Conscious awareness and memory during general anesthesia

KAREN KIVINIEMI, CRNA, BSN, ARNP
Lexington, Kentucky

Conscious awareness is an infrequent complication of general anesthesia. All methods of anesthesia have been implicated, and no method guarantees amnesia. This article examines implicit and explicit memory and discusses factors associated with awareness. Common methods of detection are unreliable, and symptoms resembling post-traumatic stress disorder may result if awareness goes unrecognized and untreated.

Patients who experience awareness may sue on grounds of malpractice, breach of contract, and lack of consent. Overhearing negative stimuli may affect patient outcome, because learning and language comprehension can occur during what appears to be clinically adequate anesthesia.

Strategies to block threatening auditory stimuli include use of earphones, music tapes, white noise, reassuring statements, or positive suggestion. Behavioral anesthesia decreases patient stress to enhance recovery. Evidence of patient benefit resulting from therapeutic suggestion is inconclusive.

Key words: Conscious awareness, memory, recall, therapeutic suggestion.

Conscious awareness and memory with general anesthesia are complications that occur rarely. It is commonly accepted that memory can occur under light general anesthesia; however, evidence indicates that awareness, with or without later recall, occurs in some individuals who were considered adequately anesthetized.

How can conscious awareness be detected under anesthesia? What stimuli penetrate and imprint on the brain at different levels of anesthesia? How is memory currently defined? Is there value in therapeutic suggestion while the patient is anesthetized? How can this knowledge be used to benefit patients?

This article examines literature concerning learning, recall, implicit and explicit memory under anesthesia, clinical indicators of consciousness, medicolegal consequences, post-traumatic stress disorder as a result of incomplete amnesia, and practical applications for patients undergoing anesthesia.

History

Reports of memory of events under anesthesia date back as far as its early use. The problem of awareness during anesthesia did not appear to become significant until muscle relaxants came into use in the 1940s that permitted an insufficient depth of anesthesia to prevent awareness.

Awareness and recall

Wilson defined awareness as "the ability of the patient to recall, with or without prompting, any event occurring during the period when the patient was believed to be unconscious." Awareness has also been described as being conscious or
wakeful. It is important to note that an aware patient may respond to commands under anesthesia without later recall. However, the converse is also true—an aware patient may not respond but still demonstrate recall postoperatively."

Conscious recollection of events occurs significantly less often than recall under hypnosis, dreaming of events, or conversations during anesthesia. Awareness occurs in 0.5-1% of anesthetics, but it may be higher in select populations, and it is most frequent in those requiring a rapid sequence induction, such as for emergency cesarean section. About 10% of those with incomplete amnesia also will experience associated pain.

Because most patients do not spontaneously complain of awareness, some clinicians consider awareness under anesthesia to be a rarity; others believe these reported cases reflect the tip of the iceberg. Practitioners should be cognizant that a nonverbal response to an intraoperative conversation may have been established as well.

Unexpected awareness during general anesthesia can be psychologically traumatic. Patients who are undergoing local or regional anesthesia do not suffer the psychological trauma that can occur when the patient who expects to be asleep for surgery is actually aware. Such a patient may experience total loss of control because of pharmacological paralysis, endure pain, feel unable to breathe, and be incapable of communicating his or her plight.

Auditory processing remains active under general anesthesia

Recall can occur during apparently adequate planes of anesthesia. There is currently no reliable measure of anesthetic depth, and depth itself seems to vary throughout surgery depending on stimulation. Dreaming appears to be more commonly associated with “light” anesthesia. Pain, loud noises, and statements that have a high emotional impact or are of a derogatory nature are most frequently retained in memory, whether consciously or unconsciously.

Auditory evoked responses that reflect the sense of hearing are maintained at clinical concentrations of inhalation agents. Although general anesthesia depresses the central nervous system in a dose-dependent fashion, the central nervous system monitors the environment for significant information, even during clinically adequate anesthesia. Postoperative amnesia usually prevents verbal recall of intraoperative events and makes evaluation of intraoperative awareness more complex. Bennett and colleagues assert that verbal recall is not sufficient to assess memory.

Explicit and implicit memory

The terms memory, awareness, and recall have been used interchangeably in the past, which has caused confusion. The term “memory” refers to learning, acquiring new information, and storage and retrieval of information. “Awareness” refers to wakefulness, whereas “recall” has been used in a broad sense to indicate memory. Recent distinctions that have been brought about through work with organic and functionally amnesic patients have further qualified memory as explicit and implicit. The terms “explicit” and “implicit” memory may be more helpful to our understanding in anesthesiology (Table I).

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<th>Table I</th>
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<tr>
<td>Memory</td>
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<tr>
<td>Explicit—verbal recall, recognition</td>
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<tr>
<td>Consciously remembered, requires effort</td>
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<td>Usually eliminated by general anesthesia</td>
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<tr>
<td>Affected by benzodiazepines</td>
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<td>Overt testing used to detect</td>
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<td>Less incidence of explicit memory</td>
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<tr>
<td>Implicit—nonverbal memory</td>
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<td>Seen by nonconscious changes in task performance, motor behaviors, and therapeutic suggestion</td>
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<td>Covert testing used—more sensitive to this learning</td>
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<tr>
<td>Usually spared by general anesthesia</td>
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<tr>
<td>Incidence greater</td>
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<tr>
<td>Benzodiazepines’ effects not known</td>
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<tr>
<td>Therapeutic suggestion may utilize implicit memory</td>
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<td>Middle latency auditory-evoked potentials preserved</td>
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Explicit memory is also known as declarative memory. It is memory that may be consciously remembered, as in recall or recognition of stimuli. Overt tests for explicit memory are commonly used in which subjects know they are being tested. For example, patients may be queried regarding recall during their postoperative interview by a direct question from an interviewer. General anesthesia usually abolishes explicit memory while it leaves implicit memory intact.

Implicit memory is also referred to as nondeclarative or nonverbal memory. It requires no effort and is reflected in unconscious changes in task performance. Nonverbal memory may exist despite complete conscious amnesia after anesthesia. That is, whereas subjects may demonstrate the usual verbal postanesthetic amnesia (lack of explicit recall
of an intraoperative command or event), their nonverbal behavior may indicate that learning did occur, i.e., their implicit memory is intact.\(^5\) Therefore, it is said that general anesthesia tends to dissociate explicit and implicit memory.\(^6\)

Implicit memory can occur regardless of anesthetic method or dosage.\(^4\) Diazepam in small doses (0.2-0.3 mg/kg) can spare implicit memory, while larger doses can impair it.\(^1\) Although there have been reports of anesthetized patients who can repeat an intraoperative conversation (demonstrating explicit memory), the incidence of implicit memory is likely to be greater than the incidence of explicit memory.\(^6\)

Implicit memory tests are usually covert, that is, subjects do not know they are being tested. Covert tests may be more sensitive to the low levels of learning seen with anesthesia.\(^4\) Examples of indirect memory testing include completion of word lists, free association, word completion tasks, and priming tasks. Priming tasks seek to show a postoperative preference or facilitation of a skill after stimuli are presented during anesthesia. Priming skills to demonstrate implicit learning include preference for unfamiliar music or recognition of nonsense words that were presented during anesthesia.\(^4\) Postoperative response to cues established during surgery for simple motor behaviors, such as ear tugging and therapeutic suggestions, further exploits implicit learning which may take place under anesthesia.\(^5\)\(^,\)\(^6\)

**Learning occurs under general anesthesia**

In a study designed to determine if learning occurs during general anesthesia, 72 women who were undergoing surgery were given implicit memory tests in which performance could be influenced by auditory information presented during general anesthesia. They were given either nitrous oxide and opioids or nitrous oxide and isoflurane. Three tests of implicit memory were given as noted below:

1. In behavioral suggestion tests, the anesthetized subjects were instructed to touch their nose or ear during the postoperative interview. During postoperative questioning later that same day, the suggested body part (ear or nose) was touched longer or more frequently than body parts that were not suggested.

2. Word completion tests involved showing a patient a page containing the first three letters of words, then asking him or her to make words beginning with those letters (e.g., pen and pension). Patients gave more words from a list that had been played during anesthesia than from a list that was not played. For example, the target word *pension* was chosen more often than the nontarget words *pencil* or *peninsula*.

3. During nonsense word tests, patients who were exposed to different auditory nonsense words (e.g., "picul") during anesthesia preferred the words played most often and guessed them more accurately.

After surgery, no patients reported recall. Explicit recognition tasks showed no evidence of learning, while the implicit tests showed evidence of learning, although it was statistically small. Overall, the investigators concluded that there is potential for learning under anesthesia and that learning does not vary with the anesthetic technique. The widespread belief that "light" versus "deep" anesthesia increases the likelihood of retention was not confirmed. Language comprehension and learning may continue to function during adequate clinical anesthesia.\(^7\)

In another study, patients were presented with musical selections from many cultures while they were anesthetized with opioids, nitrous oxide, and isoflurane. This study indicated that unfamiliar music was preferred after exposure in the nonanesthetized control group and in patients who suffered from amnesia, while anesthetized patients showed no such effect.\(^8\)

Thus, some studies provide evidence of implicit memory during anesthesia while others do not.\(^5\)\(^,\)\(^7\) Evaluation of results is made more complex because there is a lack of a standard protocol of inquiry, anesthetic method, timing of stimuli presentation, timing of testing, and other factors.

In researching learning under anesthesia, visual and auditory stimuli, perceptual stimuli (such as music), and conceptual stimuli (category naming) have all been used to discern the possibility of effects on different memory systems and cognitive processing. In general, the fragile nature of information processing while under anesthesia requires more sophisticated measures than either prompted or spontaneous recall can provide. Indirect methods, such as implicit memory tests, nonverbal responses, hypnosis, and improvement in postoperative outcome, have been employed.\(^7\) Explicit memory tests that are given postoperatively usually demonstrate no recall or recognition.\(^4\)

**Detection of conscious awareness—Common methods are unreliable**

Detection of conscious awareness is elusive, and no anesthetic technique or depth of anesthesia guarantees amnesia. Interviewing the patient after surgery is most commonly done to detect intraoperative wakefulness and is a good practice for med-
Clinical signs of light anesthesia including pupil dilation, blood pressure and pulse changes, and lacrimation are unreliable for predicting those at risk for awareness. A patient can experience awareness without exhibiting clinical signs of light anesthesia. The converse is also true; a patient who showed intraoperative responses may not experience wakefulness.

Other objective techniques have been proposed, but they are either inconclusive or impractical. These include the isolated forearm technique, electroencephalography (EEG), sensory-evoked potentials, auditory-evoked potentials, and middle latency auditory-evoked potentials (MLAEPS).

Electroencephalography and sensory-evoked potentials as indicators of depth of anesthesia are complicated and expensive technologies that are not available for common use. Furthermore, an EEG pattern that is common to all anesthetic agents that correlates with depth of anesthesia has not been identified. Although some EEG patterns always indicate unconsciousness, there are no patterns that prove the presence of consciousness, a shortcoming that is common to the MLAEPs discussed below.

MLAEPS are another indicator of consciousness that is under investigation. MLAEPs reflect the level of auditory processing during general anesthesia. MLAEPs (including Na, Pa, Nb, and P1 waves) are generated mainly in the primary auditory cortex of the temporal lobe. They are the electrophysiologic correlate of primary processing of auditory stimuli by the cortex.

In a study by Schwender and colleagues, “implicit recall was related to continued presence of MLAEP.” In contrast, patients without implicit memory showed MLAEPs which were suppressed, with prolonged latencies and decreased amplitudes. They conclude, MLAEP monitoring during anesthesia might be useful for investigating doses and concentrations of general anesthetics that reliably block conscious and unconscious perception and explicit and implicit memory during general anesthesia.

Madler and colleagues studied the oscillatory activity at 30-40 Hz of the MLAEP to discern if hearing may be used as an indicator of wakefulness. They examined the effects of isoflurane on the latency of this response and found that these concentrations of isoflurane were equal to or less than 0.6%. They conclude, “Therefore, to guarantee suppression of conscious awareness and sufficient ‘depth of anesthesia,’ isoflurane should be used only in concentrations exceeding 0.6%.”

Madler and colleagues propose that sensory information can enter the brainstem, where it is processed and integrated in discrete time segments by one or more generators in the midbrain and cortical structures. These generators produce a 40-Hz oscillatory response in EEG and sensory-evoked potentials. If neuronal oscillations are suppressed, higher cognitive functions such as perception and memory should be blocked. This neuropsychological model has yet to be tested, and the behavior of other anesthetic agents on neuronal oscillations is not known. Suppression of neuronal oscillations may result in the perception of time loss that patients report.

Other methods being studied to evaluate anesthetic depth include auditory-evoked potentials, surface electromyography to measure frontalis muscle activity, lower esophageal contractility and skin conductance responses. Each method has inherent limitations, and findings to date are inconclusive.

Clearly, it is not always possible in current clinical practice to determine with certainty if an anesthetized patient is experiencing conscious awareness during surgery.

Factors related to awareness

It is commonly believed that narcotic-based anesthesia has a higher incidence of incomplete amnesia than inhalation techniques; however, the evidence is inconclusive. It is important to realize that awareness can occur with any method of anesthesia.

Benzodiazepines such as diazepam (Valium®) and midazolam (Versed®) have proven to be extremely useful anxiolytics; however, variability in patient response precludes their use as unfailing amnestic agents. Although they impair formation of new long-term memories, the benzodiazepines may spare implicit memory. Their effects on implicit memory have not been well documented. Further investigation is warranted to determine if benzodiazepines make it more difficult for the patient who has experienced awareness to verbalize his or her trauma and thus hinder recovery.

Historically, the highest incidence of awareness has been in cesarean sections, where relatively light anesthesia is utilized so as not to depress the neonate. Awareness is also more likely in alcoholics; chronic users of sedative, tranquilizers, and narcotics; in obese patients; in patients with high metabolic rates; and in those undergoing cardiac bypass surgery (Table II).
Hypothermia, hypotension, and acute ethanol intoxication are factors that are known to decrease minimum alveolar concentration. These conditions are often seen in trauma patients who are undergoing surgery. However, they do not reliably affect awareness. Bogetz and Katz postoperatively interviewed 51 patients who had undergone surgery for severe trauma. Of those who received nearly continuous anesthesia, 11% reported awareness. Nearly 43% of those who had anesthesia interrupted for 20 minutes or so due to hemodynamic instability reported awareness.

Other related factors that contribute to awareness include the use of ultra-short-acting induction agents which may redistribute before a sufficient alveolar concentration of the inhalation agent has accumulated and apparatus-related incidents that result in inappropriate circuit concentrations.

The alveolar and plasma concentrations of anesthetics that reliably prevent recall and awareness have not been determined. It is evident that individual agents have specific and varying effects on memory formation with wide variation across individuals.

**Intervention**

Since auditory processing may remain active during the course of anesthesia, it is imperative that surgical and recovery room personnel engage in respectful conversations. Intraoperatively, if the possibility of awareness is detected, the anesthetist should talk to the patient reassuringly while deepening the anesthesia. Anecdotal evidence suggests that unfavorable comments are particularly likely to be recalled, whether they are derogatory or pessimistic. Some, but not all, investigators claim that stimuli of personal significance to the patient are more likely to be retained than neutral information.

Strategies to block auditory stimuli include ensuring discreet operating and recovery room conversations, applying earphones to play positive suggestions, the use of white noise or relaxing music, or simply using some form of earplugs.

Patients who are at increased risk, such as obstetric patients undergoing cesarean section, should be informed in advance of the possibility of intraoperative awareness. Postoperatively, every patient should be interviewed during the first 24 hours to discern recall and/or recognition of intraoperative events. The interview should include questions: What is the last thing you remember before going to sleep for your surgery? What is the first thing you remember when you awoke? Do you remember anything in between? Did you have any dreams? It must be recognized that direct questioning of the patient may not be sufficient to uncover awareness, because learning may occur despite verbal amnesia.

Intraoperative awareness can result in a wide range of reactions, depending upon the patient's personality and circumstances. Awareness, particularly if it is accompanied by pain, may result in severe psychiatric sequelae, which seem to conform to the diagnostic criteria for post-traumatic stress disorder. Although these severe cases are unusual, the expectation that they will spontaneously resolve or be manageable through explanation and simple reassurance is questionable. Post-traumatic stress disorder may be acute and/or chronic, and its guarded prognosis can be improved through early psychological intervention (Table III).

### Table II

**Factors relating to awareness**

- Cesarean section, cardiac bypass surgery
- Ultra-short-acting induction agents
- Apparatus failure
- Alcoholics, chronic users of sedatives, tranquilizers, or narcotics
- Obese patients
- Patients with high metabolic rates
- Patients with hemodynamic instability that necessitates interruption of anesthesia

### Table III

**Post-traumatic stress disorder**

Symptoms compatible with post-traumatic stress disorder may occur in severe cases after intraoperative awareness, especially if pain was experienced. This includes:

- Recurrent distressing memories or nightmares
- Flashbacks or feelings of reexperiencing the event
- Distress at reexposure to similar stimuli
- Avoidance behaviors: emotional numbing, forgetting, detachment, loss of interest
- Increased arousal: sleep disturbances, exaggerated startle reflex, irritability, outbursts of anger, difficulty with concentration
- Acute and/or chronic—may have delayed onset

The patient with post-traumatic stress syndrome may exhibit avoidance symptoms, emotional numbing, anxiety, rage or depression, and preoccupation with death. Sleep disturbances, recurrent nightmares, a feeling of reexperiencing the event, flashbacks, difficulty concentrating, and an exaggerated startle response are signs of increased arousal of the autonomic nervous system. Stimuli...
that are associated with a strong effect, particularly unpleasant events or meaningful conversations, are most likely to register with the patient. Patients rarely spontaneously complain of the distressing event to the medical staff and are more likely to inform a relative. The public may not believe that consciousness is possible during an anesthetic. Therefore, a patient who has experienced this profound stressor may fear insanity and encounter the disbelief of others, even within the medical community.

Post-traumatic stress disorder may be delayed weeks or years in its presentation, and it may manifest when a similar cue or stress occurs, such as the need for a repeat anesthetic. The secondary trauma of disbelief intensifies the experience, but it can be prevented by education.

Survivors of trauma are usually reticent to talk about their traumatic events. Their inability to communicate distress during or after surgery may be compounded by medical staff denial, disbelief, avoidance of the patient, embarrassment, and fear of litigation. Recognition and early psychiatric referral are appropriate to diminish such sequelae. Personal contact with the patient should be maintained. Prevention of awareness by provision of an adequate depth of anesthesia is important, especially when muscle relaxants are used. Minimizing auditory stimuli can be helpful. Preoperative benzodiazepines may diminish awareness, and when given postoperatively, they may suppress traumatic memory. However, insufficient pharmacological understanding of benzodiazepines makes them unreliable for ensuring a lack of intraoperative awareness.

Behavioral anesthesia

The area of behavioral anesthesia deals with ways in which patient recovery can be enhanced and the public can be provided with what it has come to expect, a comfortable, low stress anesthetic (Table IV). Much of the following information is taken from the work of Bennett and colleagues. Bennett proposes that surgeons and anesthetists consistently act in ways that increase the stress of surgery and postoperative complications.

Studies have shown that physical recovery is exquisitely sensitive to psychological factors. Words alone can direct specific autonomic physiologic events in the body, although the mechanism is unclear. Hypnosis, biofeedback, placebo effects, and the words of an encouraging caregiver also demonstrate the psyche’s ability to influence the physical body.

Depression and rage are common responses to incomplete intraoperative amnesia. Perioperative myocardial infarction induced by stress has been claimed as well. Some researchers claim that unfavorable comments voiced during anesthesia are more likely to influence the patient’s postoperative course than improvement through therapeutic suggestion. Surgeons, anesthetists, and perioperative personnel are often unaware of the negative physiological impact their casual conversation has on patients and the potential benefit of positive statements and teaching.

The stress response of the surgical patient can be decreased by teaching the patient coping skills for surgery based on his or her existing abilities and by giving verbal suggestions to elicit specific physiologic responses. The result may be a more rapid and complete recovery.

Why have such relevant findings been ignored by the medical community? The philosophy taught in anesthesiology and surgery is that if dualism, that is, that the body and the mind or soul are separate and independent entities. The foremost concern in the operating room is with the patient’s biological and physiological systems.

The contrasting philosophy is monism, which is the position that thoughts, feelings, and all of mental life has a physical basis. The monistic viewpoint holds that the psychological representation of a thought can produce observable physical effects. Thus, words alone can influence recovery.

Surgical patients experience intense fear, arising from the loss of control, the anticipation of pain, past anesthetic and surgical experiences, and the possibility of injury or death. The psychological state of fear and anxiety induces a physiological response and is a source of stress to the body. Symptomatic treatment of the stress response is often necessary, typically through pharmacologic interventions, including antihypertensives, anti-anxiety agents, and pain and nausea medications.

Patient stress can be lessened by scheduling

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<td><strong>Behavioral anesthesiology</strong></td>
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<tr>
<td>Decreases patient stress and enhances recovery:</td>
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<tr>
<td>- Consider patient’s coping style when premedicating.</td>
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<tr>
<td>- Schedule preoperative admitting procedures before the day of surgery.</td>
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<tr>
<td>- Emphasize positive statements.</td>
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<td>- Monitor noise and conversations.</td>
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<td>- Consider blocking threatening auditory stimuli with earplugs, earphones, etc.</td>
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<tr>
<td>- Consider therapeutic suggestion.</td>
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<td>Treat every patient as though he or she was listening.</td>
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Journal of the American Association of Nurse Anesthetists
admission procedures prior to the day of surgery, although current economic constraints related to third-party payment pressures may be a detriment. At some institutions, patients face painful blood work; are required to give informed consent; listen to explanations about possible complications of anesthesia and surgery, including injury and death; give or deny permission to receive blood transfusions with its attendant peril of AIDS and hepatitis; and discuss living wills and advance directives, all within a short time before being wheeled into surgery.

These grim elicitors of fear are delivered while the patient lies vulnerable, cold, and nearly naked on the stretcher in a state of heightened suggestibility. Positive counteracting suggestions are sorely lacking. As a result, the typical preoperative course primes the patient for a negative experience, with fear controlling his or her physiological responses. The effects of fear and the stress response have been implicated in affective and vegetative disorders that occur unexpectedly after surgery, as well as perioperative myocardial infarction.

It is not surprising that anesthetists are frequently called upon to give medication to alleviate anxiety preoperatively. Patients differ in their style of coping. One patient may cope through vigilance and prefer to have little or no premedication to remain clearheaded and in control, whereas a patient who is an avoider or denier may desire more medication. The choice of medication includes a consideration of the pain state of the patient as well.

Eliciting patient cooperation through teaching may be helpful to decrease the need for sedatives and narcotics. Bennett writes, for example, to decrease straining on the endotracheal tube, suggest to the patient: "When you wake up, there may be a tube in your throat. If there is, it is there because we need to know you can breathe on your own. Therefore, because it needs to be there, it will not bother you. By relaxing all of the muscles in your throat, the tube will not bother you, so you will relax the muscles in your throat and neck if you notice that the breathing tube is still there when you awaken. Then, when you are taking good deep breaths through the tube, we will know you can breathe on your own and we'll take it out right away." Undergoing anesthesia is a stressful experience. It is the role of anesthetists, perioperative personnel, and surgeons to help the patient cope. The challenge is to treat the patient as a whole and not as a separate mind and body and to use psychological assessment and intervention to help the patient have a successful, comfortable operation.

Shhh! The patient may be listening

Managing the environment of surgery, decreasing noise, and monitoring conversation are aspects of behavioral anesthesiology. When loud noises occur, anesthetists can counter with reassurances, positive suggestions, and calming statements to the patient. Conscious effort on the part of anesthetists will be needed to consider their own behavior, their patients' needs, and to speak in positive terms to their awake and "sleeping" patients, despite skeptical glances from the operating and recovery room teams. Anesthetists must consider how their conversations influence their patients. Operating and recovery room personnel may have to be reminded that disparaging remarks can be retained by the patient.

A recent legal decision in Sacramento ruled in favor of a patient who recalled offensive remarks about her made by her surgeons in the operating room. Financial awards were made to her for emotional and physiological damages which slowed her recovery. The surgeons who made the remarks were exonerated, and blame was laid on the anesthesiologist instead for failing to provide adequate anesthesia. However, the crucial point was missed: that the surgeons' words produced sufficient stress to delay the patient's recovery.

Patients today are generally better informed in this litigious society, and they want comfortable anesthesia. Legal experts agree that proper communication is the best way to stay out of court. A patient who sues because of consciousness during general anesthesia is most likely to sue for medical malpractice, in which case the jury must be convinced that awareness occurred, caused harm to the patient, and was a result of negligence.

The patient can also sue for breach of contract if he or she was promised unconsciousness during the anesthetic, whether or not the breach resulted from malpractice. Lack of informed consent can be a third cause for a lawsuit if the patient was not told about and did not consent to the possibility of consciousness during surgery, the sensations of pain or suffocation, or listening to alarming sounds and conversation (Table V).

Psychological interventions may aid in recovery from surgery

Although anesthetists attempt to minimize explicit memory, it may be possible to exploit implicit memory to achieve a better postoperative outcome. Evans and Richardson showed an im-
Table V
Patient with intraoperative awareness may sue for:
1. Malpractice/negligence
2. Breach of contract
3. Lack of informed consent

proved recovery and a reduced postoperative hospital stay after positive suggestions were made during general anesthesia.14

Their results were not reproduced, however, in Liu and colleagues' study, despite the use of identical therapeutic suggestions.6 Using a small group of patients undergoing total abdominal hysterectomy, Liu and colleagues concluded there was no evidence of any improvement in postoperative outcome related to either positive suggestions or the presence of a voice during anesthesia.7 Block and associates also were unable to replicate positive findings regarding the use of therapeutic suggestion.15

In a study by McLintock and associates, requirements for morphine in the early postoperative period were significantly reduced by positive intraoperative suggestions.6 Audio tapes were continuously played to patients undergoing surgery. "The suggestions consisted of statements such as: 'Everything is going very well, we're very pleased with your progress'; 'You feel warm and comfortable, calm, and relaxed'; 'Any pain that you feel after the operation will not concern you'."6 Blank tapes were played to a control group of patients. Observers were not aware of which group a patient was in, and all patients were given patient-controlled analgesia by morphine pumps. The experimental group used 23% less morphine in the first 24 hours postoperatively. The incidence of nausea and vomiting was no different, although the investigators suspected that a therapeutic effect might have been demonstrated if statements referring to nausea and vomiting had been included.

The evidence regarding the value of therapeutic suggestion is conflicting. The ideal form of positive suggestion has yet to be found, and relatively few patients have been offered exposure to positive suggestions during general anesthesia.16 Clinical hypnotists emphasize the importance of using positive rather than negative phrasing to maximize patient benefit.15 Beneficial effects from therapeutic suggestions can result, as well as protection from overhearing adverse comments.16

Conclusion
In the current practice of anesthesiology, evi-

dence that learning can take place under adequate planes of anesthesia is largely ignored, untreated, and unrecognized. Incomplete amnesia can occur in individuals who appear to be adequately anesthetized. Properly designed double-blind studies have confirmed for the most part that some form of unconscious perception can occur in patients undergoing general anesthesia.16 While implicit (nonconscious) memory may remain intact, explicit recall (consciously remembered) is usually abolished by general anesthesia and is less common in incidence.4

It is difficult to detect conscious awareness with common methods. Clinical signs are unreliable, and there is no clinically practical "depth indicator" available at present. MLAEP monitoring may prove to be a useful indicator of blocked perception and memory under general anesthesia.15 Benzodiazepines are not foolproof in creating a lack of awareness. In severe cases, patients who experience intraoperative awareness can develop post-traumatic stress disorder. Prompt recognition and psychiatric referral may improve outcome.4 A patient can sue on the grounds of malpractice, breach of contract, and lack of informed consent.4

Earplugs, and tapes of music or "white noise" all may spare the patient from hearing adverse and threatening operating room events and conversations. Studies concerning positive therapeutic suggestion are intriguing but inconclusive.16 More study is needed to determine the nature of learning under anesthesia and thresholds for memory.

A behavioral approach to anesthesia is beneficial to patients and involves preparing the patient psychologically for surgery, in the belief that thoughts can influence physiological responses to the stress. Interventions include determining a patient's individual coping style when choosing a premedication, making suggestions preoperatively to influence physiological responses, managing the operating room environment for excessive noise and inappropriate remarks, and countering with reassurance when these occur.13 It may be an unsolicited role for anesthetists to monitor irreverent operating and recovery room conversation, but we must educate others about patient hearing and memory during anesthesia. Every patient deserves to be treated as though he or she was listening.

Finally, it must be realized that no method of anesthesia is guaranteed to prevent awareness. No method of detection that is commonly used today can pinpoint which patients will be consciously aware during general anesthesia.4 Therefore, we must be sensitive to the issues of implicit and explicit memory as well as unconscious and conscious.
awareness in every patient who receives a general anesthetic.

REFERENCES

AUTHOR
Karen Kiviniemi, CRNA, BSN, ARNP, received her anesthesia education at the Mayo School of Health Related Sciences. Her BSN was obtained at the University of Kentucky where she is currently pursuing a master's degree in Instructional Design. She is a staff anesthetist at Central Baptist Hospital, Lexington, Kentucky.