Wakeful Response to Command Indicates Memory Potential During Emergence From General Anesthesia

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ABSTRACT. Objective. An important aspect of assessing anesthetic depth is determining whether a patient will remember events during surgery. We looked for a clinical sign that would indicate a patient's potential for memory formation during emergence from anesthesia. A clinical sign indicating memory potential could be a useful endpoint for measuring the performance of anesthetic depth monitors and for titrating administration of anesthetic agents. Methods. We evaluated patients' responses to commands to open the eyes, squeeze the hand four times, and count 20 numbers. These responses were correlated with results on recall, cued recall, and multiple-choice memory tests. Main Results. Patients did not have evidence of memory formation until they sustained wakefulness sufficiently long to complete at least four hand squeezes or count four numbers. Of 28 patients, 13 (46%) with this sustained wakeful response had memory. Of 22 patients, 0 (0%) had evidence of memory formation when they demonstrated a brief wakeful response, defined as being responsive to command but unable to complete more than one hand squeeze or count, or an intermediate response, defined as two or three hand squeezes or counts. Conclusions. We conclude that a brief wakeful response to command indicates that a patient is unlikely to form memories, while a sustained wakeful response indicates that a patient may form memories. Thus, a patient's wakeful response to command could be a useful indicator of potential for memory.


INTRODUCTION

An adequate anesthetic normally suppresses memory of events during surgery. To aid in evaluating a patient's potential for memory, it would be helpful to have a clinical sign that indicated the return of memory formation. This sign would be useful for titrating administration of anesthetic agents during general anesthesia or sedation, and for evaluating the performance of anesthetic depth monitors, such as the electroencephalogram (EEG) or evoked potentials.

The performance of anesthetic depth monitors can be measured by how accurately they predict a patient's responses to stimuli, such as skin incision, closing sutures, verbal commands, or sounds [1-14]. Performance of the monitor could also be measured in terms of accuracy in predicting the return of memory formation. Memory formation could be measured directly by carrying out memory studies in every patient. More conveniently, if there were a clinical sign that signaled the return of memory formation, the performance of
the anesthetic depth monitor could be measured by how accurately the monitor predicted the clinical sign.

The clinical sign we evaluated was a patient's wakeful response to command, and this was assessed with eye opening, motor, and verbal responses. Memory was assessed with recall, cued recall, and multiple-choice tests. We correlated different levels of wakeful response to commands with memory test results to determine a level of wakefulness at which patients first demonstrated evidence of memory formation. The studies were carried out during emergence from anesthesia following completion of surgery.

METHODS AND MATERIALS

Patients and Anesthetic Techniques

With the approval of the Institution Review Board,* we studied 50 patients (11 men and 39 women; aged 18 to 55 years) undergoing a variety of surgical procedures. Of the 50 patients, 37 were inpatients and 13 were ambulatory surgery patients. We studied the patients during emergence from anesthesia following completion of surgery. The patients received either no preanesthetic medication, or were given meperidine 1 mg/kg and hydroxyzine 1 mg/kg, 1 hr before induction. Induction was implemented with d-tubocurare 3 mg and thiopental 4 mg/kg, followed by succinylcholine 1.5 mg/kg for intubation. We maintained anesthesia with either narcotic-N₂O (meperidine or fentanyl), volatile agent-N₂O (isoflurane or halothane), or narcotic-isoflurane (fentanyl). Muscle relaxant (d-tubocurare 0.5 mg/kg) effect was reversed before emergence.

Informed consent was obtained during the preoperative interview. Patients who participated in the study agreed to listen for, look at, and remember sounds and objects presented to them as they awoke from anesthesia.

Mental Status Examination and Arousal Response

A brief mental status examination was given to patients as they emerged from anesthesia. Following the Glasgow Coma Scale, the mental status examination consisted of arousing patients and asking for eye opening, hand squeezing, and counting [15,16]. For example, the investigator placed his fingers in a patient's right hand, and then called the patient by name: "John, John, the operation is over and everything is fine! John, John, open your eyes! John, John, squeeze your right hand!" If the patient did not open his eyes or did not squeeze his hand, the instruction was repeated. If the patient did hand squeeze, further instruction was given: "John, John, squeeze your right hand four times, exactly four times!" If the patient began hand squeezing, the investigator counted aloud the patient's first two squeezes, saying, "Once, Twice!" The investigator then paused to see if the patient went on to complete the four squeezes and stop at four. If the patient did not complete four squeezes, the instruction for four hand squeezes was repeated, and this time, as the patient hand squeezed, the investigator gently squeezed the patient's hand in return while counting aloud the first two squeezes. The investigator's counting aloud and gently hand squeezing as patients squeezed seemed to arouse the patients and encourage them to continue their hand squeeze response. Patients who had a few hand squeezes but did not complete the four hand squeezes lost responsiveness and appeared to return to an anesthetized state. Occasionally, the squeezing response perseverated, going many counts beyond four. Patients who completed exactly four squeezes often emphasized the fourth squeeze, as if to indicate they had been counting and knew the task was completed. After the hand squeeze response test, patients were instructed to count backwards from 20 to 0. If the count was incomplete or incorrect, the instruction was repeated.

Eye opening was defined as present if patients opened their eyes, either in response to their name or to the request that they open their eyes. Hand squeezing was defined as present if the investigator could feel the patient's hand squeeze response. The number of hand squeezes was noted. Counting was defined as present if patients counted numbers so that the investigator could clearly hear or lip read the numbers. The numbers of counts and the mistakes and pauses in counting were noted. The mental status examination was performed just before the presentation of target items and then again immediately following the presentation.

Classification of Patients by Wakeful Response to Command

Wakeful responses to command were used to classify patients into five groups (Table 1). A patient was classified according to the response on the hand squeeze test or counting test that indicated the most sustained wakefulness. All patients had at least an eye opening.

*This project, "Identifying the Reemergence of Memory in Patients Awakening from General Anesthesia," was last reviewed in 1983, by the Institutional Review Board, Kaiser Permanente, Oakland, CA.