

CLINICAL CONCEPTS AND COMMENTARY

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Awareness during Anesthesia

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MEMORY is not a single entity. Current classification distinguishes between two types: explicit, or conscious memory, and implicit, or unconscious memory. *Explicit memory* refers to the conscious recollection of previous experiences. *Implicit memory*, by contrast, refers to changes in performance or behavior that are produced by previous experiences but without any conscious recollection of those experiences.¹

Explicit memory is equivalent to "remembering" (e.g., can you remember what you did last Tuesday evening?). In the case of an anesthetized patient, one might ask the patient in the postoperative period "can you remember hearing any words or sounds during your operation?" (i.e., a recall test) or "which of the following words were played to you during surgery?" (a recognition test). As an example of implicit memory, consider the following scenario. Patients were exposed during anesthesia to a list of words containing the word "pension." Postoperatively, when they were presented with the three-letter word stem "PEN__" and were asked to supply the first word that came to their minds beginning with those letters, they gave the word "pension" more often than "pencil" or "peninsula" or others. The term "awareness" will be used to describe explicit memory during anesthesia.

Incidence

The incidence of awareness during anesthesia and surgery is best estimated by formally interviewing patients postoperatively. Patients, particularly those who were not unduly disturbed by their experiences, may not voluntarily report them without being asked directly.² Some patients also may not recall events shortly after surgery but may recall them 1-2 weeks after surgery.³ It is also possible that some patients may need a detailed and extensive interview to "jog" their memories for the intraoperative experience.⁴

When a structured interview was used in a large series of patients, the incidence of awareness in nonobstetric and noncardiac surgical cases was 0.2%.² The incidence is greater, however, when light anesthesia is used: the incidence in cardiac surgery ranges from 1.1-1.5%. A higher incidence also has been reported for obstetric cases (0.4%) and major trauma cases (11-43%), and this incidence varies according to the dose of anesthetic administered.⁵ The incidence of intraoperative recall is 2% when 70% nitrous oxide (N₂O) alone is used for anesthetic maintenance.⁶ This incidence is not reduced by intermittent boluses of opioids.⁴ Nevertheless, Jones⁷ estimates that only 0.01% of patients report pain while being aware. It is probable that opioids, together with N₂O, provide sufficient analgesia to decrease complaints from pain. Some or all of the quoted estimates about the incidence of awareness may need to be updated.

Patients also may recall dreams, some of which are disturbing. Dreams may be recalled more often than actual events. For example, in Utting's⁶ series of 500 patients anesthetized with N₂O, the incidence of dreams that the patients considered to be the worst features of their perioperative experiences was 7% *versus* 2% for recall of intraoperative events. Utting⁶ proposed a continuum, with adequate anesthesia resulting in complete amnesia, lighter anesthesia resulting in dream recall, and still lighter anesthesia resulting in explicit recall.

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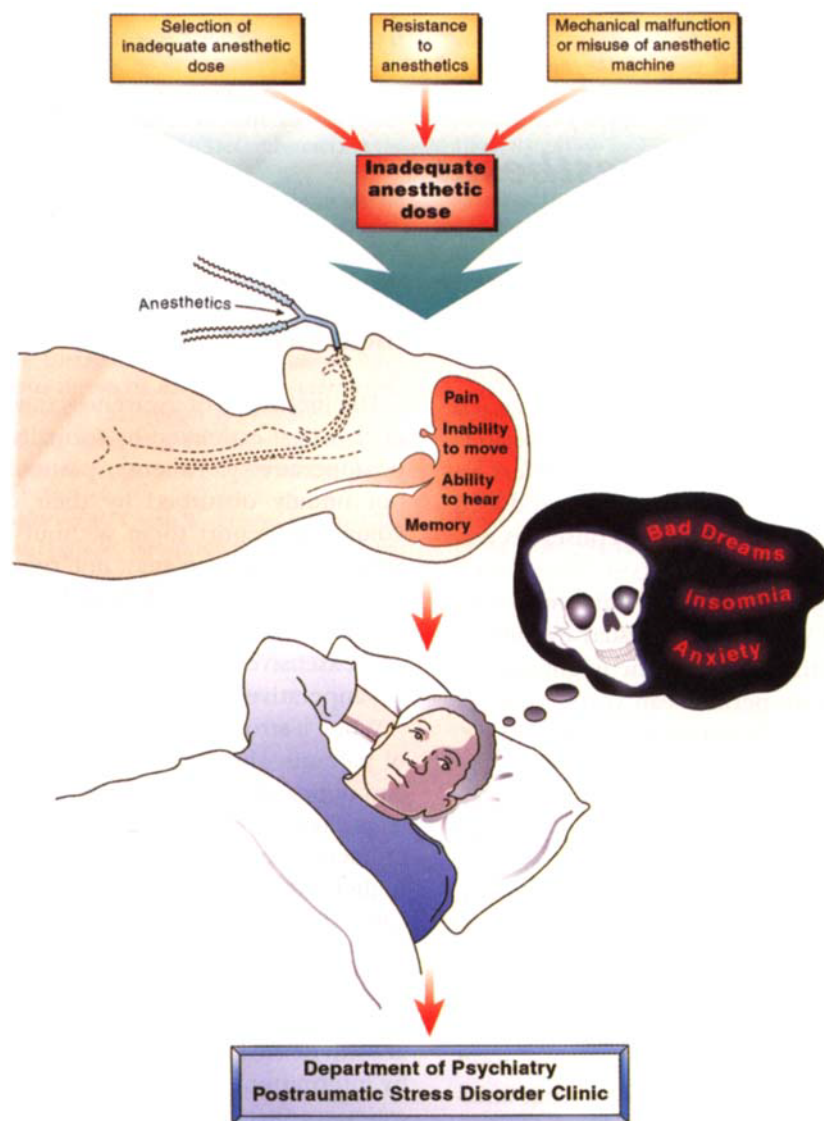


Fig. 1. The causes and consequences of awareness during anesthesia.

Causes

Awareness usually is associated with one of three situations (fig. 1):

1. **Light anesthesia.** For certain operations, such as Cesarean section, or in hypovolemic patients or patients with minimal cardiac reserve, the anesthesiologist may aim to provide light anesthesia. During such circumstances, consciousness and recall is not surprising because judgments of depth of anesthesia are not precise. Muscle relaxants also lead to the problem

of the unintentionally “too light” anesthesia in the motionless patient. This is probably the most common cause of awareness, and represents, in a sense, an iatrogenic mishap.⁵ Because anesthetic concentrations that block awareness are less than those that prevent motor responses to pain,^{8,9} an inadequately anesthetized, but nonparalyzed, patient usually communicates awokeness by movement. Deepening the anesthetic at this stage usually prevents awareness.

2. **Increased anesthetic requirement of some patients.** Some patients may be more “resistant” to the effects

of anesthetics than others. Younger age, tobacco smoking, long-term use of certain drugs (alcohol, opiates, or amphetamines) may increase the anesthetic dose needed to produce unconsciousness.¹⁰

3. *Machine malfunction or misuse resulting in an inadequate delivery of anesthetic.* This may be caused by an empty vaporizer (or N₂O cylinder) or a malfunctioning intravenous pump or disconnection of its delivery tubing.

Consequences

The pain was like that of a tooth drilled without local anesthetic—when the drill hits a nerve. Multiply this pain so that the area involved would equal a thumb-print, then pour a steady stream of molten lead into it.

This quotation is from a physician describing her almost unbearable pain when she was aware during a cesarean section.¹¹ There is no doubt that pain during surgery is the most distressing feature of awareness. Other frequent complaints are the ability to hear events during surgery, sensations of weakness or paralysis, and feelings of helplessness, anxiety, panic, and impending death. The patients also may be tormented, if they were in an obtunded state, by doubts about whether what they experienced really happened or whether there is something wrong with their minds¹² (fig. 1).

For some patients, awareness may cause temporary after effects, including sleep disturbances, nightmares, and daytime anxiety, which subside eventually. Nevertheless, there may remain a fear that awareness may happen again if they require anesthesia in the future. In some patients, post-traumatic stress disorder develops, marked by repetitive nightmares, anxiety, and irritability; a preoccupation with death; and a concern with sanity that make the patients reluctant to discuss their symptoms.¹² It is not apparent why post-traumatic stress disorder develops in some patients and not in others. Patient personality, predisposition to mental disease, emotional response to illness, and reason for surgery may be factors.

There are also medicolegal consequences to awareness. Domino *et al.*¹³ recently analyzed claims from the American Society of Anesthesiologists Closed Claims Project. Claims for awareness during anesthesia accounted for 2% of all claims. This incidence was similar to rates of claims for such familiar complications after anesthesia as aspiration pneumonia and myocardial infarction. Claims were more likely in females and with the nitrous oxide-opioid-relaxant technique. The amount of

compensation was small, a median of \$18,000. Payments for awareness claims also show interesting variability from one country to another. Although sizable payments have been reported in the United Kingdom, low payments have been reported in Finland. Social, cultural, or other factors may be important.

Management

If a patient complains of awareness, a detailed account of the experience should be obtained (table 1). Although there have been cases of fraudulent claims and mistaken recall of events during emergence from anesthesia,¹⁴ most claims are genuine and credibility can be established easily.

The patient should be assured that the anesthesiologist believes their account and sympathizes with their suffering. Denial of the authenticity of the patient's experience may adversely influence the patient's psychologic recovery and may turn the patient toward litigation. Some explanation of what happened and its reasons should be given; *e.g.*, necessity to administer light anesthesia in the presence of significant cardiovascular instability. The patient should be reassured about nonrepetition of the same mishap with future anesthetics because the details will be in the patient's records and will guide the anesthesiologist managing subsequent anesthetics. An apology should be given, and it is possible to apologize without admitting liability. The patient should be offered psychologic or psychiatric support. The details of the interview should be recorded in the patient's chart, and the surgeon, the patient's nurse, and the hospital lawyer or the physician's insurer should be notified. Subsequently, the patient should be visited daily during the hospital stay to look for and treat psychologic sequelae; *e.g.*, sleep disturbances, daytime anxiety, among others. After the patient is discharged, frequent contacts by telephone should be made until the patient is judged to be fully recovered. Referral to a psychiatrist or psychologist should not be delayed; there is anecdotal evidence that early counseling may reduce the incidence of post-traumatic stress disorder.¹⁵

Prevention

Prevention of recall of events during anesthesia should be feasible in most cases. The following methods should be effective (table 1):

1. *Consider premedication with amnesic drugs, e.g.,*

Table 1. Prevention and Management of Awareness

Prevention: Ten Suggestions	Management: Five Memoranda
<ul style="list-style-type: none"> • Check the delivery of anesthetic agents to the patient • Consider premedicating with amnesics • Give adequate doses of induction agents • Avoid muscle paralysis unless it is needed and even then avoid total paralysis • Supplement N₂O and opioid anesthesia with at least 0.6 MAC of volatile agent • Administer at least 0.8-1 MAC when volatile agents are used alone • Use amnesics when light anesthesia is the only regimen which can be tolerated by the patient • Inform the patient about the possibility of awareness and prevent hearing of operating room sounds • Teaching and research • Development of an awareness monitor 	<ul style="list-style-type: none"> • Detailed interview with the patient <ul style="list-style-type: none"> – Verify the patient's account – Sympathize with the patient – Try to explain what happened – Reassure the patient about non-repetition in the future – Apologize – Offer psychological support • Interview should be recorded in the patient's chart • Inform the patient's surgeon, nurse and hospital lawyer • Visit the patient daily during hospital stay and keep in contact by telephone afterwards • Don't delay referral to a psychologist or psychiatrist

benzodiazepines or scopolamine, particularly when light anesthesia is anticipated. These drugs impair acquisition or encoding of new information while leaving the retrieval of previously learned material intact. The degree and duration of memory impairment progressively increase as the dose of each drug is increased.

2. *Administer more than a "sleep dose" of induction agents if they will be followed immediately by tracheal intubation.* The rapid redistribution of induction agents and the strong stimuli of laryngoscopy and intubation tend to awaken the patients if an inadequate dose has been administered. Supplemental doses of induction agents should also be

given when a difficult intubation necessitates a protracted period of repeated intubation attempts.

3. *Avoid muscle paralysis unless absolutely necessary, and even then, avoid total paralysis.* Autonomic responses to noxious stimuli during light anesthesia; *i.e.*, tachycardia, hypertension, sweating, lacrimation, and pupillary dilatation and reaction are unreliable indicators of anesthetic depth.¹⁰ Moerman *et al.*¹⁴ reported that inspection of anesthetic records of awareness cases for relevant parameters, such as heart rate and blood pressure, could not be distinguished reliably from controls by experienced anesthesiologists. Therefore, observation of voluntary movements or movement responses to noxious

stimuli is the best clinical measure available for detecting wakefulness or impending wakefulness during surgery.

4. *Supplement N₂O and opioids with volatile agents with end-tidal concentrations of 0.6 minimum alveolar concentration (MAC) or more.*¹⁶ In healthy volunteers, opioids do not affect learning and recall, and, even in large doses, do not reliably produce unconsciousness.¹⁰ N₂O has weaker memory and cognitive effects than do equipotent concentrations of isoflurane.⁸
5. *When inhalational agents are used alone, at least 0.8-1 MAC should be administered.*⁹ These figures, and those in the previous paragraph, should be considered as tentative. Data obtained from volunteers and patients before surgery may underestimate the concentrations of anesthetic necessitated during surgery. A prudent anesthesiologist may elect to use higher doses whenever feasible.
6. *In cases in which light anesthesia is deemed necessary, the use of even small doses of amnesic drugs, e.g., scopolamine, midazolam, subanesthetic doses of ketamine, or inhalation agents, should be considered.*¹⁰ Supplemental regional anesthesia through deafferentation may reduce the dose of general anesthetic necessary to produce unconsciousness.¹⁷ Can episodes of intraoperative consciousness without subsequent recall because of administration of small doses of amnesic drugs cause harm? There is no direct evidence for this possibility, but there are a few anecdotal reports^{5,10,12} of unfavorable comments, which were voiced during anesthesia and retrieved during hypnosis, that caused psychologic disorders.
7. *Periodic maintenance of the anesthesia machine and its vaporizers and meticulous checking of the machine and its ventilator before administration of anesthesia.* Regular checking of flow meters and the vaporizer and the level of the anesthetic in the vaporizer; monitoring of the concentrations of inspired and expired gases and inhalation agents; and general vigilance should eliminate cases caused by inadequate anesthetic delivery. Infusion pumps must have volume and pressure alarms, and the anesthetic infusion should preferably be administered *via* a dedicated intravenous line.
8. *Discussion of the potential for awareness-auditory masking.* It has been suggested that, in some cases, the anesthesiologist should talk to the patient about the potential for awareness or use measures such as

earplugs and audiocassette earphones playing music or positive therapeutic suggestions. Informing the patient about the possibility of awareness should be restricted to cases in which such a risk is relatively high; e.g., a high-risk obstetric procedure. Measures to prevent the patient from hearing operating room sounds fall short of alleviating most patient complaints; e.g., pain, sensation of paralysis, and others. Nevertheless, because patients are most likely to recall emotionally threatening remarks,¹⁴ it is prudent for the operating room team to avoid voicing negative or derogatory remarks about the patient or the prognosis.

9. *Understanding.* Cobcroft and Forsdick,¹⁸ after reviewing a series of cases of awareness, concluded that, in most cases, understanding of the phenomenon and its management by medical personnel were poor or entirely lacking. In the Moerman *et al.*¹⁴ series, half of the patients had not informed their anesthesiologists about their awareness because they had not seen him or her since the operation.
10. *Monitor for awareness.* There is interest in the development and use of a monitor of anesthetic depth. This subject will be discussed in a subsequent article.

Conclusions

The waking of patients during anesthetic administration is an uncommon complication, though alarming to patients and anesthesiologists alike. When we consider that approximately 20 million general anesthetics are administered each year in the United States, the incidence of one case in 500 anesthetics corresponds to 40,000 cases of awareness annually. Awareness appears to be a dose-related phenomenon, and the risk is greatest when muscle relaxants are used. Its most-feared consequence is post-traumatic stress disorder. Management of a case of awareness should be precise, detailed, and documented, but compassionate. Measures to prevent awareness include avoidance of "overly" light anesthesia, gaining more knowledge about anesthetic requirements of patients, and development of methods to detect consciousness during anesthesia.

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