Essentials of General Anaesthesia

MACINTOSH & BANNISTER

Essentials of

GENERAL ANÆSTHESIA

By R. R. MACINTOSH,
M.A., M.D., F.R.C.S., D.A.

Nuffield Professor of Anæsthetics, University of Oxford; Consulting Anæsthetist to the Royal Air Force; Anæsthetist to the Radcliffe Infirmary, Oxford; Late Anæsthetist and Lecturer in Anæsthetics, University College Hospital Dental School; Anæsthetist, Golden Square Ear, Nose and Throat Hospital; Assistant Anæsthetist, Guy's Hospital Dental School

and

FREDA B. BANNISTER,
M.A., M.D., D.A.

Honorary Anæsthetist, Chester Royal Infirmary; Late First Assistant, Nuffield Department of Anæsthetics, University of Oxford; Anæsthetist to the Oxford Eye Hospital; Clinical Assistant in Anæsthetics, University College Hospital Dental School; Temp. Major R.A.M.C., Anæsthetist to Military Hospitals.

Illustrated by
MISS M. C. McLARTY

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PREFACE

THIS book is based on a series of lectures given to students at the Dental School of University College Hospital, London, and the University of Oxford Medical School. In presenting it we hope that it will assist, not only those seeking an introduction to anæsthetics or preparing for their final examinations, but also the medical or dental practitioner who desires to refresh his knowledge of the essentials of general anæsthesia.

The lack of a text-book suitable as a supplement to undergraduate lectures and the practical lessons learned in the operating room has induced us to attempt a statement of the foundation of principles underlying the administration of anæsthetics in general. The case histories cited, however, in the main have been chosen deliberately from the field of dental surgery, since the art of dental anæsthesia is often much neglected, and in our opinion a mastery of the difficulties encountered there will help the anæsthetist to understand and overcome many of the problems he is likely to meet in anæsthesia for operations on other parts of the body. In order to clarify the descriptions given in the text we have made full use of illustrations.

The standard of administration of anæsthetics by the family doctor is a standing joke between dentists, and is frequently a matter of comment among general surgeons. Although the criticism is amply justified, the reproach itself is unfair, inasmuch as a general practitioner has little more opportunity of reaching the standard attained by the specialist in anæsthetics than he has of becoming a specialist in any other branch of medicine or surgery. It must be admitted, however, that the average doctor, while fully recognising that he has something to learn in other fields, is apt to be unduly complacent about his knowledge of anæsthesia and the technique of its administration, especially for dental operations.

At many general hospitals extractions are performed only in cases of emergency; non-urgent work is referred to dental hospitals. The doctor's early experience in anæsthesia for dental work is often, therefore, confined to the administration of nitrous oxide in cases where an acute alveolar abscess necessitates extraction of a tooth. Such an extraction is usually easy, and a short and not necessarily skilful anæsthesia frequently suffices. The average medical student has, in

fact, little opportunity of seeing, and far less of practising, the refinements of anæsthesia required for operations in the mouth. We have therefore incorporated in this book practical hints which should prove useful to the general practitioner with limited experience of this subject, and even to the anæsthetist who devotes but little of his time to this branch. Gone are the days when it was considered sufficient for the doctor to present the dentist with an unconscious patient and then to walk round the room, leaving the supervision of the patient and the extraction of the teeth to the dentist. The production and maintenance of surgical anæsthesia should be regarded both as an art and as a science ; in dental work particularly the former plays an important role, and the anæsthetist must realise that it is his duty to co-operate with the dentist in every possible way.

The anæsthetist must train himself to recognise at a glance the type, temperament, and physical condition of the patient. He must know the significance of breathlessness, of œdema, of protruding eyes, of plethora, and of anæmia ; and he must recognise the signs of alcoholism. He will soon learn that pallor does not necessarily indicate anæmia, nor a rapid pulse cardiac disorder. He must interpret correctly the cause of any cyanosis which may develop during anæsthesia, and be technically expert enough to deal with all the incidents, whether grave or trifling, which may occur during narcosis. He must be constantly alert to observe every indication, however small, of a change in the patient's reactions to the anæsthetic, and he must be alive to the importance of maintaining a clear airway. He has the entire responsibility for the patient's safety during unconsciousness and thus for his life, and this responsibility is no whit less serious during anæsthesia for dental extractions than during anæsthesia for more severe operations. This is often inadequately appreciated, since the patient is rarely ill and the operation generally lasts only a short time.

The anæsthetist has always three people to satisfy—the patient, the surgeon, and himself. Although it is to be hoped that he will never succeed in satisfying himself completely, he can succeed in safeguarding his patient and, if he is fortunate, in satisfying the surgeon or dentist with whom he co-operates.

We are greatly indebted to Miss Marjorie R. Gibson for her invaluable care and patience in dealing with our manuscripts, and to Miss M. C. McLarty for her skill and attention to detail in the preparation of the majority of the illustrations. Our thanks are also due to Miss A. J. Arnott for the remainder of the drawings, to Miss M.

Herring-Shaw for the photographs, and to Mrs. B. M. Duncum, D.Phil., for assistance with the chapter on history.

As anæsthetists frequently refer to nitrous oxide, carbon dioxide, and oxygen by their chemical symbols, we have used these abbreviations (N_2O, CO_2, and O_2) where we might have done so in conversation or in making case records.

OXFORD.
November 1940.

PREFACE TO FOURTH EDITION

CHANGES in this edition include the complete revision and rewriting of the chapter on Endotracheal Anæsthesia ; the addition of a chapter on Trilene ; additions to the chapter on Pentothal, as well as many small additions and changes.

Once again we are indebted to our friends for their constructive criticisms.

R. R. MACINTOSH.
FREDA B. BANNISTER.

OXFORD AND CHESTER.
April, 1947

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CHAPTER I

HISTORY OF ANÆSTHESIA

MAN'S attempts to produce insensibility to pain are of very long standing. The Assyrians were aware of the anodyne and soporific properties of poppy and mandrake,[1] and we know from the Homeric reference to nepenthes[2] that the Greeks alleviated mental, and probably physical, suffering by narcotic drinks. Theophrastus (370–286 B.C.), the "protobotanist," specifically tells us that the root of mandrake steeped in wine produces sleep.[3]

The Romans also used decoctions of mandrake in alcohol. Pliny (A.D. 23–79) says of the juice of the mandrake, "Administered in doses proportional to the strength of the patient, this juice has a narcotic effect. . . . It is given . . . for injuries inflicted by serpents, and before incisions or punctures are made in the body, in order to ensure insensibility to the pain," and he adds, "Indeed, for this last purpose, with some persons, the odour of it is quite sufficient to induce sleep."[4] Dioscorides also, who was a Greek surgeon in the army of Nero from A.D. 54 to 68 and compiled the first great work on materia medica, prescribed mandrake for the relief of pain, and stated that according to the preparation it might either be drunk, or inhaled, or given in an enema.[5]

Analgesic potions in fact have been well known for more than two thousand years, but although described in medical text-books throughout the mediæval and early Renaissance periods and sporadically even until the end of the eighteenth century, their utilisation seems to have been the exception rather than the rule. Although on empirical grounds early physicians recognised that certain plants possessed narcotic properties, they had no means of assessing the potency of the extracts employed. Different samples of the same herb differ considerably in the amounts of active principle contained. Thus, though a measured dose of one extract of poppy might produce the required depth of unconsciousness, the same dose of another sample similarly prepared might be either entirely inadequate or might produce extreme depression, or even death. The prudent surgeon, therefore, while acknowledging the successes, was deterred by the numerous failures and disasters from using so uncertain a means of preventing pain. So hazardous was the method considered that until the middle of the

nineteenth century an unfortunate patient about to be operated upon found himself bound and held down by strong men, his only help being fortitude or unconsciousness from fainting.[6]

During the seventeenth and eighteenth centuries opium had become increasingly important as an anodyne and narcotic, as indeed the word *opiate* itself suggests. It was sometimes given in an enema as a mild sedative before operations, but more frequently after the operation. In extremely painful conditions held to be inoperable, where pain could not be relieved otherwise, its use was, and still is, considered essential for mitigating the sufferings of the patient's last days. It was universally recognised that opium, like alcohol, if pushed to excess, produced complete insensibility, but this use of these drugs was vigorously condemned by physicians and surgeons of good repute as a dangerous and unjustified practice.[7]

Administration of narcotics in known doses first became possible in 1806, when Sertürner[8] succeeded in isolating morphine, the chief alkaloid of opium. Its routine use in medicine in place of opium dates from about 1820, and was due to the French physiologist Magendie[9] (1783–1855), who fully appreciated that the superiority of the pure alkaloids lay in the fact that they could be given in known doses.

In adopting morphine, Magendie prescribed it only by mouth. Though the isolation of this alkaloid made it possible for physicians to administer a dose of constant composition, the results continued to be inconsistent, because of the variations in the rate of absorption of drugs given by mouth (p. 103). It was not until five years after the discovery of ether that the hypodermic syringe was introduced by Pravaz, in 1851, and independently by Alexander Wood, in 1853. By administering morphine hypodermically the rate of absorption was brought under control, but since inhalation anæsthesia had already been enthusiastically adopted, there was now no incentive to exploit to the full the possibility of producing narcosis with this drug.

The work of Priestley (1733–1804) and Lavoisier (1743–1794) on oxygen and the nature of respiration turned medical thought in a new direction, and led to a theory that some diseases might be benefited by inhaling oxygen or other gases. In 1796 Thomas Beddoes founded at Bristol a "Medical Pneumatic Institution," where experiments and treatment along such lines could be carried out.[10] He commissioned James Watt to design the apparatus required and appointed Humphry Davy (1778–1829) as superintendent of the Institution.

During his investigations into the properties of nitrous oxide, Davy in 1799 verified by animal experiment that the gas was respirable ; he then inhaled it himself and stumbled upon its analgesic properties. In

1800 he published an exhaustive monograph,[11] in a comparatively small section of which he records his mental and physiological reactions on inhaling the gas, and states that " inspiration was accompanied with loss of distinct sensation and voluntary power," and that it would relieve headache. On p. 464 he writes that " the power of the immediate operation of the gas in removing intense physical pain, I had a very good opportunity of ascertaining. In cutting one of the unlucky teeth called *dentes sapientiæ*, I experienced an extensive inflammation of the gum, accompanied with great pain. . . . On the day when the inflammation was most troublesome, I breathed three large doses of nitrous oxide. The pain always diminished after the first four or five inspirations. . . . As the former state of mind however returned, the state of organ returned with it ; and once I imagined that the pain was more severe after the experiment than before."

Davy's somewhat lengthy summary of his conclusions includes the brief statement, " As nitrous oxide in its extensive operation appears capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place." These few words, lifted from the unimportant position assigned to them by Davy among a mass of his other deductions, not all of them accurate, have been given much prominence in the history of anæsthesia, and it is often implied that Davy was suggesting that nitrous oxide should be used as a general anæsthetic. It is probable, however, that no such idea occurred to him, even though he knew that prolonged inhalation of the gas would produce stupor. If indeed he had conceived the idea of producing surgical anæsthesia by means of nitrous oxide, he would deserve blame rather than praise, in that he, fresh from apprenticeship to a surgeon, made no attempt either to follow up this important idea himself or to encourage others to do so. It should, however, be realised that Davy was then only twenty-two years old, and that his dominant enthusiasm was chemistry rather than medicine, as was shown by the fact that a year later he resigned his post at the Pneumatic Institution in order to take charge of the chemical laboratory of the newly founded Royal Institution in London. This early promotion resulted in the discontinuance of Davy's experiments with nitrous oxide. Had he remained at Bristol and taken his medical degree as originally intended, it is more than possible that his genius would have led him to utilise nitrous oxide as a means of producing surgical anæsthesia.

At about the time that Davy's interest in nitrous oxide began to wane, Henry Hill Hickman (1800–1830) was born. In 1820 he was

admitted a member of the Royal College of Surgeons, and set up in practice in Shropshire. Although little older than Davy had been when he carried out the researches on nitrous oxide, Hickman differed from Davy in that he had the clearly defined object of showing that surgical anæsthesia could be achieved by inhalation. He formulated this belief in a pamphlet published in 1824.[12] In a letter addressed to his friend, T. A. Knight, F.R.S., he says, "There is not an individual who does not shudder at the idea of an operation, . . . and I have frequently lamented when performing my own duties as a Surgeon that something has not been thought of whereby the fears may be tranquilised and suffering relieved. Above all, from the many experiments on suspended Animation I have wondered that some hint has not been thrown out, of its probable utility, and noticed by Surgeons, and, consequently, I have been induced to make experiments on Animals, endeavouring to ascertain the practicability of such treatment on the human subject, . . . and ultimately I think [it] will be found used with perfect safety and success in Surgical operations. . . ."[13] To this letter is appended an account of seven operations on animals rendered insensible either through the inhalation of carbonic acid gas, or by the rebreathing of atmospheric air in a closed chamber.

Although Hickman experimented with different gases, and was even credited many years later by a member of the Académie de Médecine in Paris[14] with using N_2O, he refers only to carbonic acid gas. In the light of recent research on the role of CO_2 in anæsthesia, this choice was unfortunate. At the time Hickman failed to gain encouragement from the medical profession either in this country or in France. Ardently as he believed that inhalation anæsthesia would be as successful with men as with animals, he hesitated, unsupported by a single colleague, to apply his experimental findings to man. Nevertheless, he deserves recognition as the first to advocate unequivocally the principle of producing surgical anæsthesia by inhalation.

During the first half of the nineteenth century popular lectures of an instructive though non-technical character on chemistry had an immense vogue in America. On 10th December, 1844, at Hartford, Connecticut, the dentist Horace Wells (1815–1848) attended a lecture advertised as "A Grand Exhibition of the Effects produced by inhaling Nitrous Oxid, Exhilarating or Laughing Gas!" given by Gardner Quincy Colton (1814–1898), who had studied medicine but had never taken a medical degree. At the demonstration which followed and enlivened this dissertation,[15] Wells's curiosity was aroused by the observation that a young man named Cooley, who, after inhaling N_2O,

had stumbled and barked his shins severely, nevertheless seemed quite oblivious to the accident. Wells drew him aside and questioned him closely, and finding that he stoutly maintained that he had not felt the slightest pain, became much excited, and said to a friend, " I believe a man by taking that gas could have a tooth extracted or a limb amputated and not feel any pain." Before leaving the hall he discussed the possibility with Colton and a dentist named Riggs, and it was arranged that next day, in the presence of witnesses, Wells should inhale nitrous oxide administered to him by Colton while Riggs pulled out one of his teeth. Anæsthesia in this instance proved an unqualified success.

During the next few weeks Wells, assisted by Riggs, extracted teeth from a number of people, and in January 1845, through another dentist, his former partner William Thomas Green Morton (1819–1868), obtained permission to demonstrate his discovery at the Massachusetts General Hospital in Boston. It was arranged by Dr. J. C. Warren, one of the leading surgeons of the hospital, that Wells should first address a class of students and then demonstrate the extraction of a tooth from a young man under nitrous oxide. Full details of what happened at that demonstration will never be known. Wells seems to have acted as extractor, an assistant administering the gas, probably from a comparatively small bladder-shaped rubber bag with a simple mouth tap. It is generally stated that the assistant withdrew the bag too soon. As the tooth came out the patient yelled lustily, though afterwards admitting that he felt little, if any, pain. Poor Wells was accused of humbug and hooted out of the theatre by the students, and Warren bothered no further with him.[15] Nitrous oxide was discredited and for eighteen years fell into disuse.

In explanation of the failure of Wells's demonstration, it may be surmised that the patient was of the robust type now described as " anæsthetic-resistant," for under nitrous oxide such a patient becomes cyanosed before anæsthesia has been attained, and in those early days, when cyanosis was doubtless taken as a danger-signal, it is probable that administration would have been stopped an appreciable time before surgical anæsthesia had been attained. To this day it is sometimes impossible to produce perfectly tranquil narcosis, even for dental extractions, if nitrous oxide is used to anæsthetise a robust male, particularly if he is nervous and unpremedicated.

Undeterred by Wells's failure, his former partner Morton continued to investigate the possibility of painless extraction. Since, like Wells, he specialised in prosthetic dentistry, the incentive to discover a means of relieving pain during extractions was strong. The idea of

trying ether probably suggested itself as a result of the " frolics," so popular in Europe and America during the first half of the nineteenth century, at which small quantities of nitrous oxide or ether were inhaled for the feeling of exhilaration which they produced. At these parties it had been conclusively established not only that ether vapour was respirable but that too large a quantity caused stupor. Michael Faraday had pointed out in 1818 that in these respects the effects of ether and nitrous oxide were similar.[16]

As nitrous oxide had been discredited, the distinction of discovering anæsthesia would belong to the one who introduced ether. In the bitter quarrel which immediately followed the successful use of ether, Morton claimed that he had introduced it, but Dr. Charles Thomas Jackson (1805–1880), chemist and geologist, alleged that the credit should be his, since he had suggested its use to Morton. Weighing up the pros and cons of the argument, it now seems reasonably certain that Jackson did not originally suggest the use of ether, but it seems equally certain that he gave Morton valuable advice. For Morton, having tried the inhalation of ether upon one or two household pets without mishap, nevertheless admitted to his partner, Grenville G. Hayden,[17] who appears to be a fairly reliable witness, that "in some particulars his discovery did not work exactly right," whereupon Hayden advised him to consult a chemist. Towards the end of September 1846, Morton saw Jackson, and though he did not disclose that he had been experimenting with ether, managed to glean important information. " Dr. Morton told me," wrote Hayden in his testimony, " that he had just tried ether again—in accordance with Jackson's hint—on himself, and that he had remained insensible seven or eight minutes, by the watch." A few days later, on 30th September, 1846, Morton, pouring ether on a folded cloth, successfully anæsthetised Eben Frost for the extraction of a tooth. However, all was not yet plain sailing. A series of failures followed, and Morton once more consulted Jackson, who this time recommended the use of a glass inhaler. After making certain modifications in the inhaler, Morton demonstrated ether anæsthesia at the Massachusetts General Hospital on 16th October, 1846. At this demonstration he administered ether under the name of " letheon " (trying unsuccessfully to keep its precise nature secret), and Warren dissected out a " congenital but superficial vascular tumor " from the neck of a man. As the patient recovered consciousness, Warren exclaimed, " Gentlemen, this is no humbug."

It subsequently transpired that Crawford W. Long (1815–1878), a busy general practitioner, had used ether as early as 1842 in a few minor surgical operations in Georgia, U.S.A., but the exigencies of a