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Editorial Views

Recovery from Anesthesia

IN THE PAST TEN YEARS a great deal of attention has been directed to the period of recovery following general anesthesia. To a certain extent, this has been due to the simultaneous development of outpatient anesthesia. Usually, the inpatient recovery room is a halfway house where the patient regains consciousness and reflexes before being sent to his room, where he sleeps off the effects of depressant medication overnight or for days later. In contrast, the outpatient participates actively in the period of awakening. Rapid recovery and early ambulation are major objectives, but the anesthesiologist cannot rely solely on early return of consciousness or stabilization of vital signs as indexes of full recovery. He must guarantee safe discharge not only from the recovery room but also from the hospital. There is no second opportunity to transfer care of the outpatient to other medical or paramedical personnel. There is no further period of observation, monitoring, and treatment.

One would think that with the popularity of outpatient surgery and with the need to redefine criteria for discharge home of the ambulatory patient, research on the subject would become standardized so that data could be shared among institutions and uniform policies established. This is not the case. The literature related to the recovery period is confusing and contradictory. Often, results obtained from young, healthy, human volunteers are compared with values in a mixed-age population undergoing surgical procedures. In comparing the effects of the same drug, doses may vary, as may the methods of testing. These problems occur in other areas of investigation; however, an additional problem seems unique, that is, definition of recovery to an ambulatory state. The endpoint for discharge in some institutions may be the stage of "immediate recovery" in others.

In what psychologic and physiologic state *should* the patient be prior to discharge? Is it enough that he be able to walk to be discharged under the care of a responsible adult, or is this merely a convenient method of finessing the issue of distinguishing between immediate, partial recovery, and delayed but complete recovery? If, as suggested by James,[1] impairment of mental activity can persist for as long as a week after general anesthesia, maybe we can direct our attention to the early phase of recovery only, but is the duration of this phase two or 24 hours? Are there tests that we can rely on to standardize and predict criteria for safe discharge? Unfortunately, most tests used in a clinical setting are unsophisticated or difficult to quantitate, while equipment employed in a laboratory is bulky, expensive, and too complex to be used routinely in clinical practice. In this issue, Korttila and colleagues[2] have used a "Sim-L-Car" to test the recovery of driving skills of adult human volunteers after they received a single injection of one of four intravenous anesthetic agents. A clinical test, the Romberg sign, was used to define "immediate recovery," while the more sophisticated driving tests were employed to delineate the duration of the recovery period.

Subjects who received propanidid could not stand steadily with their eyes closed before those who received alphadione could open their eyes. However, when the subjects receiv-

ing propanidid assessed their own state of consciousness and driving ability, almost as many felt tired eight hours later as those who received methohexital and thiopental. At this time, fewer subjects receiving propanidid considered their driving ability to be normal compared with those receiving the other three drugs studied. In spite of the pessimistic opinion of the subjects at that time, no impairment in simulated driving compared with controls could be observed two hours or later after 6.6 mg/kg of propanidid, while driving performances were considerably worse for more than six hours after a comparable dose of any of the other three drugs. These results and conclusions are similar to those of Doenicke,[3] who used encephalography as the test mode. Data such as these emphasize the shortcomings and hazards of allowing the patient to assess his own capabilities subjectively. One would anticipate that a drug like propanidid, with rapid onset and rapid immediate as well as rapid delayed recovery (less than five minutes and and two hours, respectively), would be widely accepted for outpatient surgery. Although used abroad, not only is the drug unapproved for use in the United States, but requests to the Food and Drug Administration for investigation have been minimal and requests for approval, nonexistent.*

The authors of the present article conclude that longer sleep times with thiopental and with alphadione than with methohexital or propanidid might allow for better performance of outpatient procedures of more than five minutes' duration with the former two drugs. However, one can hardly equate sleep time with analgesia, anesthesia, or the ability to perform a "minor" surgical procedure. Perhaps propanidid is too short-acting for most outpatient operations. If used in doses greater than 6.6 mg/kg for induction or if given intermittently rather than in a single administration, vital signs are more profoundly depressed, recovery is more delayed, and its apparent advantages disappear. Yet, there is an alternative. The use of a single administration of propanidid, alone, might be indicated for procedures of less than five minutes' duration or for induction of anesthesia to be followed by a drug like halothane in a more lengthy procedure.[3,4] This could minimize or eliminate the problem of a prolonged recovery period or an apparent early awakening followed by a subsequent return to a more depressed state. Both phenomena have been found by the authors after the use of the other intravenous agents.

For example, while subjects given alphadione did not make more performance errors compared with the control group in the simulated driving tests at two and four hours, their errors were significantly greater than those of the controls at six hours. At that time, 80 per cent of the subjects assessed their driving ability to be normal. The authors offer the possible explanation that a metabolite of the steroids in alphadione might have anesthetic potency or that an enterohepatic cycle might result in impaired performance after eating. A lapse back into a sleep state has been noted by others after the use of diazepam[5] and thiobutabarbital,[3] and has been similarly attributed to mobilization of the drug from storage sites with resultant increasing blood levels, or, in the case of diazepam, production of a depressant metabolite. The authors discuss the decrease in performance after an initial "normal response" after alphadione as a potential hazard, particularly since the subjects could not detect their own difficulties. It is therefore of special interest that recently Carson *et al.*[6] stated that "a striking feature of recovery from Althesin† is its completeness. Patients did not tend to fall asleep again unlike those who received thiopentone; also they seemed to be well aware of their capabilities as evidenced by the low percentage (5%) who overestimated their degree of recovery." Same drug, different doses, different assessment of recovery endpoints, different testing device and what do we have?—whatsone group concludes is a disadvantage becomes an advantage!

The use of the Sim-L-Car should re-emphasize the inability of most subjects to drive an automobile safely, particularly after the administration of alphadione, methohexital, and thiopental. Even though immediate clinical and psychomotor recovery was faster

* Margaret Clark, M.D., Acting Director, Division of Surgical and Dental Drug Products, Bureau of Drugs, Food and Drug Administration, personal communication.

† Alphadione.

after methohexital than after thiopental, the impairment of driving ability after either drug was still severe after eight hours. The times to full psychomotor recovery were found to be the same after both drugs. This is in keeping with other studies[4-7] yet many clinicians still are impressed with the fact that methohexital is more "ultrashort acting" than thiopental. In 1965 Dundee warned that "While clinical recovery is undoubtedly quicker after some barbiturates than others, it is doubtful if there is a great difference in time for complete removal of a clinical dose from the blood stream. The term "ultrashort-acting" is a misnomer; it applies to small doses of the drugs only, and it suggests that their action has worn off completely. This can never be assumed even if consciousness has returned. 'Rapidly acting' is a better word."[8] Not only have the authors of the current study re-emphasized and confirmed that complete recovery may be delayed well beyond the disappearance of gross clinical signs of anesthesia, they have defined the clinical doses and the time course of recovery associated with them. Using the Miles Auto Trainer, Green *et al.*[9] found that with the same 3:1 ratio of dosages of thiopental to methohexital but with a quantity half that used in the current study, no deterioration in the driving task resulted in the absence of clinical symptoms. One must compare equals.

The previous remarks have been directed at the recovery of psychological or performance function. It should also be emphasized that in the immediate recovery phase most physiologic measurements have been performed by observation of gross values (blood pressure, respiratory rate). While these signs may be "normal," more sophisticated tests of cardiac depression have demonstrated a prolonged depression of myocardial performance following the use of thiopental for induction and/or maintenance as well as following methohexital used intermittently for procedures lasting longer than 10–30 minutes.[10-12] The return of blood pressure to normal does not insure full recovery of the circulatory system any more than the return of consciousness implies recovery of the nervous system.

All of these factors have led to adoption of conservative clinical guidelines for the time of safe discharge of the adult outpatient. Most advocate that such patients be discharged only in the care of a responsible adult. Some[4,13] have recommended the use of a special consent form which specifies that for at least 24 hours following the use of intravenous barbiturates or long-acting inhalation anesthetics the patient must not: 1) drive an automobile or operate complex machinery; 2) make important business decisions; 3) drink alcohol. The form is signed by the patient and witnessed prior to administration of anesthesia. In spite of these warnings, Ogg[13] found that 73 per cent of all car owners drove within 24 hours and 30 per cent within 12 hours. Nine per cent drove themselves home alone even though they were unfit to do so. Data presented by the present authors confirm the hazards of this practice.

We must unify our efforts at performing more controlled studies of the recovery phase of not only the outpatient but also the inpatient. Criteria for safe discharge of outpatient infants and children must be developed.

Analyses of the effects of environmental pollution and trace anesthetics on performance of operating room personnel have added a new dimension to investigations of the recovery period.[15,16] Who knows how long an anesthesiologist exposed to trace anesthetic agents can safely administer an anesthetic? Perhaps after a long day and night in the operating room, an anesthesiologist should not administer anesthesia, drive a car, make important decisions or drink alcohol. Should he be discharged in the care of a responsible adult?

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The Blood Shortage:

Is Autotransfusion an Answer?

MORE THAN EIGHT MILLION units of blood are administered to patients annually in the United States, and this volume will undoubtedly continue to increase as our surgical colleagues attempt increasingly complex procedures, ranging from radical cancer or trauma surgery to transplant and open-heart procedures. In fact, it has been suggested that if the growth of coronary-artery surgery were to continue at the present rate and the amount of blood used per case to remain the same, the nation's entire blood resource would be required for that one procedure by 1976.[1] Increased donor recruitment through such ingenious means as giving tax credits[2] or the new national blood system[3] may alter the fact that 97 per cent of the eligible population are non-donors. Similarly, more efficient use of the available supply through selective component therapy,[4] use of blood substitutes, and acceptance of lower hematocrits will also help to conserve a precious national resource.

Autologous blood transfusion is an additional technique that has been proven to reduce the requirement for homologous blood. There are three variations to this technique[5]: 1) preoperative collection and storage; 2) acute perioperative collection and simultaneous hemodilution; 3) intraoperative blood scavenging.

Preoperative Collection and Storage

Autologous blood banking has lagged behind homologous mainly because of an inability to store whole blood more than 21 days. However, preoperative collection and storage can be expanded to provide as many as four units of blood less than ten daysold.[6] Milles *et al.* now meet more than 90 per cent of their surgical blood needs with autologous blood. This group started conservatively in the mid-60's with single-unit phlebotomies ten days prior to operation and gradually expanded their work, until now they collect as much as three units at two-day intervals, the last being collected four days prior to operation.[7]

A variant of serial single-unit phlebotomies in which units are removed and reinfused at seven-day intervals in such a way that three units of blood less than ten days old are available at operation has been described