

The background of the cover is an abstract painting. The top half is a textured brown color. Below that is a horizontal band of pink and light red, followed by a thin white line. The bottom half is a vibrant green, also with a textured, brush-stroke appearance.

Aidan O'Donnell

ANAESTHESIA

A Very Short Introduction

OXFORD

Anaesthesia: A Very Short Introduction

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Aidan O'Donnell

Anaesthesia

A Very Short Introduction

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Chapter 1

Suspended animation: concepts of anaesthesia

Introduction

A recent study estimated that 234 million surgical procedures requiring anaesthesia are performed worldwide annually. Anaesthesia is the largest hospital specialty in the UK, with over 12,000 practising anaesthetists, yet in many ways it is the most mysterious. Most non-medical people have only the haziest idea of what anaesthesia involves. The media image is unhelpful. Medical dramas, for example, traditionally paint the surgeon as the hero, and the anaesthetist as a panic-stricken subordinate.

When undergoing an operation, the anaesthetic contributes only a tiny part of the overall risk. Yet, in general, people seem to fear the anaesthetic most of all. Many of my patients express real fears, and ask things like ‘What happens if I don’t go to sleep?’, ‘What happens if I don’t wake up?’, ‘What happens if I wake up in the middle?’, and ‘How do you know I am really asleep?’

Anaesthesia is both fascinating and rewarding. What I do every day is to suspend the conscious mind of my patients, so that they can undergo painful, invasive surgical procedures of which they remain entirely unaware. The means by which this is brought about still has a hint of magic for me.

In this book, I give a short account of the historical background of anaesthetic practice, a review of anaesthetic equipment, techniques, and medications, and a discussion of how they work. The risks and side effects of anaesthetics will be covered, and some of the subspecialties of anaesthetic practice will be explored.

Concepts of anaesthesia

Many of us have undergone general anaesthesia ourselves, or we may know someone who has. The concept of general anaesthesia is familiar to us, but it is worth having a closer look at the fundamental aspects.

If you observe an adult male under general anaesthesia, he appears to be asleep. He is lying on his back with his eyes closed, not moving. His breathing is slow and regular. His skin is warm and dry. However, if you were to shout his name, or shake him by the shoulder, he would not wake up. Even if you were to cut into his skin with a scalpel, he would not wake up, move, or show any obvious outward response.

Although we often use the word 'asleep' to describe someone who is anaesthetized (and I usually use this form of words when talking to patients and colleagues), general anaesthesia is not sleep. In physiological terms, the two states are very dissimilar. The term **general anaesthesia** refers to the state of unconsciousness which is deliberately produced by the action of drugs on the patient. **Local anaesthesia** (and its related terms) refers to the numbness produced in a part of the body by deliberate interruption of nerve function; this is typically achieved without affecting consciousness.

What is general anaesthesia?

In the early days of anaesthesia, the mid-19th century, the term *etherization* was used to describe the state produced by the inhalation of ether vapour. However, it soon became clear that chloroform and other agents could produce effectively the same state as ether. Clearly, a patient could not be etherized with chloroform. To try to find one word which sufficed to describe this new state was not easy. Some of the early terms were 'clumsy, and some of them cacophonous', such as *narcotism*, *sopor*, *hebetization*, *apathization*, *letheonization*, and *stupefaction*. The American neurologist Oliver Wendell Holmes suggested the term *anaesthesia* in 1846 in a letter to William Morton, from the Greek meaning 'without sensation', and this word, together with its adjective *anaesthetic*, caught on rapidly. By the time James Young Simpson was publishing his early results with chloroform in 1847, the term was in common use, although ungainly alternative terms such as *northria* or *metaesthesia* are still occasionally proposed.

The purpose of inhaling ether vapour was so that surgery would be painless, not so that unconsciousness would necessarily be produced. However, unconsciousness and immobility soon came to be considered desirable attributes of anaesthesia. John Snow, the first doctor to specialize in anaesthesia, wrote in 1872: 'Ether contributes other benefits besides ... preventing pain. It keeps patients still who otherwise would not be.' For almost a century, lying still was the only reliable sign of adequate anaesthesia. The state of unconsciousness was considered an advantageous relief from the traumatic experience of surgery.

For nearly a century after the introduction of general anaesthesia, it was provided by a single agent in the majority of cases. Usually, this was ether or chloroform; occasionally, a mixture of the two, or switching from one to the other, was used. Since those agents did what everyone thought was required (they kept the patient unconscious and unmoving), no further consideration was needed. However, the introduction of intravenous agents, muscle relaxants, and other adjuncts led to a discussion of the more specific components of general anaesthesia.

In 1926, John Lundy from the Mayo Clinic introduced the term **balanced anaesthesia** to describe using an array of techniques (such as a sedative premedicant to cause sedation together with general anaesthesia using different agents) to obtain best results. In 1950, Gordon Jackson Rees and Cecil Gray from Liverpool proposed a 'triad' of anaesthesia: narcosis (by which they meant 'unconsciousness'), analgesia, and muscle relaxation, which are often represented on a triangular diagram still taught to students. Crucially, one agent was no longer sufficient to produce all of the effects, but by using (for example) halothane for unconsciousness, morphine for analgesia, and

tubocurarine for muscle relaxation, safe and reliable operating conditions could be produced. The combination of an anaesthetic agent, an analgesic, and a muscle relaxant is still widely used, but the triad model is out of date. For a better model, a more careful consideration of the components of general anaesthesia is required.

Unconsciousness

A few years ago, an anaesthetist friend dislocated his shoulder playing squash. He went to his local emergency department, where he was given a large dose of the analgesic morphine, and a large dose of the sedative midazolam. His shoulder was then put back into joint. He knows he was awake at the time, and he knows that relocation of the shoulder is an extremely painful procedure, despite the morphine. However, due to the effects of the midazolam, which causes transient memory loss, he cannot remember the pain.

What my friend underwent was not general anaesthesia. However, the question he asked me was whether it is ethical to inflict pain on a patient who does not remember it afterwards, assuming there is no emergency or other urgent reason to do so. After some thought, I replied that I do not think that it is ethical to deliberately inflict pain on a conscious human being at any time, when alternative courses of action are to hand. Whether that person remembers it afterwards is beside the point.

General anaesthesia provides unconsciousness, but it is reasonable to look closer at what this actually means.

Among many other functions, the conscious mind is responsible for forming both experiences and memories of those experiences. If only one of those functions were interrupted, the mind might form experiences, such as pain, but not memories, and a situation like my friend's might ensue. However, general anaesthesia temporarily suspends the formation of both experiences (perceptions, awareness) and memories of those experiences.

In addition, general anaesthesia is considered to be a state induced by anaesthetic drugs (the patient cannot make it happen to him- or herself), and one that is reversible, in the sense of not being permanent: if I were to suffer a head injury, I might cease to form experiences or memories, but this is not general anaesthesia.

Muscle relaxation

Another point on the triad model is muscle relaxation. Cutting into muscle, such as the muscle of the abdominal wall, causes a reflex spasm of the muscle itself which makes surgery technically more difficult, and this reaction is only abolished at very deep planes of anaesthesia. Placing a tube in the trachea is also an extremely stimulating procedure, which can only be performed under very deep anaesthesia. Both these problems can be circumvented by the use of drugs to paralyse the muscle. Anaesthesia need therefore only be deep enough to produce unconsciousness, but paralysis sufficient

for surgical access or intubation can be readily produced by drugs. The term **muscle relaxants** is used to describe such drugs, which came widely into practice in the 1940s.

However, for many surgical procedures, muscle relaxation is not required. Even without muscle relaxants, a patient under general anaesthesia will not make voluntary movement, even in response to a painful stimulus such as surgery, and immobility to stimulation is one of the easiest objective signs of general anaesthesia.

But unconsciousness and immobility are not the end of the story. Anaesthesia was first introduced as a means of eliminating pain.

What is pain?

All of us have experienced pain, from our earliest experiences as infants teething or with colic.

The International Association for the Study of Pain (IASP) defines pain as ‘an unpleasant sensory and emotional experience resulting from a stimulus causing, or likely to cause, tissue damage, expressed in terms of that damage’. This is a helpful definition, as it incorporates those things which cause pain (actual or potential damage to the body), and the result (an unpleasant sensory experience as well as the consequences of that result (an unpleasant emotional experience)).

The neurophysiology of pain has been extensively studied, and it can be considered to comprise several steps. First, there is the detection of a painful stimulus (**nociception**), which happens by the triggering of specific nerve endings called nociceptors in the skin and other organs. Nociceptors produce electrical signals in pain nerve fibres. These electrical signals are transmitted to the spinal cord by peripheral nerves. The signals may be modified in the spinal cord, but are then transmitted up to the thalamus, a part of the brain which is responsible for integrating sensory signals of all types. From the thalamus, the signals travel to the cortex, the convoluted surface of the brain. At this point the pain signals are integrated into conscious perception, and it can be stated that pain is being perceived. (Until this point, there were only pain signals.)

However, the process does not end there. The experience of pain triggers powerful emotional consequences, including fear, anger, and anxiety. A reasonable word for the emotional response to pain is ‘suffering’. Pain also triggers the formation of memories which remind us to avoid potential painful experiences in the future. The intensity of pain perception and suffering also depends on the mental state of the subject at the time, and the relationship between pain, memory, and emotion is subtle and complex.

On their journey through the subconscious parts of the brain, pain signals also trigger physiological responses to stress, by activating what is called the sympathetic nervous system to produce adrenaline (the so-called ‘fight or flight’ response). The effects of adrenaline are responsible for the appearance

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