



## Anesthesia Awareness

Awareness has been associated with the administration of general anesthesia since its inception. More than 150 years ago, when William Morton administered ether as the first anesthetic, his patient reported being aware during the surgical procedure.<sup>1</sup> Not until the early 1960s did anesthesia awareness become a significant subject of inquiry, with reports estimating the incidence and the psychological consequences of awareness during general anesthesia.<sup>2</sup>

### Types of Awareness

Awareness is usually defined simply as the patient remembering an event that occurs during anesthesia.<sup>3</sup> A variation of anesthesia awareness is awake paralysis, in which the patient inadvertently receives a paralytic agent but is still awake because an anesthetic agent is not given or the level of anesthesia is not adequate.<sup>4</sup>

Another way of categorizing anesthesia awareness is from the perspective of memory. Explicit memory (remembering) is conscious recall of a previous event or stimulus.<sup>3,5</sup> Implicit memory involves no conscious recollection of the event that contributed to the memory,<sup>5</sup> but nevertheless, emotions and behavior may be adversely affected.<sup>3,5</sup>

### PA-PSRS Reports

Pennsylvania facilities have submitted at least 22 reports indicating awareness during general anesthesia since the inception of PA-PSRS on June 7, 2004. While most have come from hospitals, at least three reports were submitted by an ambulatory surgery unit or facility. Seventy-seven percent of patients in these reports were female. The procedures being performed varied considerably (see Table 1). Most patient complaints were of pain or feeling an incision or surgical manipulation; others indicated intraoperative patient movement, overheard conversations, and waking up. The anesthetic used was rarely specified in the reports submitted to PA-PSRS.

A few reports indicate the cause of the episode. Three reports attribute the cause to patient factors (e.g., history of reduced oxygen saturation during anesthesia). Two reports questioned the potency of the anesthetic drug (pentathol in both cases). Other causes described include:

- The anesthesia canister was locked in place but not seated properly, presumably preventing the anesthetic gas from flowing to the patient.
- A discrepancy between the vaporizer setting and the amount of anesthesia the patient actually received.
- A procedure was started before the anesthetic was administered.
- The anesthesiologist thought the procedure was completed and woke the patient prematurely.

### Incidence

Historically, anesthesia awareness has been under-recognized and under-treated. As a result, the incidence of intraoperative awareness and recall has been poorly documented in the past. More recent studies, however, report that the incidence of awareness with recall while undergoing general anesthesia ranges from 0.1% to 0.2%,<sup>2,6,7</sup> or about 1 to 2 cases per thousand.<sup>2,6</sup>

While these estimates make the problem seem rare, with an estimated 20 to 21 million patients receiving general anesthesia annually in the US, approximately 100 cases occur each work day across the nation.<sup>6,7</sup> Further, incidence estimates have increased over the past decade as recognition of this problem has increased.<sup>8</sup> The incidence of anesthesia awareness is higher for certain types of procedures. For example, estimates range from 1.1% to 1.5% in cardiac surgery,<sup>1,3</sup> 0.4% to 4% in obstetrics,<sup>1,3,8</sup> and 11% to 43% in major trauma surgery.<sup>1,3,8</sup>

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### Immediate Manifestations

Patients' experience of anesthesia awareness includes many sensory perceptions. Patients may be aware of conversations, voices, and other sounds around them.<sup>1,4-7</sup> Others may be aware of the sensation of paralysis.<sup>1,4-6</sup> When neuromuscular blocking drugs are used, the patient is completely paralyzed and unable to communicate to the surgical team.<sup>5,9</sup> In addition, they may sense the endotracheal tube<sup>1,6</sup> or their inability to breathe for themselves.<sup>5-7</sup> Patients may experience pain when the incision is made/closed or during surgical manipulation.<sup>1,2,4,5,9</sup> They may also feel pressure without pain.<sup>1,6</sup> Less commonly, the patient may have visual perceptions.<sup>1</sup> Intraoperatively, anesthesia awareness may produce stress, mental distress, anxiety, panic and terror,<sup>1,2,4-6,9</sup> as well as feelings of helplessness and powerlessness.<sup>1,5,9</sup>

### Sequelae

Patients' responses to anesthesia awareness may range from simple dissatisfaction<sup>2</sup> to severe psychological sequelae. Studies indicate that from 50-70% of patients experiencing intraoperative awareness experience unpleasant after effects.<sup>1,5,7,8</sup> These include phobias such as fear of intraoperative awareness recurring if anesthesia is required in the future.<sup>3,5,8</sup> Other sequelae include recurrent dreams and nightmares, flashbacks, sleep disturbances/insomnia, daytime anxiety, and panic attacks.<sup>1,3-5</sup> Impaired social and work interactions are also reported.<sup>8</sup> Patients may feel betrayed or abandoned by their healthcare workers.<sup>1,9</sup> This may result in unwillingness to discuss symptoms or the anesthesia awareness experience, general distrust of healthcare personnel, as well as avoidance of healthcare workers and environments that remind them of their surgical and anesthesia experience.<sup>1,3,4</sup> Without intervention, from 10 to 25% of patients experiencing anesthesia awareness develop post-traumatic stress disorder (PTSD).<sup>1,3,4</sup> PTSD may

continue for months, and even years, after the awareness event.<sup>1</sup> Permanent disability from these symptoms may ensue.<sup>8</sup>

Patients who experience anesthesia awareness may not report it. Those who do not suffer during awareness may not feel there is a reason to tell anyone or may not care about it.<sup>2</sup> Patients who are traumatized by the event and who develop dissociation may appear calm or unaffected by the event. Patients with PTSD or post-awareness dissociation may not, therefore, be identified as having suffered.<sup>9</sup> Postoperative psychiatric complaints that appear unrelated to anesthesia awareness may also be reflective of a post-anesthesia awareness psychiatric complication.<sup>9</sup>

### Factors Contributing to Anesthesia Awareness

#### Patient Condition

Anesthesia awareness may occur with normal doses of anesthesia in patients who have increased anesthesia requirement and/or who are unexpectedly tolerant to anesthesia.<sup>5</sup> Such patients include those with chronic use of amphetamines, opioids/cocaine, or alcohol.<sup>1,3,5,8,10</sup> Other factors associated with an increased anesthesia dose to produce unconsciousness include a younger age, tobacco smoking, and morbid obesity.<sup>3,5</sup>

Other patient conditions may require light anesthesia, thus increasing the risk of anesthesia awareness.<sup>10</sup> For example, patients with ASA ratings of III to V are at increased risk if heavy anesthesia is used.<sup>6</sup> The risk of anesthesia awareness is therefore increased in such patients. In patients undergoing major trauma or cardiothoracic surgery, or in hypovolemic patients and those with minimal cardiac reserve, anesthesia may need to be reduced to maintain blood pressure.<sup>1-3,5,7,10</sup> For patients undergoing obstetric procedures, such as Cesarean section, light anesthetic technique is used to reduce the potential for depression of the fetus.<sup>1-</sup>

<sup>3,5,7,8,11</sup> Abdominal and ophthalmic surgery has also been associated with anesthesia awareness.<sup>6</sup>

#### Process/Type of Anesthesia

The use of inhalation volatile anesthetic is more effective than nitrous oxide in reducing the incidence of recall during general anesthesia.<sup>1,7,8</sup> The risk of intraoperative awareness is increased with the use of nitrous oxide only, or in combination with IV opioids, benzodiazepines, barbiturates, propofol, and muscle

Table 1. Procedures Being Performed in Reports of Anesthesia Awareness

Procedure	Number
Colonoscopy or cystoscopy under general anesthesia	2
Laparoscopic cholecystectomy	2
Cesarean section	2
Unspecified abdominal procedure	2
Gastric bypass	1
Unspecified cardiac surgery procedure	1
Exploratory laparotomy	2
Mastectomy	1
Prolonged/difficult intubation for unspecified surgical procedure	2
Other unspecified surgical procedure	7

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relaxants.<sup>1,4,5,7,10</sup> There appears to be greater patient-to-patient pharmacokinetic variability with IV agents than with volatile anesthetics.<sup>1,10</sup> Thus, titrating the IV agents may be more difficult to meet a specific patient need. Malpractice claims for recall during general anesthesia are more likely to involve techniques using nitrous oxide/narcotic/relaxant techniques than volatile anesthetics.<sup>1,3</sup>

Also, during a difficult intubation, anesthetic drugs may wear off during an intubation period that is longer than originally anticipated.<sup>1,2,5,10</sup>

If intraoperative hypotension occurs, anesthetic agents may be prematurely discontinued, increasing the risk of intraoperative awareness.<sup>1,5</sup>

Some small studies have found that women wake up faster from nitrous oxide with propofol/alfentanil than men.<sup>1,5,12</sup> This may explain why malpractice claims for recall during general anesthesia are more likely to be filed by women.<sup>4</sup> However, a study of 19,000 cases of general anesthesia found that sex did not influence the incidence of awareness.<sup>6</sup> Further study of the pharmacodynamics of anesthetic drugs would be needed to determine the role of gender in anesthesia awareness.<sup>4</sup>

### Medications/Drugs

Anesthesia in the presence of amnestic drugs increases the risk of anesthesia awareness.<sup>8</sup> Use of amphetamines<sup>3</sup>, beta blockers, and calcium channel blockers can mask physiologic responses to inadequate anesthesia.<sup>7</sup> A high level of Vitamin C may interfere with anesthetic effect.<sup>13</sup> The use of neuromuscular blocking agents/muscle relaxants may contribute to unintentional provision of insufficient anesthesia.<sup>3,8,11</sup> When a non-paralyzed patient is inadequately anesthetized, the patient is able to communicate awareness through movement. This cue is absent when patients receive a neuromuscular blocking agent.<sup>3</sup>

### Medication Errors

Calculation errors or infusion pump programming errors may result in failure to administer an appropriate dose of an anesthetic agent.<sup>1,8,10,11</sup> During a long intubation, the healthcare worker may not administer a second anesthetic dose on a timely basis, thus increasing the possibility of awareness.<sup>1,10</sup> Awake paralysis events are most likely to be associated with errors in labeling<sup>10</sup> and sequence of administration during the pre-induction phase.<sup>4</sup> The ASA closed claims project indicated that two-thirds of the awake paralysis claims related to succinylcholine infusions

being unlabeled or mislabeled, or failure to check labels.<sup>8</sup> In addition, swapping of properly labeled syringes has been reported.<sup>8</sup> In some cases, muscle relaxants were administered first instead of a sedative or hypnotic agent.<sup>1,10</sup>

### Machine Malfunctions

The delivery of anesthetic agents to the patient can be impeded/prevented through many equipment-related issues. Vaporizers may malfunction, not be turned on, or may be empty.<sup>3,5,8</sup> The source of anesthetic gas (such as a nitrous oxide cylinder) may be empty.<sup>3</sup> Intravenous pumps may malfunction.<sup>3</sup> There may be leaks or disconnections between vaporizers and circuits or delivery tubing.<sup>1,3,5,10</sup> Technical equipment failures of the anesthesia machine can affect the delivery of the anesthetic agent to the patient.<sup>5,10,11</sup>

### Interventions

If anesthesia awareness is reported, the foremost therapeutic interventions are to respect the patient by taking it seriously and to treat the patient sympathetically.<sup>1,5,9,10</sup> While spurious claims have been reported,<sup>14</sup> for the most part, reports of anesthesia awareness are genuine and can have significant consequences. Ignoring or disbelieving the report is likely to promote more serious emotional after-effects. Effective interventions include: compassionate debriefing; assuring the patient that the report is credible; and empathizing with the patient's suffering.<sup>1,3,7,10</sup> If awareness is discovered intraoperatively, patient stress may be reduced by offering comforting/affirming comments until anesthesia is increased and the patient loses consciousness.<sup>10</sup>

Investigation of the event is conducted,<sup>5</sup> followed by explaining what happened to the patient.<sup>1,3</sup> The explanation is more effective if an apology is offered,<sup>1,3,7</sup> and the reason is presented (such as light anesthesia was required because of substantial cardiovascular instability).<sup>7</sup> Explaining to the patient methods to prevent recurrence of anesthesia awareness can be reassuring.<sup>1,3</sup>

Counseling or other forms of psychological support are indicated, particularly if anxiety, flashbacks, or persistent nightmares exist.<sup>3,5,7,10</sup> Anecdotal evidence suggests that debriefing by the anesthesiologist after an awareness event may be effective in preventing a chronic traumatic reaction. In addition, early referral for psychological/psychiatric counseling may also reduce the occurrence and severity of the emotional aftereffects of PTSD.<sup>1,3,5</sup>

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Table 2. Post-Anesthesia Interview Questions

The following questions may be helpful in eliciting information from patients concerning anesthesia awareness.<sup>15</sup>

### Questions asked of all patients who have undergone general anesthesia

1. What was the last thing you remember before going to sleep before your surgery/procedure?
2. What is the first thing you remember when waking up from your surgery/procedure?
3. Do you recall anything in between?
4. Did you have any dreams while you were asleep during your surgery/procedure?
5. What was the most unpleasant thing you remember from your surgery/procedure and your anesthesia?

### Additional questions to ask if a patient reports anesthesia awareness

1. What do you remember (tactile sensations, pain, sounds, conversations, visual perceptions, pain, paralysis)?
2. Did you feel something in your throat or mouth?
3. What was going through your mind during this experience?
4. Did you think you were dreaming?
5. How long do you think this recollection lasted?
6. Did you try to alert anyone during your surgery/procedure?
7. How was your emotional/mental state before your surgery/procedure?
8. Have there been any consequences of this awareness experience?
9. How do you feel now?
10. Did you inform any healthcare worker of this experience after you woke up?
11. Has this experience changed your opinion about anesthesia, your healthcare workers, or healthcare facility?
12. What can I, as a healthcare worker, do to help you?

Adapted from: Wennervirta J, Ranta S O-V, Hynynen M. Awareness and recall in outpatient anesthesia. *Anesth Analg* 2002;95:72-7.

When interviewing the patient who reports awareness, information can be encouraged by asking several questions (See Table 2).<sup>3,15</sup> Such an interview reaffirms that the patient's report is respected, and it provides an opportunity for the anesthesiologist to assess not only the patient's perceptions of the experience, but also to determine adverse after-effects for which early referral for psychological support are indicated.<sup>5,7</sup>

Communicating with healthcare workers involved in the procedure helps to ensure their contribution to the

investigation of the event as well as validation and support of the patient.<sup>9</sup> The healthcare team can be instrumental in identifying adverse outcomes that may require treatment,<sup>9</sup> as well as ensuring that a support network is available to the patient. Healthcare workers can document in the medical record the conversations with the patient, the details of the experience expressed by the patient, the patient's response, and recommendations/referrals for follow-up care.<sup>3,5,7</sup>

Maintaining contact with the patient is helpful to monitor and refer for psychological sequelae.<sup>1</sup> The post-anesthesia visit conducted within the first 24 hours after surgery, daily visiting during hospitalization, and regular telephone contacts thereafter until the patient appears to have recovered from the event allows the healthcare team to determine whether complete recovery has occurred or additional intervention is required.<sup>3</sup>

### Prevention/Risk Reduction

The following actions may reduce the risk of anesthetic awareness.

### Administration of Anesthetic Agents/Drug Associated with Anesthesia

- Administering amnestic premedications when light anesthesia is necessary (scopolamine, benzodiazepines, midazolam,<sup>1,7,10</sup> or subanesthetic doses of ketamine or inhalation agents<sup>4</sup>).
- Minimizing the use of complete neuromuscular blockade<sup>1</sup> and avoiding muscle paralysis unless absolutely necessary.<sup>3,11</sup> By avoiding complete muscle relaxation, patients may have a movement response or may open their eyes in response to a verbal command if anesthesia awareness is imminent.<sup>5,7,10</sup> Usually, a patient does not recall responding to a verbal command by movement, because movement occurs at a higher dose of anesthetic agent than the level allowing recall. Likewise, if a patient does not respond to a verbal command to move, recall under general anesthesia is less likely.<sup>1</sup>
- Supplementing nitrous oxide/opiate anesthesia with a potent volatile anesthetic, with end-tidal concentrations of 0.6 minimum alveolar concentration (MAC).<sup>1,3,4</sup>
- When a potent volatile anesthetic agent is used by itself, maintaining 0.8 to 1.0 MAC.<sup>1,3</sup>
- If tracheal intubation is to follow immediately, or if a difficult intubation requires repeated

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intubation attempts over an extended period of time, administering more than a “sleep dose” of induction agents<sup>1,4,7,11</sup> or repeating the induction agent.<sup>5,10</sup>

- Giving adequate doses of anesthetic agents that are safe for the patient, consistent with patient history and medical conditions.<sup>3,5,10,11</sup> Intraoperatively, if low anesthesia concentrations are required, adding a sedative agent such as scopolamine and talking to the patient during the procedure to explain why awareness may be occurring.<sup>5</sup>
- Scrupulous checking of syringes before administration. Labeling all syringes and checking prefilled syringes by two persons.<sup>16</sup>

### Assessment/Identification of Patients at Risk

- Using the anesthesia preoperative assessment to identify patients who are at risk for anesthesia awareness.<sup>5</sup>
- For those at risk, using the informed consent process prior to surgery to discuss the concept of anesthesia awareness, the reasons it might occur, and interventions to prevent its occurrence.<sup>1,3,5,17</sup>

### Post Operative Assessment

- Incorporating assessment for anesthesia awareness as part of the ongoing postoperative process for all patients including children,<sup>17,18</sup> from the recovery room through postoperative visits by the anesthesiologist, as well as office visits with the surgeon.<sup>9</sup>

Memory of intraoperative awareness may be delayed by several days in as many as 50% of patients who experience awareness.<sup>2,6</sup> Some patients may recall this awareness one to two weeks after surgery because subhypnotic concentrations of anesthetics may impair recall during the first 24 hours after surgery.<sup>2,3</sup> In addition, no relationship has been found between when recall first occurs and the severity of the patient’s experience.<sup>2</sup> Postoperative inquiry over time would help identify patients who may have delayed recall.

Postoperative inquiries (See Table 2) of all patients who have undergone anesthesia may also encourage those patients who would not ordinarily report the experience to discuss this issue.<sup>3</sup> Such patients might include those who were not disturbed by the experience or those who have dissociated in response to the experience. One study indicated that half of patients who experienced anesthesia awareness did not

report it to their anesthesiologist because they had not seen him/her since the operation.<sup>3</sup>

### Communication

Limiting OR conversation to what is clinically appropriate respects the dignity of every patient. Avoiding negative or derogatory comments about the patient’s physical condition, prognosis, or appearance will ensure that inflammatory words/terms will not contribute to the patient’s emotional distress if awareness occurs.<sup>5</sup> Some have recommended the use of auditory masking so that intraoperative remarks are not heard, but this does not address other awareness complaints, such as pain or paralysis.<sup>3</sup> In non-paralyzed patients, auditory masking might prevent a patient from moving in response to a verbal command – a test of anesthesia awareness.

### Equipment Maintenance

- Involving clinical engineering and incorporating anesthesia machines, vaporizers, infusion pumps and other anesthesia-related equipment into a periodic preventive maintenance program, to ensure that equipment is functioning properly.<sup>3,10,18</sup>
- Meticulously checking the machine and ventilator before each administration of anesthesia.<sup>3,5</sup>
- Regularly checking flow meters, vaporizers, and level of anesthetic in the vaporizer intraoperatively.<sup>3,10</sup>
- Monitoring the levels of inspired/expired gases and inhalation agents.<sup>3</sup>
- Administering anesthetic infusions preferably through a dedicated line.<sup>3</sup>
- Using infusion pumps with volume and pressure alarms that are activated/audible.<sup>3</sup>

### Education

Overall, the clinical literature indicates that healthcare personnel understanding of the existence and management of anesthesia awareness is poor or lacking.<sup>3</sup> Heightening awareness of the following will alert healthcare workers of this phenomenon: incidence, symptoms, sequelae, risk factors, interventions, and prevention/risk reduction. Conditions/drugs that affect the effectiveness of anesthesia or mask responses to inadequate anesthesia can be presented.<sup>7</sup> Skills can be developed to identify those at risk, intervene when awareness occurs, and to validate/empathize when awareness occurs.<sup>5,10</sup> Education and confirming competencies concerning the appropriate use and

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checking of all anesthesia-related equipment may reduce anesthesia awareness events associated with equipment.

Advising the patient to inform anesthesia providers about the anesthesia awareness experience and the factors that placed the patient at risk may improve planning for and risk reduction during future procedures.<sup>3</sup>

### Protocols

Developing/reviewing and revising policies/protocols may effectively contribute to reducing or managing anesthesia awareness events.<sup>18</sup> Concepts to consider in such protocols include:

- Education of clinical staff about anesthesia awareness and management of patients experiencing awareness.<sup>7</sup>
- Identification of patients at risk and discussion with such patients prior to surgery of the potential for awareness and prevention efforts.<sup>7</sup>
- Regular identification of anesthesia-related equipment.<sup>7</sup>
- Application of appropriate anesthesia monitoring techniques.<sup>7</sup>
- Postoperative follow-up of all patients, including children, who have received general anesthesia.<sup>7</sup>
- Mechanisms for referral/access for patients who are in need of counseling, support and effective treatment for mental distress or PTSD.<sup>7,9</sup>
- Reporting processes of such events both within and outside the healthcare organization.<sup>5</sup>
- Documentation of the patient complaint.<sup>5</sup>
- Investigation and reporting processes.<sup>5</sup>
- Evaluation of the outcome of the intervention.<sup>5</sup>
- Identification, analysis, and implementation of opportunities for improvement.
- Mechanisms/processes used to monitor patients for anesthesia awareness.<sup>5</sup>
- Specification of training requirements and competencies required of personnel who use anesthesia-related equipment.

### Monitoring

Vigilant application of current monitoring techniques/technologies can have a positive impact upon anesthesia safety and may also prevent or reduce anesthesia awareness.<sup>18</sup> The American Society of Anesthesiologists (ASA) has developed standards for basic anesthesia monitoring that include continual evaluation of the patient's oxygenation, ventilation, circulation, and temperature.<sup>5,19</sup> The American Association of Nurse Anesthetists (AANA) has standards for continuous monitoring of the same patient parameters, as well as for neuromuscular function/status and assessment of patient positioning.<sup>20</sup> In addition, gas monitoring can verify that proper levels of anesthetic gases are delivered or identify equipment failures/abnormalities in the gas delivery system.<sup>5</sup>

Indirect physiologic monitoring techniques are used to monitor for anesthesia awareness.<sup>21</sup> These signs include blood pressure, respiratory and heart rate, skeletal muscle relaxation, ocular movement and pupillary dilatation, and sweating.<sup>1,3,7,8,21,22</sup> In some countries the autonomic vegetative clinical signs are quantified as the PRST score (changes in blood pressure, heart rate, sweating, tear production).<sup>23</sup> One small study indicated that in 4 of 5 cases, blood pressure and heart rates substantially above resting levels were a clear indication of the patient returning to consciousness.<sup>5</sup>

However, autonomic responses may be unreliable in detecting level of consciousness.<sup>3,5,10,23</sup> For example, patients medicated with antihypertensive medications (such as beta blockers or calcium channel blockers) may not have hemodynamic responses to anesthesia awareness.<sup>5,7</sup> The use of muscle relaxants during general anesthesia will limit a patient's ability to move and communicate in response to awareness.<sup>5</sup> End-tidal monitoring of anesthetic gas concentrations also has been shown not to prevent anesthesia awareness in a prospective study.<sup>10</sup>

Voluntary movements, or movement responses to noxious stimuli, however, are one of the best clinical measures for detection wakefulness or potential wakefulness during surgery in non-paralyzed patients.<sup>1,3,23</sup> The isolated forearm technique (IFT) has been utilized over the past 25 years, and it has been regarded as a scientific "gold standard" for detecting cognitive function during relaxant anesthesia. However, it has not been used widely in the US.<sup>2</sup>

IFT involves the application of a blood pressure cuff/pneumatic tourniquet after induction of anesthesia. The cuff/tourniquet is placed on the arm opposite that

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in which neuromuscular blocking agents are to be injected, and it is inflated above systolic pressure. The cuff/tourniquet remains inflated until the relaxant drug is tissue-bound.<sup>24</sup> As a result, the forearm is not paralyzed. This allows the patient to move wrist and fingers if the anesthesia becomes too light.<sup>24</sup> The patient is asked to clench the fist as an assessment of responsiveness.<sup>21</sup> Prolonged monitoring is achieved by releasing the cuff and reinflating it later if/when further muscle relaxation is necessary. This cycle can be continued indefinitely when non-depolarizing muscle relaxants are used (such as atracurium or vecuronium), but not when pancuronium is used.<sup>25</sup>

This technique could be offered to persons with a history of anesthesia awareness. While it does not guarantee that awareness will not happen, it can ensure that the patient has a method of communication if the event recurs. The technique is cost-effective, and the required equipment is already available in the surgical services environment.<sup>24</sup>

Some manufacturers have developed devices that directly measure brain activity, rather than physiologic responses.<sup>7,21</sup> This technology is based on processed electroencephalogram (EEG) data or auditory evoked potentials. These devices include bispectral index (BIS), spectral edge frequency (SEF), median frequency (MF), mid-latency auditory evoked potentials (MLEAP or AEP), steady-state evoked potentials, and m-entropy.<sup>1,2,10,21,23</sup> These new methodologies may be less affected by medications usually administered during general anesthesia, thereby helping to detect and prevent anesthesia awareness in high-risk patients.<sup>7</sup> However, a sufficient body of independent evidence must be further developed to definitively determine the effectiveness of these monitors in the prevention and reduction of anesthesia awareness.<sup>7,18,21</sup>

Currently, neither the ASA or AANA have a standard for brain-wave monitoring. These organizations have constituted a joint scientific work force to conduct a critical review of the technology. Published, peer reviewed studies will be evaluated, and a report is expected to be available within the next year.<sup>22</sup> The JCAHO has indicated that, at this time, adequate evidence is not available to define the role of the technology in the prevention and detection of anesthesia awareness. However, additional information is expected to develop.<sup>18</sup>

If a facility is currently using, or is considering purchasing, level-of-consciousness monitors, users can be educated concerning the indications for and limitations of this technology.<sup>5,18</sup>

### Resources on Anesthesia Awareness

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An Independent Agency of the Commonwealth of Pennsylvania

The Patient Safety Authority is an independent state agency created by Act 13 of 2002, the Medical Care Availability and Reduction of Error ("Mcare") Act. Consistent with Act 13, ECRI, as contractor for the PA-PSRS program, is issuing this newsletter to advise medical facilities of immediate changes that can be instituted to reduce serious events and incidents. For more information about the PA-PSRS program or the Patient Safety Authority, see the Authority's website at [www.psa.state.pa.us](http://www.psa.state.pa.us).



ECRI is an independent, nonprofit health services research agency dedicated to improving the safety, efficacy and cost-effectiveness of healthcare. ECRI's focus is healthcare technology, healthcare risk and quality management and healthcare environmental management. ECRI provides information services and technical assistance to more than 5,000 hospitals, healthcare organizations, ministries of health, government and planning agencies, and other organizations worldwide.



The Institute for Safe Medication Practices (ISMP) is an independent, nonprofit organization dedicated solely to medication error prevention and safe medication use. ISMP provides recommendations for the safe use of medications to the healthcare community including healthcare professionals, government agencies, accrediting organizations, and consumers. ISMP's efforts are built on a non-punitive approach and systems-based solutions.