2009 Medical Student Prize Winner

A Brief Overview of Awareness During General Anesthesia

Austin Lamb
(University of Saskatchewan College of Medicine, Class of 2010)

Abstract:
Awareness during general anesthesia is a very common concern among patients undergoing a surgical procedure, and its existence is as old as the specialty of anesthesia itself. While the occurrence of awareness with recall with general anesthesia is rare at least from a statistical standpoint, it can be a frightening experience that may result in both negative psychological sequelae for the patient and medicolegal implications for the anesthetist. There are, however, certain patient and anesthetic factors which should be considered to help identify at-risk patients. Additionally, both clinical signs and depth of anesthesia monitors can be employed to monitor for potential patient awareness and help prevent its occurrence.

Full article

Awareness during anesthesia is nothing new. In the 1840s, with the arrival of the first anesthetic agents such as etherand nitrous oxide, physicians and patients were so happy that surgery could be provided without pain that it was of little significance that the patient would be aware during the procedure. When neuromuscular blocking agents first started coming into use in the 1940s, however, there simultaneously emerged the potential risk of having patients being aware during their surgeries without the knowledge of the anesthetist, who would be lacking the most common clinical sign of an overly light anesthetic and potential patient awareness – movement. For a patient, awareness during anesthesia ranks only second behind death as the most feared complication of a general anesthetic, and the risk of adverse psychological consequences resulting from it should make its possibility very important to the anesthetist. In North America, over 40 million patients receive general anesthetics annually, and with the awareness incidence being approximately 1 or 2 in every 1000 patients, between 40,000 and 80,000 patients will be affected each year. As a result, countless studies have been conducted in an effort to learn more about the various sequelae associated with awareness during anesthesia, the causes and risk factors contributing to it, and lastly, the ways to detect and prevent it.

Awareness during anesthesia can manifest itself postoperatively as either explicit memory with recall or implicit memory without recall. Unless otherwise stated, however, awareness under general anesthesia will be used with reference to unintended intraoperative awareness with postoperative recall. The typical symptoms reported by patients with awareness are vague auditory perceptions, a sensation of paralysis, anxiety or panic, and a sense of helplessness. The other most common symptom is pain, which can be severe and has been reported at incidences of up to or near 40%. Unfortunately, as many as 48.9% to 70% of patients with awareness suffer unpleasant consequences including sleep disturbances, nightmares and dreams, and flashbacks and anxiety during the day. Some of these patients go on to develop post-traumatic stress disorder (PTSD), with one study citing the incidence of such being 14.3%. Awareness can also result in medicolegal implications, with approximately 2% of claims against anesthetists being attributed to cases of awareness.

There are a variety of contributing factors that can lead to a state of awareness during anesthesia. Firstly, certain procedures such as cesarean section (0.4% incidence), heart surgery (1.5% incidence), and trauma cases (11-43% incidence) have an increased risk. These instances, however, are often the result of intentionally light anesthesia owing to patient factors such as limited cardiac reserve, hypotension or hypovolemia, and in the case of cesarean section and obstetrical procedures, the fear of decreasing uterine tone and increasing blood loss. In other instances, patient dose requirements can be unexpectedly higher due to the altered expression or function of target receptors. A patient's chronic use of certain substances such as benzodiazepines, monoamine oxidase inhibitors, amphetamines, cocaine, alcohol, and opiates also appear to increase the anesthetic requirements and the incidence of awareness. Further patient related factors include a higher ASA status, a past history of awareness, and patient age.

With regards to specific anesthetic techniques, nitrous and opiate anesthesia alone can be insufficient to prevent awareness and must be supplemented with other inhalational or intravenous agents. Opiates may reduce awareness, but they have no effect on learning and memory, and nitrous is not as effective as other inhalational agents in preventing awareness. As alluded to previously, whether or not a neuromuscular block is used also has an impact on the incidence of aware-

ness. In an often cited Swedish study, the incidence of awareness was 0.10% in patients who did not receive a neuromuscular block and 0.18% in patients who had. Because higher concentrations of anesthetic agents are needed to produce akinesia than amnesia, a non-paralyzed patient receiving inadequate anesthesia will likely move before forming a memory that can be recalled postoperatively. Thus, muscle relaxants should only be use if absolutely necessary. Other very important factors which can result in an overly light anesthetic and precipitate awareness are a difficult intubation, the premature discontinuation of anesthesia, and equipment malfunction or misuse (including syringe swaps). In a patient at high risk for awareness, one can consider the administration of an amnestic medication preoperatively or when the anesthetic is presumed to be too light intraoperatively.

Over the years, there have been numerous attempts to determine the adequate depth of anesthesia to prevent awareness. Traditionally, anesthetic depth is assessed by using end tidal volatile gas concentration and indirect clinical signs of autonomic responsiveness such as tachycardia, increased blood pressure, pupillary dilation, lacrimation, and diaphoresis. While these parameters can be useful, they can also result in a patient receiving more anesthetic than is necessary, and many studies have disputed their reliability. Opioids and anticholinergics can attenuate or eliminate autonomic responses, and the hemodynamic measurements in particular can be affected by a wide range of factors including ß-blockers, calcium channel blockers, volume status, and preoperative ventricular function. The reliability of end tidal MAC values has also been questioned. Hypotension, bronchodilators, and emphysema can all cause end tidal concentrations to be misrepresentative of the actual partial pressure of volatile agents in the brain. Nevertheless, literature suggests administering 0.8-1.0 MAC if using volatile agents alone, and to supplement nitrous and opioid anesthesia with at least ≥ 0.6 MAC.

Because there are many reports of patient awareness when there have been adequate end tidal MAC levels and no changes in autonomic indicators, a variety of monitors have been developed in an attempt to better gauge whether or not a patient will have awareness. These monitors do not measure learning and the possibility for later recall, but consciousness. Most of these monitors utilize a processed EEG reading in some capacity (e.g. Bispectral Index, Patient State Index, Narcotrend Index, Entropy, and Auditory Evoked Potentials). While these monitors have some proponents, none of them have proven effective enough to become universally adopted. With respect to Bispectral Index (BIS) (Aspect Medical Systems, Norwood, MA), the most extensively studied depth of anesthesia monitor and the only one to be approved for such use by the FDA, the evidence thus far is conflicting. Some studies support its use, while there is other research which indicates that awareness incidences are not statistically different when BIS is employed. In addition, research indicates that the consciousness threshold values of the various depth of anesthesia monitors may not only be dependent on the various anesthetic combinations used, but also on different types of patients. Given that there is no single formula of anesthesia that can be used on every patient, this presents an obstacle to their use. Whether or not these monitors are cost effective is also questioned. These monitors do appear to decrease the amount of anesthetic used, however, and recovery times appear to be quicker. Interestingly, while the claim that these monitors may result in overly light anesthetics and actually increase the incidence awareness seems at least plausible, there is evidence which refutes this notion. At present, it is recommended by the ASA that brain function monitors are only to be used on a case to case basis and that they are not routinely indicated.

Another method, the Isolated Forearm Technique, uses movement in response to commands in paralyzed patients to assess the depth of anesthesia, employing the theory that if movement can not be elicited in an isolated non-paralyzed arm, then the patient is sufficiently anesthetized to prevent awareness. While this technique has been regarded by some as the most reliable tool to detect intraoperative amnestic wakefulness, it is cumbersome and can only be used for very short time periods. Nevertheless, it remains a useful technique when judging the efficacy of other methods.

While there have been many advancements in anesthesia over the years, the issue of unintended intraoperative patient awareness with recall still exists and is likely to be around for some time. While the occurrence of awareness is rare statistically speaking, patient volume and the potential for adverse psychological consequences to the patient necessitates that anesthetists are vigilant in identifying patients at risk. Unfortunately, there is currently nothing that can prevent awareness, as both clinical signs and depth of anesthesia monitors rely on parameters which correlate only indirectly with potential patient awareness. Therefore, the only reliable indicator of awareness is the patient's own experience and subsequent testimonial of it. As such, despite the multiple preventative measures that can and should be taken, awareness can happen even under the care of the most well-trained and experienced anesthetist.

References available on request.