Anaesthetic Awareness: a past, present and future challenge

Daire Shanahan
Fifth year Medicine, Trinity College Dublin

Abstract

Anaesthetic awareness is a rare complication of general anaesthesia. Its occurrence is likely to be multifactorial, with young age, female sex, Chinese ethnicity, previous awareness, gestation, and pulmonary hypertension associated with a higher risk of awareness. Awareness is a distressing complication for patients, with 30% of patients who experience awareness developing psychiatric symptoms ranging from nightmares, flashbacks, and anxiety to post-traumatic stress. Therefore, attempts to monitor awareness are desirable. The aim of this short article is to look at past achievements and future challenges in detecting, monitoring, managing and avoiding awareness.

Introduction

On a cold and frosty Friday morning in 1846, twenty-one-year-old Gilbert Abbot sat nervously in the main operating theatre of the Massachusetts General Hospital. He felt a cold bead of sweat run down his temple. The room felt as if it was getting smaller, hotter- suffocating in tension. The audience sat on edge in the surgical amphitheater, eyes fixed on the clock above the operating table. The dentist, Mr. Morton was late. Time was ticking by; each stroke of the second hand seemed louder than the last.

Morton burst through the theatre doors, a glass dome apparatus in his hand. Inhaling deeply from Morton's ether vaporiser, Abbot 'sank into a state of insensibility'. Mr. John Collins Warren, the attending surgeon then proceeded to dissect a tumor from Abbots jaw and the patient "did not experience any pain at the time, although aware that the operation was proceeding." The first public demonstration of ether anaesthesia - a success![1]

The above account is taken from an article published by Warren in 1846[1]. Not only was it one of the first demonstrations of general anaesthesia, but it was also one of the first reported cases of anaesthetic awareness. The challenge of awareness during anaesthesia was further complicated in 1942 with the introduction of curare to achieve complete paralysis which allowed patients to be fully aware but unable to alert operating staff[2, 3]. One hundred and-sixty-seven years on from Morton's achievement, awareness continues to be an issue which presents many challenges for anaesthetists.

CLINICAL POINTS

Anaesthetic awareness is a rare complication of general anaesthesia occurring in 1-2/1,000 population

It is associated with postoperative psychological sequelae for the patient and medico-legal consequences for the anaesthetist

It has a multifactorial aetiology: patient, operation and anaesthetic factors

Monitoring intra-operative awareness is both challenging and often inaccurate

Intra-operative awareness management protocols are required

Causes of anaesthetic awareness

Awareness is defined as postoperative recollection, with or without prompting, of events following general anaesthesia[4, 5]. It can be either explicit, where the patient can consciously recall events such as hearing conversations and sounds, or implicit, where the patient has unclear memories and is unable to recall exact details[6]. The incidence of awareness is in the range of 1-2 per 1,000 general anaesthetics administered[7-10], while a higher occurrence has been reported in a paediatric population[11, 12, 13]. However, the actual incidence is difficult to measure because

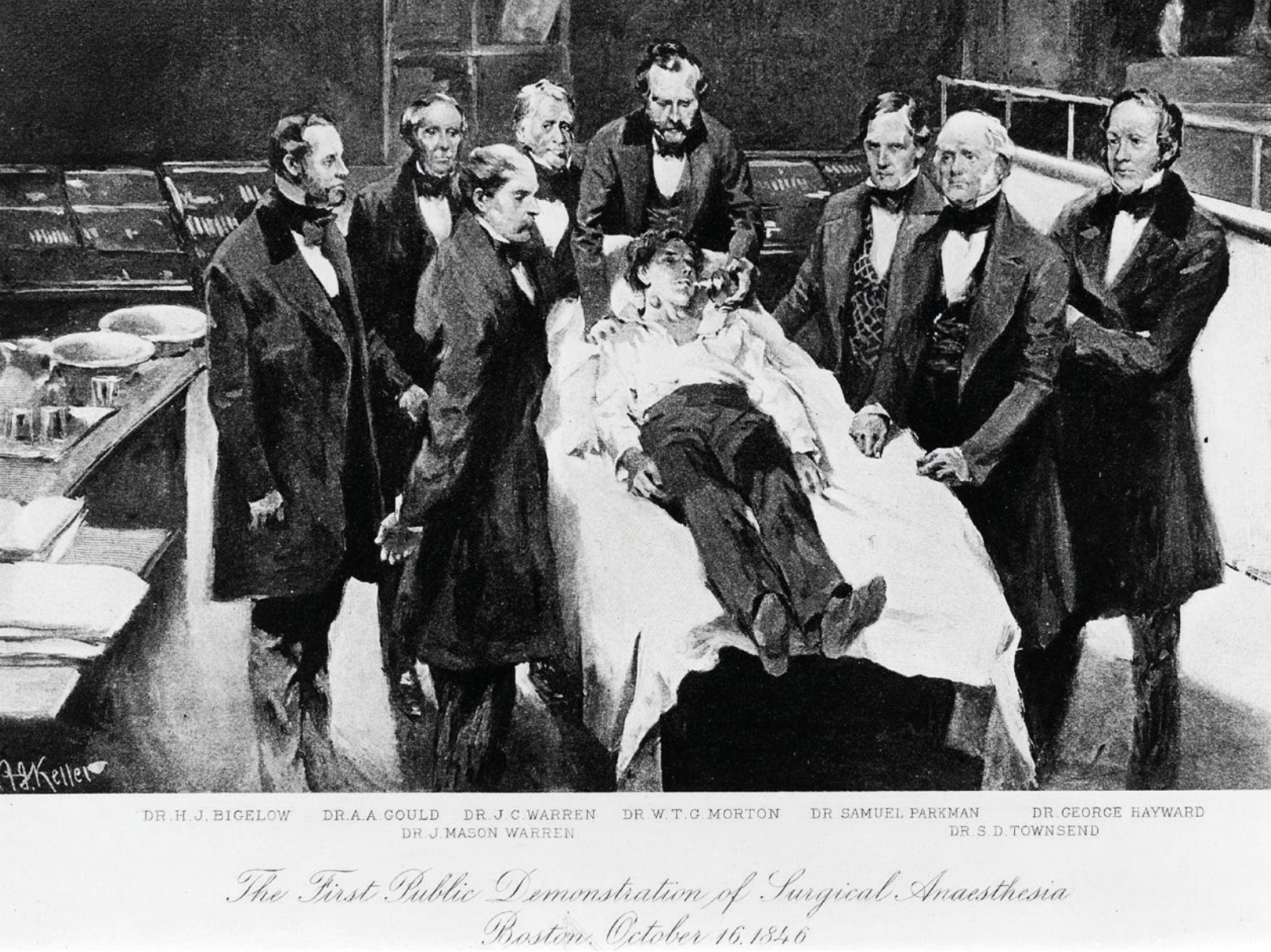

image 1 The first public demonstration of surgical anaesthesia, Boston, 16th October 1846: Dr W. T. G. Morton is administering the anaesthetic, ether. c. 1897
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there may be under-reporting by medial staff and over-reporting of dreams and false memories by patients which are classified as awareness[14].

It is important to identify which groups of patients are especially at risk of experiencing awareness. Risk groups can be divided into patient, operation and anaesthetic factors[15]. Patient factors include young age[16], female sex[17], Chinese ethnicity[18], ASA III or above (defined as patients with severe systemic disease)[19], previous awareness[20], and pulmonary hypertension[21], are all associated with a higher risk of awareness. Patients undergoing cardiac, obstetric and trauma surgery are at an increased risk, as intentional reduction of anaesthesia is used to maintain a higher blood pressure[22]. Under-dosing and use of muscle relaxants are regarded as the primary cause of awareness during general anaesthesia[23].

Awareness is a distressing complication for patients. One third of patients who report this experience have developed psychiatric symptoms ranging from nightmares, flashbacks, and anxiety to post-traumatic stress disorder[24, 25, 26]. Although awareness is rare, it does have serious consequences for patients. Attempts to monitor awareness are

image 2 This is a copy of the inhaler Morton used in his public demonstration, which took place in Boston, Massachusetts, United States. The air is drawn into the glass jar where ether-soaked sponges emit vapour which is inhaled by the patient through the glass mouthpiece at the top. The patient's expired air is diverted by a valve in the mouthpiece. This type of inhaler was widely used and adapted by a large number of dentists. The original is on show at Massachusetts General Hospital in Boston
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therefore highly desirable.

Detecting awareness

Awareness may be detected from clinical signs generated through the sympathetic nervous system. These signs include tachycardia, hypertension, tear formation, sweating, pupil dilatation, pupil reactivity to light, and movement. However; these signs can be masked by some diseases such as autonomic neuropathy (diabetes, renal failure), heart block, and hypothyroidism, while some concurrent medications have a similar effect, such as beta antagonists, anti-muscarinic (atropine, glycopyrrolate) and opioids[27].

Monitoring awareness

One way to prevent awareness is to monitor the depth of anaesthesia. This can be achieved by assessing the end tidal volume of volatile anaesthetic agent concentration, which in turn is measured by the minimum alveolar concentration (MAC). MAC is defined as the concentration of the vapour in the lungs that is needed to prevent a motor response in 50% of subjects in response to surgical stimulus[28]. It is useful because it allows real time monitoring of the depth of anaesthesia. However, MAC does present a number of problems: firstly, it is a median value and so 50% of patients may still demonstrate a

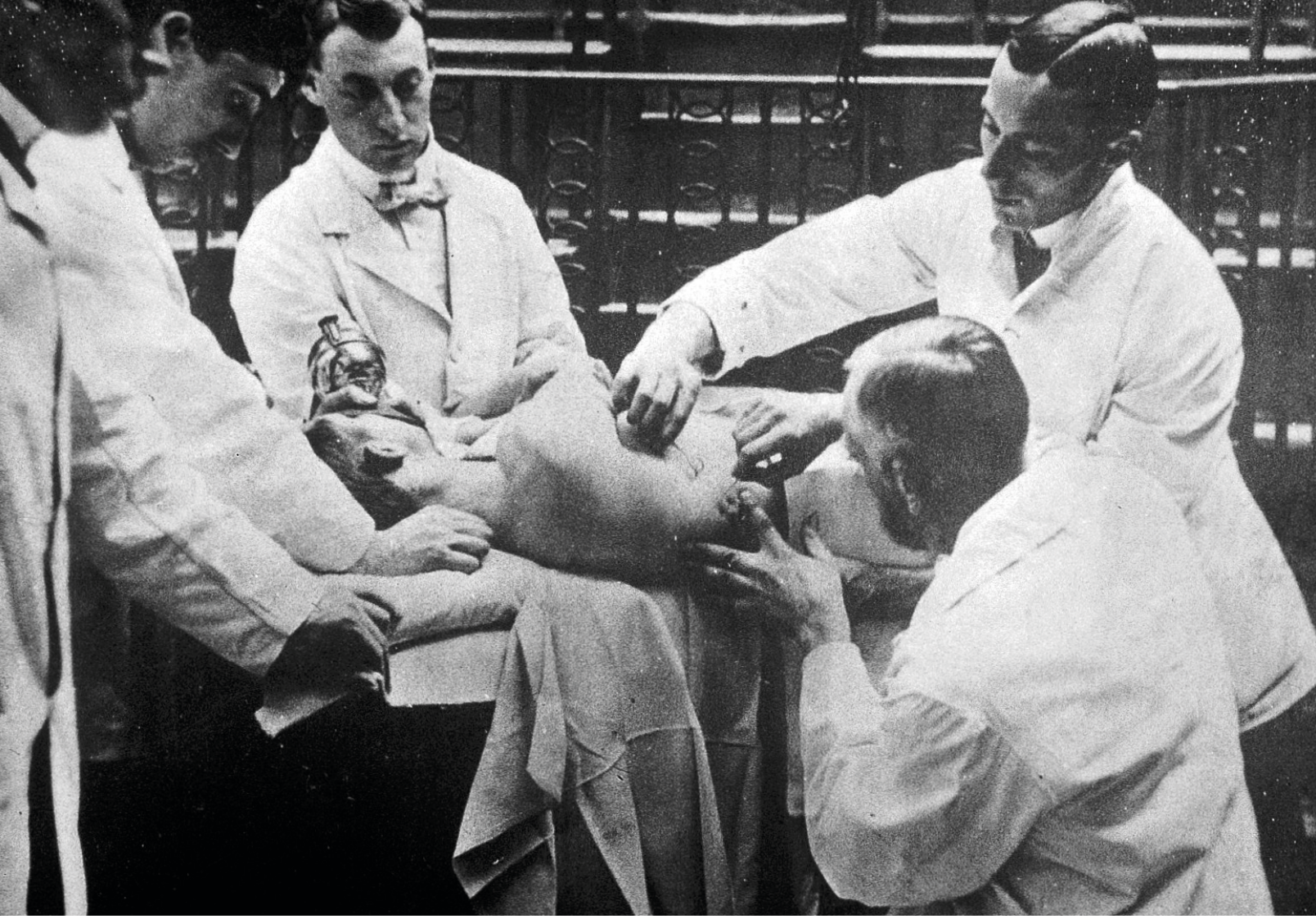

image 3 Surgeon Sir Rickman Godlee operating at University College Hospital. The anaesthetist is using a Clover's portable inhaler or a modification
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motor response to surgical stimulation. Secondly, MAC is affected by a number of physiological and pathological factors such as age[29], pregnancy, metabolic diseases, and chronic use of drugs such as opioid analgesics[30]. Thirdly, MAC is only applicable to inhaled agents and as of yet there is no similar method to measure intravenous anaesthetic agents.

Specialised monitoring equipment has been developed to alert the clinician to awareness. Electro-encephalography (EEG) allows for detection of brain responsiveness by measuring spontaneous electrical activity. A number of processing devices are available on the market that both analyse EEG activity, and present this data numerically. The most widely used EEG machines is the Bi-spectral (BIS). BIS will display a number on a scale of 0 to 100, where 40-60 indicates an appropriate level for surgical anaesthesia[31, 32].

Many studies have reported a reduction in the incidence of awareness from use of BIS[33, 34], while others have demonstrated no effect[35, 36, 37]. BIS does have limitations- senile dementia, nitrous oxide and ketamine have all been reported to affect the interpretation of BIS[38, 39]. Despite these issues, the National Institute of Health and Clinical Excellence (NICE) recommend the use of BIS (and other EEG machines) for the reduction of the risk of awareness[40].

Other methods include, “evoked potential monitors”, which are similar to EEG except that they

image 4 *Amputation* by Thomas Rowlandson, coloured aquatint, 1793. Five surgeons participating in the amputation of a man's leg while another oversees them
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detect electrical responses at localised parts of the brain. The use of auditory evoked potential in particular has been reported to detect unintentional awareness[41, 42]. The isolated forearm technique, forehead galvanometry and lower oesophageal motility assessment are of historical interest; but due to their unreliability and they do not have a place in current practice[27].

Managing awareness

Pre-operatively, a detailed history and examination of the patient may identify potential risk factors. Intra-operatively, the use of benziodiapine during induction, appropriate titration of anaesthetic agents and the avoidance of neuromuscular blockade where possible, all reduce the incidence awareness[27].

If awareness is detected intra-operatively, stop any painful stimuli, verbally re-assure, rapidly deepen anaesthesia and consider amnestic drugs such as benzodiazepines. Post operatively, interview the patient, reassure and explain what has happened in a honest, open and sympathetic manner, and arrange appropriate follow up[43].

Future challenges

The ability to detect and monitor awareness during general anaesthesia is essential for its prevention. However, in order to do this, it is necessary to un-

derstand what it means to be "aware". This is not a simple question. Philosophers have long debated the meaning of awareness long before anaesthetists - Descartes famously proposed that "I think therefore I am"[44], while Locke describes awareness as "that conscious thinking thing, (whatever substance, made up of whether spiritual, or material, simple, or compounded, it matters not) which is sensible, or conscious of pleasure and pain, capable of happiness or misery, and so is concerned for itself, as far as that consciousness extends"[45]. In philosophy, awareness could be considered to be the ability to appreciate "self" when experiencing sensations. From the prospective of neuroscience, the theory is not much clearer. Difficult questions raised in this field include: how does neural activity form thoughts and process the concept of awareness? How can one monitor "self" and "self in situation"? What should monitors actually be checking? How can a monitor which is itself "unaware" measure "awareness"?[46] In short, awareness is a difficult concept to understand, on which neither philosophers nor scientists have reached a consensus.

The National Audit Project (NAP5) of the Royal College of Anaesthetists (UK) in collaboration with the Association of Anaesthetists of Great Britain and Ireland, found that only 1.5% of anaesthetists used an EEG machine despite over two-thirds of centres possessing monitoring equipment, and only 4.5% of centres had intra-operative awareness management protocols in place[14]. Such results suggest that the future challenge is to move away from developing monitoring equipment and focus on the development of polices to prevent and manage accidental awareness[14, 47-49].

First encountered in 1846, awareness is a rare occurrence, but its consequences can be devastating. The greatest, most impelling challenge for the future of anaesthetics is to translate the abstract concept of consciousness into a concrete, scientific model. Once this is achieved, it will be desirable to develop effective neuromonitoring techniques, which can be used to detect awareness in real-time, with all current anaesthetic drugs, and in all disease states. It will also be important to implement evidence based management protocols for those suffering from awareness.

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Daire Shanahan