

# ANAESTHESIA IN GENERAL PRACTICE

*This is one of a series of articles, contributed by invitation*

## THE STAGES AND SIGNS OF GENERAL ANAESTHESIA

BY

C. LANGTON HEWER, M.B., B.S., D.A.

It is customary to describe four stages in anaesthesia, and this general classification will be adopted in this article. It must be realized, however, that although definite stages are useful for descriptive purposes, in practice they are not sharply defined, but blend into each other. The various phases of anaesthesia will be considered generally, and then as shown in greater detail by the individual anaesthetic agents.

### Stage I—Disordered Consciousness

The first action of an anaesthetic on the cerebral cortex is to render its functions more acute but unbalanced. The sensations experienced by the patient will depend largely upon his temperament. There is usually a feeling of well-being or of warmth or tingling in the limbs. The thoughts may become exalted, and delusions are not uncommon. For this reason, among others, a third person should always be present during the induction of anaesthesia. The sense of hearing may be extremely acute, and a conversation, even when carried out in a whisper, may be remembered and misinterpreted. Except for some encouraging remarks from the anaesthetist absolute silence should be maintained during this stage, and the patient must not be touched in any way unless he has previously expressed a desire to hold a nurse's hand. It is a curious fact that with most of the sensations abnormally acute that of pain appears to be dulled from the first. This may be so marked that with some drugs, notably nitrous oxide and trichlorethylene, a definite state of general analgesia may be obtained in some patients.

The physical signs of the first stage of anaesthesia are very variable, and will depend almost entirely on the degree of nervousness shown by the patient. It should be noted that the first stage is profoundly modified by preliminary medication, and if basal narcosis has been induced the first two stages have already occurred before the superimposed general anaesthesia is added. These subjects are dealt with in another article.

### Stage II—Excitement

Consciousness is lost at the end of the first stage, and there follows a period in which the patient may exhibit such signs of excitement as muscular movements, phonation, staring eyes, irregular respiration, etc. The reflexes will be brisk, and there may be some laryngeal spasm leading to cyanosis. The blood pressure is usually raised and the pulse slightly increased in rate. These manifestations are thought by some to be due to vivid dreams, while supporters of the electrical theory of anaesthesia impute them to negative impulses passing out from the cerebral cortex over the motor nerves.

The excitement stage is most marked in men, in highly strung patients who have been repressing their emotions, in alcoholics, and in cases where di-ethyl ether is the

agent employed. On the other hand, this stage may be unnoticeable in women, in phlegmatic patients, and in cases where heavy premedication or basal narcosis has been employed.

### Stage III—Surgical Anaesthesia

Having passed through the stages already described the patient emerges into a tranquil phase of narcosis which resembles natural sleep. The respiration becomes automatic and muscular relaxation progressively greater. The corneal reflex disappears about the middle of this stage, but both it and the size and reaction of the pupil are so affected by the drugs used for premedication and narcosis that a generalization is impossible. The blood pressure is usually within normal limits, but tends to be raised with cyclopropane and ether and lowered with chloroform. As the tongue muscles lose their tone this organ may drop back and cause respiratory obstruction, a condition generally overcome by jaw traction or by the introduction of an artificial airway. It is the anaesthetist's aim to maintain the level of narcosis within the limits of this stage as required by the nature of the operation.

### Stage IV—Overdose

The signs of overdosage vary somewhat with different agents, but resemble those of shock. Thus we have to note pallor, coldness of the skin, absent reflexes, a dilated inactive pupil, rising pulse rate, falling blood pressure (systolic more than diastolic), spaced or sighing type of respiration, which becomes shallow and ultimately ceases. At a varying time after this the pulse fails and death supervenes. In order to distinguish overdosage from other factors in shock McKesson devised the "depression test." A large volume of oxygen is suddenly added to the anaesthetic mixture and the blood pressure is observed. An obvious rise indicates overdosage (especially with nitrous oxide and ethylene). If there is no appreciable change the shock is due to other factors. The "law of diminishing resistance," which was propounded many years ago by Richard Gill, states that "the amount of a drug required to produce a given depth of anaesthesia diminishes with the time of its administration." Ignorance of this law leads to many cases of overdosage.

The signs relating to the depth of anaesthesia induced by the individual volatile agents will now be considered.

### Nitrous Oxide and Air

*Analgesia* can be induced in most patients by the self-administration of about 35 per cent. nitrous oxide in air. This method is becoming increasingly popular in midwifery and dentistry. Minnitt's intermittent-flow apparatus is extremely efficient and reliable for this purpose, as is a somewhat simplified machine working on the same principle (the Minnitt-Walton). The success of these types has flooded the market with many imitations, all of which are not uniformly satisfactory. The signs associated with the analgesic state are inconstant and variable, most patients remaining quite conscious but insensitive to pain.

*Anaesthesia* is induced with pure nitrous oxide. A few moments after the beginning of the inhalation the

patient's respiration becomes regular and deep. This is misleading to a beginner, who may imagine that it indicates the automatic breathing characteristic of the third stage of anaesthesia already described. The only reliable guide to the onset of anaesthesia is the change in respiration to irregularity and/or stertor—a change which is certain to take place if air leaks are absent. The operation may be started at this point, and thereafter the anaesthetist alternates between "air" and "rebreathing" in such proportion as to avoid the convulsive bilateral twitching which indicates a commencing jactitation on the one hand and purposeful reflex movements on the other. Slight cyanosis is usual when anaesthesia has become established, but depends upon the type of patient. An anaemic girl may actually jactitate without any colour change; while a plethoric alcoholic may be almost black before reaching the stage of unconsciousness. The eye signs, although usually stressed, are so variable that in my opinion they are best ignored. The blood pressure is always raised during the administration of gas and air owing to the inevitable partial asphyxia which accompanies it.

#### Nitrous Oxide and Oxygen

The induction of anaesthesia is effected with pure gas until just before the "end-point" previously described. Oxygen is then added to the gas in accordance with the requirements of the individual patient. It must be realized that some degree of anoxaemia will be present in the normal subject unless fairly heavy premedication or basal narcosis has been used. When this is the case, however, it should be possible to keep most patients at a continuous level of quiet anaesthesia with little or no cyanosis. Opinions differ as to whether a slight degree of cyanosis is detrimental to patients with a normal haemoglobin value provided that the airway is clear. Respiration is fairly deep with the usual technique of partial rebreathing, but if complete rebreathing with CO<sub>2</sub> absorption is adopted respiration resembles that of natural sleep, and a very perfect anaesthesia can be secured. The corneal reflex will be brisk throughout the administration, and the blood pressure will be either normal or slightly raised if appreciable anoxaemia is present. Complete muscular relaxation cannot be obtained with pure nitrous oxide and oxygen unless some type of local analgesia is added or recourse is had to "secondary saturation." The latter technique will not be described here as it is unsuitable for the general practitioner, and necessitates an apparatus capable of inflating the lungs instantly with oxygen under pressure.

It must be realized that there is a very narrow margin with pure gas and oxygen, and a mixture which is slightly too rich or too poor in oxygen will eventually cause retching or actual vomiting. The beginner will find that he requires the help of a small quantity of ether added to the gases, but as his experience increases this necessity diminishes, with consequent benefit to the patient. If complete muscular relaxation is imperative sufficient ether is added to secure it, in which case the patient will show the signs of a semi-closed ether narcosis.

#### Ethylene and Acetylene

Ethylene-oxygen anaesthesia resembles nitrous-oxide-oxygen anaesthesia except that muscular relaxation is better and a rather higher percentage of oxygen can be used. The same remarks apply to acetylene. Since these gases are seldom employed for anaesthesia in Great Britain they will not be discussed further.

#### Cyclopropane

Owing to its high cost cyclopropane is always given by the closed-circuit technique, quite a simple apparatus being adequate. This gas is an extremely potent anaesthetic, and approximately 85 per cent. oxygen can be administered. Good relaxation can be obtained with this mixture, so that cyanosis should never occur. The second stage of anaesthesia is usually unnoticeable, the induction being rapid and smooth. Since cyclopropane causes no irritation and is a respiratory depressant it is easy for the inexperienced anaesthetist to give an overdose. In this case the breathing becomes imperceptible, but a few compressions of the rebreathing bag and the addition of oxygen soon restores normal rhythm. The blood pressure usually rises, and vascular oozing from the skin and superficial tissues is increased. A careful watch should be kept on the pulse, and if there is a pronounced degree of bradycardia, tachycardia, or arrhythmia the gas concentration should immediately be reduced.

#### Ethyl Chloride

Ethyl chloride is usually employed as a "single-dose" anaesthetic of short duration for children, and may be given by the open or closed methods. Although the child may show apparently little change for the first few moments, actually the induction of anaesthesia is extremely rapid, and the third stage may be reached within a few seconds of the cessation of talking or moving. Muscular spasm, particularly laryngeal and masseteric, may be marked in the second stage, especially if air is limited, as in the closed technique. In order to prevent clenching of the jaw an oral prop should be inserted before administration. Directly respiration becomes quiet and regular the mask should be removed, and a variable period of anaesthesia will ensue. It is possible to supplement the dose of ethyl chloride from time to time, but it is difficult to maintain an even level of anaesthesia for long, and it is extremely easy to give an overdose.

Open ethyl chloride is also useful to induce anaesthesia in children, a change-over to ether being made directly respiration becomes quiet or stertorous. Ether must be used freely at this stage, or the child will come round from the one drug before being anaesthetized with the other, in which case there will probably be coughing.

#### Di-vinyl Ether

Di-vinyl ether is extremely volatile, and is best given with oxygen in a closed inhaler or added in minute amounts to mixtures of nitrous oxide and oxygen. Induction is rapid, and the drug differs from di-ethyl ether in being about four times as potent, less irritating to the respiratory passages, and less likely to cause nausea and vomiting. Muscular relaxation is variable, but usually good.

#### Di-ethyl Ether

Induction of anaesthesia with open ether is a lengthy and trying procedure for both patient and anaesthetist. The closed and semi-closed methods, using the expired carbon dioxide to stimulate respiration, reduce the induction period considerably, especially if nitrous oxide or ethyl chloride is administered at the beginning. Even so, the second stage is apt to be marked, particularly in robust and alcoholic males. When the plane of surgical anaesthesia is established with open ether respiration becomes quiet and rather deep, the colour is pink, and the blood pressure slightly raised. Salivation and the secretion of mucus may be troublesome unless an adequate dose of

atropine or scopolamine has been given at least half an hour before induction. If good relaxation is essential the anaesthesia must be progressively deepened until the laryngeal muscles are paralysed, unless previous cocaine-ization has been performed. After this level is reached the anaesthesia can usually be lightened appreciably. Although there is a large margin of safety with di-ethyl ether it causes an appreciable metabolic upset, as shown by raised blood-sugar and blood-urea values and post-operative albuminuria.

Two curious manifestations are occasionally seen during ether narcosis. A mild and innocuous tremor may occur during the initial stages. This generally disappears as anaesthesia becomes deeper. The more serious ether spasm is as a rule confined to the stage of deep narcosis and begins in the face muscles, ending as generalized epileptiform convulsions. The cause remains obscure, and if the usual remedies fail to stop the twitching calcium gluconate should be injected intravenously.

#### Chloroform

Some degree of analgesia is common in the first stage of chloroform narcosis; the second stage is not so marked as that of ether, and there is less tendency to laryngeal spasm. The danger period of primary cardiac failure has been proved to be at the end of the second stage, just before full surgical anaesthesia is reached. A "pre-fibrillation phase" can often be demonstrated at this point by the electrocardiograph. For some imperfectly understood reason there appears to be little risk of primary cardiac failure in parturient women. Since chloroform is a respiratory depressant and does not appreciably irritate the air passages, the third stage is marked by quiet and shallow respiration. Salivation is usually absent and muscular relaxation is excellent. The blood pressure is somewhat lowered. The pupil is small and tends to become larger and inactive in overdose, while it becomes larger and active with a positive corneal reflex if anaesthesia gets lighter. The movement of swallowing may accompany these signs. The margin of safety is much smaller than with ether, but in true overdose the respiration fails first and allows time for restorative measures to take effect before secondary cardiac failure develops. Chloroform is an extremely toxic drug, and can cause grave metabolic changes. Chloroform-ether mixtures will cause deeper respiration in proportion to the amount of ether present, but it should be noted that they give no immunity from the risk of primary cardiac failure.

## CHEAP MILK FOR MOTHERS AND CHILDREN

### DEPUTATION TO MINISTRY OF HEALTH

Sir KINGSLEY WOOD, who was accompanied by Mr. ROBERT BERNAYS, Parliamentary Secretary to the Ministry of Health, received on July 27 a deputation from the Children's Minimum Council to urge that milk should be provided for nursing and expectant mothers and children under school age of working-class families at 1½d. a pint, and that the milk should be free where the family income fell below a scale to be determined by the Ministry. This "positive milk policy" was referred to in a leading article in the *British Medical Journal* of July 17 (p. 121).

#### Policy of Children's Minimum Council

Miss ELEANOR RATHBONE, M.P., introducing the deputation, said that it was supported by twenty-nine societies, including

nearly all those working for child welfare. Health authorities were unanimous as to the great need for increased milk drinking, especially by mothers and young children. The great obstacle was the high price of milk. The deputation proposed that the cheapened supply asked for should be secured by diverting some of the milk now sold for manufacturing purposes at about 5½d. a gallon. Producers and distributors should be asked to supply milk under the scheme at a lower price than that now charged in the retail trade. The remaining deficit should be covered by a subsidy which, on a basis admittedly hypothetical, might amount to about £1,600,000 per annum. The Minister was reminded that a scheme roughly on these lines had been submitted three years previously, but though sympathetic consideration was promised no practical advance had been made.

Mr. C. S. ORWIN, Director of the Agricultural Economics Research Institute of Oxford, said that the recent survey issued by his institute had been quoted as belittling the probable effects on consumption of a reduction in price. The survey showed that the price of milk was of great importance, but also that ignorance of its food value and prejudice were deterrent factors. A propagandist and educational campaign was most important and should therefore accompany any scheme for a supply of cheap milk.

#### The Minister's Reply

Sir KINGSLEY WOOD said in reply that he was in full agreement with the main objects and the general aim of the deputation. The Government's general policy was to ensure a maximum supply of milk for the consumer consistent with a reasonable remuneration to the producer, to improve the purity of the milk supply and also to continue and, where practicable, extend their policy of increased consumption of milk among those sections of the population for whom it was of particular value.

Milk was one of the most valuable of human foods, particularly in the diet of mothers and young children. It was largely on that account that the milk-in-schools scheme had been inaugurated, and it was satisfactory that over two and a half million children were participating in it to-day. Sir Kingsley Wood said in pursuance of this policy he had recently called the attention of local authorities to the recent report of the Advisory Committee on Nutrition, and particularly to its recommendations as to the nutritional value of milk. They had been requested to review their arrangements for the supply of milk and food to expectant and nursing mothers and young children, and their special attention had also been drawn to the importance of a sufficient supply of milk being made available throughout pregnancy and for children up to the age at which they entered school. The authorities were responding to these suggestions, and a number were already extending their provisions. It was to be noted that at the beginning of 1937 406 of the 418 maternity and child welfare authorities in England and Wales were supplying milk either free or at less than cost price in necessitous cases to expectant mothers, 406 to nursing mothers, and 404 to children under 5 years of age. Closer supervision of the nutrition of children was also being secured by the provision of more nursery schools and nursery classes.

Under the recent revision of the Government grants to local authorities increased money had been made available to them for the improvement of their services, those whose needs were the greatest receiving increased assistance from the extra five million pounds which was now available. The Minister also desired to add that he attached the greatest importance to an improvement in the safety and cleanliness of the milk supply. The question of further schemes for the supply of milk, either free or at a reduced price for mothers and young children, had been under active consideration by the Government in connexion with its long-term milk policy. He could not anticipate any statement that would be made to Parliament, but he could say that the Minister of Agriculture and Fisheries still hoped that it would be possible to make a statement before Parliament rose for the recess.