulse pressure divided by the diastolic pressure is a reliable index, e.g. :

$$\frac{\text{Pulse Pressure}}{\text{Diastolic Pressure}} = \frac{40 \text{ mm. Hg}}{80 \text{ mm. Hg}} = 50 \text{ per cent.} = \text{normal.}$$

$$\frac{\text{Pulse Pressure } 75}{\text{Diastolic Pressure } 100} = 75 \text{ per cent.}$$

$$\frac{\text{Pulse Pressure } 20}{\text{Diastolic Pressure } 80} = 25 \text{ per cent.}$$

If the pulse pressure (mm. Hg) is above 75 per cent or below 25 per cent of the diastolic pressure, the operative risk is very high.

Sebrasez's breath-holding test is a formula for assessing the blood and tissue chemistry. The patient is allowed to rest in bed undisturbed for 5 minutes and then requested to take in a deep breath, close the mouth and nostrils and hold the breath. The normal time in males is 35 seconds, and in females 30 seconds. If the patient can hold the breath for only 20 seconds it indicates a condition of " acidemia," and if for only 10 seconds a condition of " acidosis." In very ill patients these formulæ are frequently not reliable, and an accurate estimate of the ability of such patients to withstand an anæsthetic and an operation can be made only on the results of a complete clinical examination.

McKesson's index of danger on the operation table states that a pulse rate of 100 and rising with a systolic blood pressure under 100 mm. Hg and falling indicates a progressive deterioration in the condition of the patient and requires immediate remedial measures.

Physiological Efficiency of Patient

The fluid balance of the surgical patient is very important, and must be conserved and maintained. In poor risk patients and in serious and prolonged operations an intravenous saline " drip " should be arranged at the commencement of the operation. Much can be done in this way to control the blood pressure and to repair the fluid balance of the patient. Prophylaxis in such cases is infinitely more important than treatment after the event, and every surgical patient should be encouraged to drink as much fluid as possible for several days before the operation.

The nearer the surgical patient can be brought to or allowed to remain in his or her normal standard of gastro-intestinal efficiency the easier and less interrupted the convalescence will be, and a sure method of reducing vitality and resistance to infective processes is to subject the patient to indiscriminate starvation, purgation and enemata.

Nutrition

There should be no solid food in the stomach when the patient arrives in the anæsthetic room. All food should be withheld

from adults for 3 to 4 hours, and in children for 2 or 3 hours before an operation. Apart from this absolute rule, any modification of the pre-operative nutrition of the patient such as tends to produce inanition or disturb metabolism is highly detrimental to post-anæsthetic convalescence. Food is the agent which stimulates normal gastro-intestinal peristalsis, and it should be given liberally in an easily digested semi-liquid form. Carbohydrates have a much greater pre-operative and post-operative food value than proteins, and a cup of weak tea with plenty of sugar or a spoonful of extract of malt or honey or glucose is much more valuable than a cup of beef-tea or bovril. The absorption of carbohydrate commences soon after it is taken, and the rate of absorption remains constant. Any deficiency of carbohydrate in the diet rapidly causes a diminution of the glycogen stored in the liver, and in this way the metabolism of the surgical patient may be seriously upset. The complete oxidation of fat into CO_2 and H_2O depends upon the normal carbohydrate content of the blood and tissues. Incomplete oxidation of fat results in diacetic and B-hydroxybutyric acids with acetone as a by-product and acidosis or ketosis in the surgical patient.

The Aperient

Drastic purgative agents should rarely be administered to the surgical patient. The regular normal daily stool need not be disturbed except at the request of the surgeon, and then a mild aperient such as cascara, or compound liquorice powder or milk of magnesia may be administered 48 hours before the operation. Any watery evacuation of the gastro-intestinal tract such as results from castor oil or magnesium sulphate, promotes conditions which tend to handicap the patient, the surgeon and the anæsthetist. A drastic aperient given to a patient in the hospital not only disturbs and actually interrupts the rest and sleep so essential to physical vitality, but it agitates the patient's mind and dissipates the nerve energy which should be conserved for the coming ordeal. It irritates the mucous membrane of the intestinal tract and renders it red and swollen, while the gut may be empty and collapsed or distended with gas, the worst possible conditions for surgical intervention and technique. Further, it depletes the body of essential fluid containing chlorides and hurries

partially digested material along the intestinal tract, producing fermentation, abdominal distension, and much discomfort. The excessive peristalsis exhausts the muscular coats of the intestine, and may be a fruitful cause of paralytic ileus.

The Enema

There is no part of the pre-operative preparation which more disturbs the psychic balance of the surgical patient than the enema, which frequently appears to be considered the necessary complement to drastic and complete evacuation of the gastro-intestinal tract. To the majority of patients the enema is anticipated with dread, borne with courage and patience, and remembered with aversion. An enema on the morning of the operation not only curtails rest and sleep, it stimulates and exhausts the lower bowel and disturbs the physical and mental equanimity of the patient. Apart from rectal and perineal operations, the enema should not form part of the routine preparation of the surgical patient.

The Psychology of the Surgical Patient

The influence of the phenomena of the mind and the personal peculiarities of physical and mental organisation known as temperament—in the one case phlegmatic and in the other emotional—dominates in many patients the pre-anæsthetic and post-anæsthetic periods. Dread of the anæsthetic is the arch-enemy of the patient. The effect of apprehension or anxiety regarding the anæsthetic or the operation and their success or failure has been under-estimated. The unusual environment of the hospital or nursing home disturbs the mental equanimity of the patient in no ordinary degree. This emotional state engenders anorexia, with diminished carbohydrate consumption. It inhibits the secretory function of the gastro-intestinal tract and its concomitant glands and impairs digestion, assimilation and motility.

Glycosuria is not uncommon in the pre-anæsthetic period. It may be first detected on the morning of the operation. If the urine contained no sugar on previous examinations, it may be assumed that the sudden appearance of glycosuria is due to pre-anæsthetic emotional metabolic disturbance. The primary cause is an emotional stimulation of the suprarenal glands with an

excessive secretion of epinephrine, which excites an abnormal breaking down of liver glycogen with resulting hyperglycæmia and glycosuria.

Pain—acute or recurrent—controls, in a remarkable degree, the psychic element in the surgical patient. It appears to increase the safety of general anæsthesia and to modify its after-effects. Labour pains and the absence of apprehension regarding the anæsthetic probably account for the fact that obstetric patients pass rapidly and without resistance through the induction stage and require a comparatively small percentage of the anæsthetic agent for the production and maintenance of analgesia and anæsthesia.

The pre-anæsthetic visit and general examination by the anæsthetist inspire confidence and equanimity in the mind of the surgical patient. Other factors which help to control mental and physical disturbance in the patient are described in Chapter II.

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CHAPTER II

PREMEDICATION AND BASAL NARCOSIS

AGENTS used for premedication and for basal narcosis may be administered by the oral, hypodermic, intravenous or rectal route. Every surgical patient should be accorded the benefits that accrue from the narcotics at the command of the anæsthetist, and particularly of undisturbed sleep during the night prior to the morning of operation, and a complete amnesia of the events of the morning and for several hours after the operation.

1. The premedication most frequently used in adult surgical patients is gr. $\frac{1}{6}$ or gr. $\frac{1}{4}$ of morphine sulphate, along with gr. $\frac{1}{100}$ or gr. $\frac{1}{75}$ of atropine sulphate, administered hypodermically, 45 to 60 minutes before the time of the operation.

Or

2. Alopon, gr. $\frac{1}{3}$, and scopolamine, gr. $\frac{1}{150}$, which is put up in 1 c.c. ampoules, and $\frac{3}{4}$ c.c. is administered hypodermically 60 minutes before the time of the operation.

3. In children up to the age of 12 years, gr. $\frac{1}{200}$ to gr. $\frac{1}{100}$ of atropine sulphate only, in proportion to the age, is administered hypodermically 45 minutes before the time of the operation.

4. From 12 to 16 years, gr. $\frac{1}{8}$ of morphine sulphate, and gr. $\frac{1}{100}$ of atropine sulphate, or $\frac{1}{2}$ c.c. of alopon scopolamine is administered hypodermically 45 to 60 minutes before the time of the operation.

If the operation is very urgent and the patient has to be hurried without delay to the operation theatre, the premedication should be administered intravenously in sterile solution.

Atropine is a depressor of the secretion of the salivary glands and of the mucous glands in the pharynx, trachea and bronchi. Scopolamine is a more powerful depressor of the secretions than atropine, and in addition it has a definite sedative action on the central nervous system.

The administration of atropine or scopolamine is essential if ether is to form any part of the anæsthetic agent because ether

stimulates the salivary and mucous glands and causes a profuse secretion of fluid in the mouth, pharynx, trachea and bronchi. The accumulation of this secretion in the respiratory system renders the production of efficient surgical anæsthesia much more difficult.

Morphine and omnopon depress the respiration and delay the induction of anæsthesia unless carbon dioxide is used, but they produce in the patient an invaluable mental equanimity and indifference to the ordeal of the anæsthetic and the operation.

The effects of the administration of atropine and of morphine on the surgical patient have an important bearing on anæsthesia:

Atropine	*Morphine*
1. Dilates the pupil.	1. Contracts the pupil.
2. Stimulates respiration.	2. Depresses respiration.
3. Stimulates metabolism.	3. Depresses metabolism.
4. Stimulates nervous system.	4. Depresses nervous system.
5. Depresses vagal terminals in heart.	5. Depresses renal function.
6. Lessens after-sickness.	6. Increases after-sickness.

The administration of morphine plus atropine neutralises, in the majority of patients, the characteristic pupillary effect of either agent when used alone.

Basal Narcosis

Basal narcosis varies in degree from the physical and mental equanimity produced in the surgical patient by the hypodermic injection of $\frac{1}{6}$ gr. of morphine sulphate to the deep sleep and muscular relaxation which results from rectal bromethyl or avertin in proper dosage.

Advantages of Basal Narcosis

1. The absence of anxiety regarding the anæsthetic and the operation. Psychic trauma disturbs the physiological processes which promote convalescence.

2. The passage of the patient into oblivion in bed without any obnoxious odours.

3. A smaller percentage of the toxic anæsthetic agent is required for efficient surgical anæsthesia.

4. The patient wakens after several hours, agreeably surprised to find that the operation is over.

5. The absence of pre-anæsthetic psychic disturbance is a potent factor in the prophylaxis of post-anæsthetic sickness.

Disadvantages of Basal Narcosis

1. The pre-anæsthetic administration of a barbiturate may very occasionally result in some mental confusion or disorientation for a few hours after the operation.

2. Physical restlessness may also be observed after the operation and the patient may make movements as if endeavouring to get out of bed.

3. These post-anæsthetic sequelæ necessitate nursing supervision for a few hours, but not more than might be expected for any patient after an operation.

4. Individual variation in susceptibility, e.g. the neurotic patient is very resistant to narcotics.

5. The difficulty of control of the narcotic agent after its administration.

It is important to note that the administration of morphine or heroin or nepenthe to restless patients may actually aggravate the mental and physical restlessness by reinforcing or prolonging the action of the barbituric narcotic agent.

Methods of Producing Basal Narcosis

1. *Age of patient,* 12 to 16 years.

Veronal, gr. $7\frac{1}{2}$ at 9 p.m. Omnopon, gr. $\frac{1}{3}$, and scopolamine, gr. $\frac{1}{150}$ in a 1 c.c. ampoule—$\frac{1}{2}$ c.c. is given hypodermically 45 minutes before the operation in the morning.

Adults

Veronal, gr. 5 at 8 p.m. and gr. 5 at 10 p.m. Omnopon-scopolamine, $\frac{3}{4}$ to 1 c.c. 60 minutes before the operation.

The majority of patients thus treated sleep well during the night, and come to the anæsthetic room drowsy and indifferent, and many of them have no memory of the events following the administration of the veronal the night before.

2. Paraldehyde per rectum and omnopon-scopolamine or morphine and atropine or atropine only, according to the age of

the patient, is administered 75 minutes before the time of the operation.

The dose of paraldehyde is reckoned as 1 drachm per stone of body weight in ten times its volume of normal saline at body temperature. The maximum dose of paraldehyde is 4 drachms for a child, 6 drachms for an adult female, and 7 drachms for a male. Paraldehyde in proper dosage is our safest basal narcotic agent.

Patients who have retained the dose come to the anæsthetic room very drowsy or asleep, but very occasionally a patient is excited and talkative. Paraldehyde is exhaled by the patient for several hours, resulting in an obnoxious odour in the ward or room.

3. Avertin or Bromethyl is tribromethyl alcohol and is administered per rectum. Avertin crystals are not readily soluble in water, and therefore "Avertin fluid," which is a solution of avertin in amylene hydrate, is used. One c.c. of "Avertin fluid" contains 1 gramme of avertin. Adults may have morphine sulphate, gr. $\frac{1}{8}$, and atropine sulphate, gr. $\frac{1}{100}$, hypodermically, at the same time as the avertin, 75 minutes before the operation.

Technique of dosage and administration:

0·1 c.c. of avertin or bromethyl fluid per kilogramme ($2\frac{1}{5}$ lb.) of body weight is made up in a $2\frac{1}{2}$ per cent solution of distilled water, heated to 35° C. (See Dosage Table on following page.)

Examples:

	Weight	Avertin	Dist. H_2O
Child	56 lb.	2·5 c.c.	101 c.c.
Adult	140 lb.	6·3 c.c.	254 c.c.

The dose of avertin must be made up fresh for each patient, either by the anæsthetist or the hospital chemist, who must be given the weight of the patient. 5 c.c. of the $2\frac{1}{2}$ per cent avertin solution is put in a test-tube and a drop of congo red added. The colour of the solution should remain orange-red, and if any blue colour appears it indicates the presence of hydrobromic acid which is highly irritant to the intestinal mucous membrane and the dose must be discarded.

Avertin depresses the respiration of the patient and cyanosis may result. Coramine rapidly stops the action of the avertin and stimulates the respiration. Oxygen, coramine and ephedrine