A comparison of the recovery times of desflurane and isoflurane in outpatient anesthesia

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The low solubility of desflurane has been shown to contribute to faster awakening from anesthesia when compared with other anesthetics in common use. However, research has failed to consistently demonstrate faster discharge times from the postanesthesia care unit following the use of desflurane.

This study was undertaken to compare the recovery and discharge times of outpatients undergoing procedures greater than 2 hours in length. Thirty-three patients aged 18 to 70 years were randomized to receive either desflurane or isoflurane following a standard intravenous induction with propofol. Patients received premedication and opioids consistent with institutional practice, and inhalation agents were titrated to effect during anesthetic maintenance. Following surgery, patients were evaluated for time to emergence and time to meeting discharge criteria.

The results demonstrated no differences between the emergence or discharge times following desflurane or isoflurane. In addition, measured parameters, such as intraoperative vital signs and postoperative emesis and opioid requirements, were not different between the groups. The use of desflurane as part of a balanced anesthetic technique did not speed the emergence or discharge time when compared with isoflurane.

Key words: Ambulatory surgery, desflurane, isoflurane, recovery time.

Introduction
Healthcare spending in the United States is rising at an overwhelming rate. While national health expenditures were approximately $74 billion in 1970, by 1991 this figure had risen to an overwhelming $751 billion. In response to these rising costs, ambulatory surgery has flourished during the past decade. Anesthetics such as desflurane have been developed and are purported to afford a faster recovery from anesthesia compared with older agents. Indeed, the emergence time following desflurane anesthesia is faster than that following isoflurane. However, research has not consistently demonstrated earlier discharge times following the use of desflurane.

Our study compared desflurane and isoflurane in outpatient cases lasting longer than 2 hours. We sought to determine whether desflurane would afford a faster discharge from the postanesthesia care unit (PACU) if both anesthetics were administered according to usual clinical practice. That is, the anesthetics would be titrated to patient response during the case and titrated downward as appropriate for each agent to facilitate a timely emergence at the end of the case.

Materials and methods
This investigation was performed in the out-

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The patient surgical department of an 800-bed university hospital. After approval by the institutional review board, written informed consent was obtained from 60 patients undergoing elective surgery scheduled to last at least 2 hours. The patients were ASA physical status I through III, men and women, and aged 18 to 70 years. Each patient was evaluated for suitability to participate in the study. Exclusion criteria consisted of a history of adverse reactions to the medications that would be administered, pregnancy, age younger than 18 years or older than 70 years, and any medical condition contraindicated the use of medications included in the protocol. Patients were randomly assigned to either the desflurane or isoflurane protocol, and the anesthetist caring for the patient was informed of the protocol to follow.

In the preoperative holding area, intravenous access was established, and all patients received premedication of midazolam 0.01 to 0.04 mg/kg. Patients were then taken to the operating room where standard monitors were applied. These monitors included blood pressure (Dinamap, Critikon, Inc. Tampa, Florida), electrocardiogram (Spacelab model 90603, Spacelab, Inc., Redmond, Virginia), and oxygen saturation (Nellcor N100, Nellcor, Inc., Pleasanton, California). After preoxygenation, anesthesia was induced with fentanyl, 1 to 2 μg/kg, and propofol, 1 to 2.5 mg/kg. A muscle relaxant appropriate for the procedure also was administered to facilitate endotracheal intubation. Additional parameters monitored intraoperatively included end-tidal carbon dioxide and anesthetic vapor concentrations (Capnomac Ultima, Datex Medical Instrumentation, Tewksbury, Massachusetts), temperature (Spacelab model 90603), peripheral nerve stimulation, and heart and lung sounds via an esophageal or precordial stethoscope. Anesthesia was maintained using a Narkomed 2B anesthesia machine (North American Drager, Telford, Pennsylvania) with 60% N₂O in oxygen and either desflurane or isoflurane. Volatile anesthetics were administered using a North American Drager Vapor 19.1 vaporizer for isoflurane or an Ohmeda Tec 6 vaporizer (Ohmeda, Liberty Corner, New Jersey) for desflurane. All patients received an inoperative dose of droperidol 10 to 20 μg/kg for antiemetic prophylaxis.

In order to evaluate the recovery profiles of these anesthetics, anesthetists were instructed to titrate the level of volatile anesthetic according to the usual signs of anesthesia, including hemodynamic response, movement, and eye signs. Additionally, the administration of fentanyl intraoperatively was allowed as needed until the patient had received a total of 2 μg/kg. The use of muscle relaxants during the procedure was optional, based upon the requirements of the given procedure.

At the conclusion of surgery, the anesthetist reversed any residual muscle relaxation, discontinued the volatile anesthetic, and allowed the patient to emerge from anesthesia according to that anesthetist's usual practice. All patients were then extubated in the operating room. The total doses of anesthetics were recorded. Patients were then transported with oxygen to the PACU.

Upon entry to the PACU, the nurse assuming care of the patient received a data form onto which the time of admission to the PACU and the patient's recovery scores were recorded. These scores were documented using a modified Aldrete postanesthesia recovery scoring system (Table I), which is the standard scoring system used in the study institution.

To document discharge times that would not be affected by nonmedical factors, PACU nurses recorded the time at which patients met the standard PACU discharge criteria for this institution. These criteria stipulate that the patient must have a recovery score of 10, the ability to walk without difficulty, and minimal or no nausea, vomiting, pain, dizziness, or bleeding. The time of patients' actual discharge by a physician was also recorded. Subsequent to patients' participation in this study, their charts were reviewed to record data on intraoperative vital signs and postoperative narcotic administration and emesis.

Desflurane and isoflurane were compared and tested for drug differences with respect to the time to extubation and the time to discharge. Time to discharge was calculated from the time of admission to the PACU until the patient was ready to be discharged as determined separately by the nurse and physician. The t test using log-transformed times was used to compare times to discharge by both the nurse and physician. The t tests with log-transformed times were used to test for drug differences in extubation times. Likewise, t tests with log-transformed times were used to test for drug differences in extubation times. The number of patients having emetic episodes or requiring opioids in the PACU for either agent was compared using chi-square and Fisher's exact tests. Finally, the systolic and diastolic blood pressure and heart rate throughout the perioperative period were compared for both agents using repeated measures analysis of variance. Throughout the statistical analysis, comparisons were considered to be statistically significant at an alpha level of P < .05.

Results
A total of 60 patients participated in this study,
with 24 being disqualified due to inadequate length of the surgical procedure and three due to drug administration in excess of the study protocol. The remaining 33 patients constituted the two treatment groups. Table II shows patient demographics and anesthetic doses. The groups were similar with respect to postoperative opioid requirements, emetic episodes, time to extubation, and discharge times (Table II). Patients in the desflurane group met discharge criteria in an average of 67 minutes (SD = 39), while those in the isoflurane group met discharge criteria in an average of 57 minutes (SD = 24). Analysis of the actual discharge times by the physician showed that desflurane patients stayed in the PACU an average of 72 minutes (SD = 39), and the isoflurane patients stayed an average of 68 minutes (SD = 24). These differences between groups were not statistically significant. The average difference between the time of patients meeting discharge criteria and their actual discharge was only 7 minutes, with a range of zero to 20 minutes.

Discussion
While the physical characteristics of desflurane suggest that it would produce a faster recovery than isoflurane, research has not yet proved that

| Table II |
| Patient demographics and anesthetic characteristics |
| Desflurane | Isoflurane |
| n = 18 | n = 15 |
| Gender (men/women) | 6/12 | 10/5 |
| Age (years) | 36 ± 13.6 | 35 ± 15 |
| Weight (kg) | 71 ± 25.9 | 70 ± 15.7 |
| Anesthesia time (minutes) | 203 ± 69 | 180 ± 43 |
| Surgery time (minutes) | 169 ± 67 | 149 ± 39 |
| Midazolam dose (mg) | 1.7 ± 0.5 | 1.4 ± 0.5 |
| Fentanyl dose (µg) | 130 ± 53 | 118 ± 63 |
| Propofol dose (mg) | 184 ± 88 | 154 ± 47* |

Note: Values for variables other than gender represent the mean ± standard deviation.

*P < .05.
Table III
Postoperative course

<table>
<thead>
<tr>
<th></th>
<th>Desflurane</th>
<th>Isoflurane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to extubation (minutes)</td>
<td>7.6</td>
<td>7.9</td>
</tr>
<tr>
<td>Opioid requirements (number of patients)</td>
<td>7 (39%)</td>
<td>7 (47%)</td>
</tr>
<tr>
<td>Emetic episodes (number of patients)</td>
<td>7 (39%)</td>
<td>7 (47%)</td>
</tr>
<tr>
<td>Discharge criteria met (minutes)</td>
<td>67</td>
<td>57</td>
</tr>
<tr>
<td>Actual discharge time (minutes)</td>
<td>72</td>
<td>68</td>
</tr>
</tbody>
</table>

Note: Time values represent mean times to each event. Percentages represent proportion of patients within each study group.

presumption. We postulated that a number of confounding issues may have obscured the advantages of desflurane in previous studies. The first issue we addressed was the balance between internal and external validity. A number of researchers used rigid protocols that called for set doses of anesthetics and for the volatile anesthetics to be discontinued at a set time prior to the end of surgery. Since we compared agents of different solubilities, we allowed titration of the volatile anesthetics in order to afford the most timely emergence from each agent. Fentanyl (up to 2 μg/kg) was provided intraoperatively, as its administration at this dosage has been shown not to lengthen discharge time. To minimize the persistent effects of the premedication, antiemetic, and induction agent, we studied only surgical cases that lasted more than 2 hours.

The second confounding issue we addressed was the definition of recovery. We identified numerous nonmedical factors that may influence a patient's discharge time. These factors include a minimum length of stay policy, a requirement to take oral fluids, or simply the unavailability of a physician to write discharge orders. One study found that in 50% of patients, discharge was delayed at least 30 minutes after discharge criteria were met. To avoid this potential confound, we measured discharge time as the time at which patients first met discharge criteria.

Contrary to our hypothesis, patients receiving desflurane did not meet discharge criteria faster than those receiving isoflurane. Additionally, the difference between the discharge times recorded by the nurses and patients' actual discharge times were not significantly different. Fifty-four percent of patients were discharged within 5 minutes after meeting discharge criteria. This finding suggests that the prevalence of nonmedical delays in discharge times is not as great as we had believed.

It is well known that the amount of time spent in the operating room and recovery area can greatly influence patients' medical costs. While research has yet to demonstrate ways of consistently reducing PACU time through anesthetic selection, the newer anesthetics have been shown to reduce emergence time. Future research should focus on identifying more specifically the components of anesthetic recovery that influence PACU discharge time. These components will hold the key to the development of future drugs and techniques that will reduce recovery time and reduce costs.

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