

Recall of Surgery for Major Trauma

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Major traumatic injury frequently causes hemodynamic instability that necessitates reducing the usual dose of anesthetic given for surgery. Nevertheless, a lower dose may be sufficient to provide anesthesia because of conditions present in trauma victims that are known to reduce anesthetic requirement (hypotension, hypothermia, and acute alcohol intoxication). To determine the incidence and patient perception of recall of surgery, 51 patients were interviewed after surgery for major trauma. Patients were assigned to one of two groups. Thirty-seven patients were given an anesthetic for endotracheal intubation and had continuous or almost continuous anesthesia during surgery. Of the four who recalled surgery (11%), two considered this awareness their worst hospital experience. Fourteen other patients, who were more severely injured, were not given an anesthetic for endotracheal intubation and/or for 20 or more consecutive minutes during surgery. Of the six patients in this group who recalled surgery (43%), two considered this awareness their worst hospital experience. No condition known to reduce anesthetic requirement did so reliably enough that recall of surgery did not occur when the anesthetic dose had to be reduced because of major trauma. The authors conclude that the incidence of recall of surgery in victims of major trauma is considerable, and that reducing the dose of anesthetic increases this incidence, despite the presence of conditions known to reduce anesthetic requirement. (Key words: Anesthesia: depth. Complications: trauma. Memory.)

AFTER MAJOR TRAUMA, hemodynamic instability frequently necessitates reducing the dose of anesthetic administered. Although a reduced dose may be sufficient to provide anesthesia because of conditions present in trauma victims that are known to reduce anesthetic requirement as defined by MAC (hypotension, hypothermia, and acute alcohol intoxication), such a reduction could result in awareness during surgery and distressing recall of this awareness. To determine the effect of reducing the dose of anesthetic on the incidence and patient perception of recall, we interviewed patients after surgery for major trauma. In addition, we retrospectively reviewed whether conditions known to reduce anesthetic requirement would do so reliably enough to prevent recall of surgery when the dose of anesthetic had to be reduced because of hemodynamic instability following major trauma.

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Methods

We received approval from the Committee on Human Research to study 51 consecutive adults who had major abdominal, thoracic, or orthopedic trauma but no head injury (based on the nature of the injury and subsequent hospital course). Specifically, 31 patients had stab wounds to the chest and/or abdomen; eight patients were involved in motor vehicle accidents; five were shot in the chest and/or abdomen; two fell accidentally; and five suffered blunt trauma or severed limbs. Anesthetic management, which was not altered by the study, followed our anesthesia service's usual procedure. If the patient was unconscious (because of hemorrhagic shock or the presence of alcohol or other drugs) or hemodynamically unstable on arrival at the emergency room, endotracheal intubation was performed immediately without an anesthetic or with only the help of succinylcholine iv. Senior surgical housestaff evaluated the injury and inserted appropriate cannulae for resuscitation. If the patient was conscious and hemodynamically stable, endotracheal intubation was performed as part of a rapid sequence iv induction of anesthesia (ketamine or sodium thiopental), with application of cricoid pressure, in the operating room. If surgery had to be started before cardiovascular stability was achieved, only oxygen and a muscle relaxant were administered. As cardiovascular stability was achieved, a volatile anesthetic was administered as tolerated. If blood oxygenation was adequate, nitrous oxide might have been used. Also, narcotics might have been used once the injury was defined and controlled. None of the patients received premedication or drugs used specifically for preventing recall of surgery, *i.e.*, scopolamine and benzodiazapines were not used.

One to four days after surgery, patients were interviewed by the same author (MSB), who was unaware of the anesthetic given and the intraoperative course. To determine the incidence and patient perception of recall of surgery without influencing the answer, the interviewer first asked the patient to describe his two worst hospital experiences. If awareness during surgery was mentioned, recall was considered "important." To determine the incidence of awareness, the interviewer then asked *each* patient to describe (regardless of his worst hospital experience) what specific details he recalled about surgery. The entire interview was repeated 5-10 days after surgery to determine if the patient's perceptions had changed with time.

After the two interviews, patients were classified into two groups, depending on the amount of anesthetic they had received; criteria for the two groups were defined prospectively. The "lower dose" group had endotracheal intubation without an anesthetic and/or had not been given an anesthetic for 20 or more consecutive minutes during surgery. The "higher dose" group had been given sodium thiopental or ketamine for endotracheal intubation and had never had the anesthetic discontinued for more than 20 consecutive minutes.

To confirm that the dose of anesthetic had been reduced because of severe injury, we compared the two groups for the following variables: systolic blood pressure on arrival at the emergency room and immediately before induction of anesthesia, the lowest body temperature during surgery, and the requirement for blood (whole blood and packed cells) during surgery. Blood pressure was measured using an arterial cannula in 35 of the patients.

Certain conditions associated with major trauma reduce anesthetic requirements. To determine which of these conditions prevent recall of surgery when the dose of anesthetic has been reduced, we reviewed the medical and anesthetic records of patients given the lower dose of anesthetic. Those who recalled surgery were compared with those who did not for the following variables: systolic blood pressure on arrival at the emergency room and immediately before induction of anesthesia; the lowest body temperature and arterial pH value during surgery; and blood alcohol concentration and a toxicologic evaluation of blood and urine during the early part of surgery. Also compared were the number of consecutive minutes without anesthetic, blood pressure when not receiving anesthetic, the type and dose of anesthetics administered, age of the patient, and type of injury.

The incidence and patient perception of recall were compared for the two groups using chi-square analysis. Severity of injury and the conditions that might reliably reduce anesthetic requirement so that recall of surgery does not occur during a reduction in the dose of anesthetic were analyzed using the Mann-Whitney test. A *P* value of less than 0.05 was considered statistically significant.

Results

Patients given the lower dose of anesthetic had a significantly greater (*P* < 0.025) incidence of recall of surgery (6 of 14, or 43%) than did those given the higher dose (4 of 37, or 11%).

The incidence of "important" recall was similar for the two groups (*P* > 0.05); two patients in each group (2 of 14; 2 of 37) considered awareness during surgery their worst hospital experience. Understandably, pain

during surgery was the most distressing feature of this awareness; the hearing of voices and the awareness of being operated on were not as distressing. Each patient's perception of his awareness was reported in the second interview as it was in the first. Therefore, the evaluation of importance of recall was unaffected by discussing the subject previously or by time.

Patients given the lower dose of anesthetic were injured more severely than those given the higher dose, judging from systolic blood pressure on arrival at the emergency room (mean \pm SD: 69 ± 44 mmHg *vs.* 102 ± 33 mmHg, *P* < 0.001) and immediately before induction of anesthesia (79 ± 41 mmHg *vs.* 123 ± 23 mmHg, *P* < 0.001), the lowest body temperature during surgery ($33.3 \pm 1.5^\circ$ C *vs.* $35.1 \pm 1.2^\circ$ C, *P* < 0.001), and the requirement for blood during surgery (11 ± 11 units *vs.* 4 ± 3 units, *P* < 0.002). In addition, patients given the lower dose were not given anesthetic agents for an average of 58 consecutive minutes during surgery (range 20–280 min, table 1). In contrast, only two patients given the higher dose ever had anesthetics discontinued: one for 5 min, the other for 15 consecutive minutes. Neither of these patients recalled surgery.

When the anesthetic records of the 14 patients given the lower dose were reviewed, we could not determine which factors reliably reduced anesthetic requirement so that recall of surgery did not occur when the dose of anesthetic had to be reduced because of severe injury and hemodynamic instability (table 1). That is, when "lower dose" patients who recalled surgery were compared with those who did not, there were no significant differences in systolic blood pressure immediately before induction of anesthesia, lowest body temperature or arterial pH value during surgery, or blood alcohol concentration. For every patient, toxicologic evaluation of blood and urine showed no barbiturates, opioids, amphetamines, or phencyclidine. Furthermore, there were no significant differences in the number of consecutive minutes without anesthetics, blood pressure during periods of no anesthetic, or type or dose of anesthetic administered. Mean age (30 yr), sex, and type of injury were also similar.

Discussion

The consequences of severe injury (*e.g.*, hypotension,^{1,2} hypothermia,³ acidemia,¹ and severe anemia⁴) are known to reduce anesthetic requirements as defined by MAC. In addition, acute alcohol intoxication, which is frequently present in trauma victims, may also reduce anesthetic requirement.⁵ Therefore, the presence of these conditions might help prevent recall of surgery if the dose of anesthetic agents had to be reduced. Conversely, other factors often present in trauma patients (*e.g.*, lower age,⁶

TABLE 1. Comparison of Patients Given the Lower Dose of Anesthetic Agent for Major Trauma Surgery

Patient	Recall of Surgery (n = 6)						No Recall of Surgery (n = 8)							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
First emergency room blood pressure (mmHg)	70	NO	NO	NA	NA	115	100	96	94	70	NO	74	110	65
Preinduction blood pressure (mmHg)	80	CPR	80	55	60	110	120	120	110	135	NO	100	75	100
Induction agent (mg ketamine)	100	ER	50	ER	ER	100	ER	100	50	50	ER	100	75	100
Consecutive minutes without anesthetic	25	70	20	55	80	50	45	20	25	35	280	20	35	45
Blood pressure range during no anesthetic (low) (mmHg)	65	NO	NO	50	NO	90	75	85	80	55	40	80	60	40
Blood pressure range during no anesthetic (high*) (mmHg)	100	120	140	100	110	125	98	120	110	85	100	120	110	90
Lowest temperature during surgery (°C)	33.0	34.3	33.0	31.0	32.4	NA	35.0	34.5	35.0	31.4	30.5	34.4	33.6	34
Blood alcohol concentration (mg/%)	228	0	0	0	122	280	240	0	94	101	0	37	0	NA

All blood pressures are systolic. NO = not obtainable; NA = not available; CPR = cardiopulmonary resuscitation in progress; and ER = trachea intubated in the emergency room in the absence of an

anesthetic.

* Higher blood pressure also represents the highest blood pressure measured before an anesthetic was given.

lack of premedication,^{7,8} increased endogenous catecholamines,⁹ and chronic abuse of alcohol† are known to increase the dose of drugs necessary to provide anesthesia.

When the dose of anesthetic was reduced because of severe injury, the incidence of recall was considerable. In more severely injured patients, who were given the lower dose, the incidence of recall (43%) was four times the incidence for less severely injured patients (11%), who were given the higher dose. We could not determine which consequences of major trauma reduced the anesthetic requirement reliably enough that recall of surgery did not occur when the dose of anesthetic had been reduced because of hemodynamic instability following severe injury. For example (table 1), patients had recall of surgery despite administration of ketamine for induction of anesthesia and a blood alcohol concentration of over 225 mg/% (patients 1 and 6). Conversely, one patient (patient 7), who had a blood alcohol concentration of 240 mg/%, did not recall surgery, even though he was not given an anesthetic for induction of anesthesia nor any anesthetic for 45 consecutive minutes during surgery. In addition, one patient (patient 11), whose lowest body temperature during surgery was 30.5° C, did not recall surgery, even though he was not given any anesthetic agent for over 4 h.

Examination of the anesthesia records of the four patients with recall in the group given the higher dose of

anesthetic showed that these patients were resuscitated easily from their injury and that cardiovascular stability was achieved. Although anesthetics never were discontinued in these patients for more than 5 min during surgery, based on the recorded blood pressure (130–150 mmHg), an even greater dose of anesthetic could have been administered. Therefore, these four patients may represent imperfect clinical judgment in a rapidly changing setting, rather than a predictable incidence of recall unique to the trauma patient.

The usefulness of a drug that causes amnesia is obvious. Unfortunately, such a drug would have to be administered to virtually all victims of major trauma, because, as this study demonstrates, one could not reliably predict awareness during surgery. Similarly, these drugs would have to be administered before surgery because they do not produce retrograde amnesia. Finally, the drug would have to produce no deleterious cardiovascular effects when administered during hypovolemia.

We conclude that the incidence of recall of surgery in victims of major trauma is considerable and that reducing the dose of anesthetics increases this incidence, despite the presence of conditions known to reduce anesthetic requirement as defined by MAC. Because of the many factors involved in determining the dose of anesthetic required to produce amnesia and our inability to know precisely when awareness occurs, we cannot predict who will be conscious during surgery for major trauma. Therefore, all patients undergoing such surgery should be considered "at risk" for awareness of surgery. Since the use of amnestic drugs during hypovolemia has not been proved safe or effective, we recommend the ad-

† Barber RE: Anesthetic requirement in alcoholic patients. Abstracts of Scientific Papers, Annual Meeting, American Society of Anesthesiologists, 1978, pp 623–624.

ministration of anesthetic as soon as tolerated by the patient and judicious conversation in the operating room. All patients should be given an opportunity to discuss any awareness in detail and to gain an understanding of the reasons for their awareness; all patients in this study readily discussed this topic. Indeed, open discussion of the circumstances and the reasons for administering a lower dose of anesthetic may be highly beneficial.¹⁰

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