Factors Contributing to a Prolonged Stay After Ambulatory Surgery

Frances Chung, FRCPC, and Gabor Mezei, MD, PhD

Department of Anesthesia, Toronto Western Hospital, University of Toronto, Toronto, Ontario, Canada

We identified predictors for prolonged postoperative stay after ambulatory surgery using multiple logistic regression models. We collected perioperative data for 16,411 ambulatory surgical patients. A log-transformed time to discharge variable was modeled by multiple linear regression, including patient-, anesthesia-, and surgery-specific variables. The impact of hypothetical elimination of perioperative adverse events on mean length of stay was also estimated. Separate analyses were performed among patients who received general anesthesia (GA) and monitored anesthesia care (MAC). Patients receiving GA stayed 50 min longer than patients receiving MAC. Patients receiving GA and undergoing strabismus, transurethral, or otorhinolaryngological/dental procedures had the longest postoperative stay. Among patients receiving GA, smokers had a 4% shorter stay compared with nonsmokers; among patients receiving MAC, those with congestive heart failure (CHF) had a 11% longer stay compared with patients without CHF. Postoperative nausea and vomiting, dizziness, excessive pain, and cardiovascular events predicted 22%–79% increases in postoperative stay. The hypothetical elimination of all adverse events resulted in a 9.6% decrease in mean length of stay among patients receiving GA, but in only a 3.8% decrease among patients receiving MAC. The length of postoperative stay among ambulatory surgical patients is mainly determined by the type of surgery and by adverse events, such as excessive pain, postoperative nausea and vomiting, dizziness, drowsiness, and cardiovascular events. Patients with CHF and those who underwent long procedures had a higher risk of a prolonged stay. Appropriate prevention and management of postoperative symptoms could significantly decrease the length of stay among patients receiving GA.
Implications: The length of postoperative stay among ambulatory surgical patients is mainly determined by the type of surgery and by adverse events, such as excessive pain, postoperative nausea and vomiting, dizziness, drowsiness, and untoward cardiovascular events. Patients with congestive heart failure and those who underwent long procedures had a higher risk of a prolonged stay. Appropriate prevention and management of postoperative symptoms could significantly decrease the length of stay among patients receiving general anesthesia.

(Anesth Analg 1999;89:1352–9)

Length of postoperative stay after ambulatory surgery is a major outcome measure in the anesthesia literature (1–5). Cost considerations are reasons for preferring a shorter postoperative stay (6–8). Identifying relevant patient, anesthesia, and surgical factors that have a strong effect on the length of postoperative stay is an important step in reducing the cost of postoperative care. Once these predictors are known, we can predict the length of the postoperative stay for outpatients, which also enables us to plan and provide appropriate perioperative care for individual patients. However, the increase in the length of postoperative stay associated with a given factor should be considered together with the frequency of that factor.

Accepted for publication August 16, 1999.

Address correspondence and reprint requests to Dr. Frances Chung, Department of Anesthesia, Toronto Western Hospital, 399 Bathurst St., Toronto, Ontario, Canada M5T 2S8. Address e-mail to fchung@torhosp.toronto.on.ca.

In this study, using a large data set of outpatients undergoing ambulatory surgery at a tertiary care facility during a 3-yr period, we determined whether patient characteristics, surgical factors, or the development of adverse events had the most significant effect on time to discharge. We also estimated the impact of hypothetically eliminating intraoperative and postoperative adverse events on the mean length of postoperative stay among patients receiving general anesthesia (GA) and monitored anesthesia care (MAC).

Methods

We conducted a prospective study between January 1, 1993, and December 31, 1995, at the ambulatory surgical unit of the Toronto Western Hospital. Enrolled in this observational study were all consecutive ambulatory surgical patients. Ambulatory surgery was performed on outpatients with ASA physical status I–III,

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aged ≥12 yr. Because there was no alteration from standard patient care, the hospital's ethics committee gave approval and did not require written consent from patients.

Specifically designed anesthesia records completed by the attending anesthesiologists were used to collect data on patient characteristics (age, sex, ASA physical status, medical history) and on surgery- and anesthesia-related information (type and duration of surgery, type of anesthesia, physiologic variables, and drugs given).

Intraoperative adverse events were also documented by the anesthesiologists on standardized event sheets. The intraoperative event sheet listed adverse events, grouped as cardiovascular (e.g., hypertension), respiratory (e.g., bronchospasm), intubation-related (e.g., difficult intubation, defined as more than one attempt), technical (e.g., equipment not working), and miscellaneous, accompanied by their concise definitions.

Postoperative adverse events occurring in the postanesthesia care unit (PACU) or in the ambulatory surgical unit (ASU) were documented on standardized event sheets by trained nursing staff. The PACU event sheet listed adverse events grouped as cardiovascular, respiratory, metabolic (e.g., hyperglycemia), and neurologic events (e.g., seizure) and excessive pain (moaning or writhing in pain, or pain requiring more analgesic than ordered), bleeding, postoperative nausea and vomiting (PONV) (complaint of nausea, or observed retching or expulsion of gastric content), and other miscellaneous events. The ASU event sheet listed PONV, pain and aches, dizziness, drowsiness, cardiovascular and neurologic events, excessive bleeding, and other miscellaneous events. Both event sheets contained concise definitions.

The Postanesthesia Discharge Scoring System was used to determine discharge eligibility (9). Verbal and written instructions were provided for the patients before discharge, and the presence of an adult escort was required for each patient before being discharged.

Because most of the patients (93%) underwent either GA or MAC, patients receiving only local or regional anesthesia or chronic pain block were excluded from the analyses. Because patients receiving GA and MAC also differed significantly in their characteristics and the type of surgery they underwent, separate analyses were performed for the two patient populations.

Hierarchically built two-stage multiple linear regression modeling was used to identify independent predictors for prolonged stay. In the first stage, variables representing age, sex, and duration and type of surgery were forced into the model regardless of whether they were statistically significant because these were the primary variables of interest. To estimate the unbiased effect of one variable, it was also necessary to control for the effect of the other potentially confounding variables.

In addition, 13 variables representing the 13 most common or clinically relevant preexisting medical conditions were entered into the model. These medical conditions included hypertension, angina pectoris, myocardial infarction, dysrhythmia, valvular heart disease, congestive heart failure (CHF), smoking, asthma, chronic obstructive pulmonary disease, gastroesophageal reflux, diabetes mellitus, obesity (body mass index >30 kg/m^2), and history of cerebrovascular attack. Stepwise backward elimination was used to exclude the variables representing medical conditions that had a nonsignificant effect on discharge time. This was the final model of the first stage. Because the presence of preexisting medical conditions determines ASA physical status, ASA physical status was not entered into the models.

In the second stage, while forcing into the model all variables from the final model of the first stage, we entered 12 additional variables representing the occurrence of intraoperative and postoperative adverse events. These included intraoperative cardiovascular, respiratory, and intubation-related events and excessive postoperative pain, PONV, dizziness, shivering and hypothermia, drowsiness, cardiovascular and respiratory events, excessive agitation, and excessive bleeding. In the model for the patients receiving MAC, the variable for intubation-related events was not included because these patients were not intubated; therefore, only 11 variables were entered in the second stage of that model. Postoperative adverse events occurring in PACU and ASU were combined to gain statistical power and to avoid sparse data. If a patient developed the same event in both the PACU and ASU, it was counted only once. Stepwise backward elimination was used to exclude variables representing adverse events with statistically nonsignificant effects on discharge time.

Because discharge time showed skewed distribution, log-transformation of this variable was necessary to achieve approximately normal distribution. This log-transformation slightly changed the interpretation of the results. In linear regression, one unit change in the independent variable predicts β change in the dependent variable, where β represents the parameter estimate. In this analysis, the dependent variable is the log of time to discharge; therefore, a unit change in the independent variable predicts β change in this log-transformed variable, which means that e^{β} is the predicted relative change in the original time-to-discharge variable (i.e., a relative length of 1.20 means that a patients with the given characteristic will experience a 20% longer stay on the average than a patient without it). The R^2 values showing the percent variability in the outcome variable associated with the

final model and the specific variables are also reported. Because a total of 35 variables were included in the models, associations with $P < 0.001$ were considered significant.

We estimated the impact of the hypothetical elimination of intraoperative and postoperative adverse events on the mean length of stay by adapting the method used by Dexter and Tinker (10,11). We calculated the actual mean length of postoperative stay for the total population. For each adverse event, we then recalculated the hypothetical population mean using the actual time to discharge for the patients without the event, applying the median length of stay of patients with no event to the patients who actually suffered from that event. This method assumes that, after eliminating a specific adverse event, the time to discharge for each patient who had that specific event would be equal to the median discharge time of the patients with no event. The percent decrease in the hypothetical population mean compared with the actual mean represents the potential impact of hypothetically eliminating that specific event. The method slightly overestimates the impact of eliminating a given event because, in each calculation, it attributes the total hypothetical decrease to the specific event, although the particular delay in discharge for a given patient could be a result of more than one event occurring concurrently. The bootstrap percentile method, using 1000 bootstrap samples, was used to determine 95% confidence intervals for the calculated hypothetical decreases in mean length of stay. Statistical analyses were performed by using SAS software (version 6.12).

Results

During the study period, 17,877 patients were scheduled for ambulatory surgery. Two hundred thirty-nine patients were excluded as a result of surgery cancellation or incomplete data; therefore, 17,638 patients were included. Of these patients, 10,110 underwent GA, 6,301 received MAC, 586 received local anesthesia, 484 received regional anesthesia, and 157 patients received chronic pain block. The mean age was 34 ± 13 yr and 67 ± 16 yr for patients receiving GA and MAC, respectively. Most of the patients were healthy: 98% and 75% of the patients receiving GA and MAC, respectively, were ASA physical status I or II. Obesity, smoking, and hypertension were the most frequently occurring medical conditions, respectively occurring in 15.9%, 14.2%, and 13.8% of the patients.

Propofol was used for anesthetic induction in 97% of patients receiving GA. Fentanyl was given for 74%, alfentanil for 22%, midazolam for 23%, inhaled anesthetic (other than nitrous oxide) for 51%, and muscle relaxant for 20% of patients receiving GA. Of the patients receiving MAC, 94% received midazolam, 58% received fentanyl, 57% received propofol, and 22% received alfentanil.

Most of the patients receiving GA (91%) underwent gynecologic, orthopedic, or ophthalmologic procedures. Of the gynecologic procedures in patients receiving GA, 84% were dilation and curettage for abortion or diagnostic reasons. Most of the orthopedic procedures in patients receiving GA were knee (68%) or shoulder (15%) arthroscopy, and 88% of the ophthalmologic procedures were strabismus surgery. The neurosurgical procedures were mainly carpal tunnel release and other nerve decompressions, and most of the plastic surgical operations were hand or skin procedures. More than half of general surgical procedures were breast-related procedures, and most of the urologic procedures were transurethral procedures. Most patients receiving MAC (92%) underwent ophthalmologic surgery, mainly cataract removal (81%). The neurosurgical procedures, the second most common procedures under MAC (3.3%), were carpal tunnel release and nerve decompressions.

The most frequent intraoperative adverse events were cardiovascular events (e.g., hypertension, dysrhythmia), which occurred in 1.5% of the patients receiving GA and in 4.3% of the patients receiving MAC. The most frequent postoperative events were excessive pain and PONV, which respectively occurred in 9.5% and 7.2% of patients receiving GA. The corresponding frequencies among patients receiving MAC were 1.4% and 1.2%.

The mean length of postoperative stay was 157 ± 71 min among patients receiving GA, with a median of 140 min and a range of 30–575 min. Among patients receiving MAC, the mean length of stay was 102 ± 48 min, with a median of 90 min and a range of 10–525 min. Multiple linear regression analysis among patients receiving GA showed that, after adjustment, there was no difference in the length of stay between men and women, but increasing age was associated with increasing length of postoperative stay (Table 1). A 10-yr difference in age was associated with a 2% change in the length of stay. The duration of a procedure was also a significant predictor. For each 30-min increase in the duration of surgery, the model predicted a 9% increase in the length of postoperative stay.

Of the 13 preexisting medical conditions included in the model, only smoking status remained as a significant factor. Smokers had a 0.96 relative length of stay compared with nonsmokers, i.e., smokers had a 4% shorter postoperative stay than nonsmokers among patients receiving GA.

Compared with patients undergoing gynecologic surgery (reference group for other types of surgery

Table 1. Variable Estimates from the Multiple Linear Regression Models Among Patients Receiving General Anesthesia

	Variable estimate (β) ± SE	Relative length of stay (e^{β}) and 99.9% CI	*P* value
Age (10-yr difference)	0.017 ± 0.003	1.02 (1.01–1.03)	0.0001
Sex (M/F)	−0.015 ± 0.011	0.99 (0.95–1.02)	0.17
Smoking	−0.039 ± 0.009	0.96 (0.93–0.99)	0.0001
Duration of surgery (30-min difference)	0.086 ± 0.005	1.09 (1.07–1.11)	0.0001
Type of surgery			
Ophthalmologic	0.473 ± 0.018	1.60 (1.51–1.70)	0.0001
Urologic	0.231 ± 0.030	1.26 (1.14–1.39)	0.0001
General	0.158 ± 0.020	1.17 (1.10–1.25)	0.0001
Orthopedic	0.137 ± 0.012	1.15 (1.10–1.19)	0.0001
Otorhinolaryngological-dental	0.122 ± 0.033	1.13 (1.01–1.26)	0.0002
Plastic	0.050 ± 0.029	1.05 (0.96–1.16)	0.09
Neurosurgical	0.024 ± 0.035	1.02 (0.91–1.15)	0.50
Gynecologic (reference group)	0.000	1.00	
Postoperative events			
Dizziness	0.267 ± 0.024	1.31 (1.21–1.41)	0.0001
Nausea/vomiting	0.220 ± 0.014	1.25 (1.19–1.30)	0.0001
Cardiovascular	0.210 ± 0.047	1.23 (1.06–1.44)	0.0001
Excessive pain	0.197 ± 0.012	1.22 (1.17–1.27)	0.0001
Drowsiness	0.149 ± 0.033	1.16 (1.04–1.29)	0.0001
Shivering	0.109 ± 0.029	1.12 (1.01–1.23)	0.0002

n = 10,110.

among patients receiving GA), patients undergoing ophthalmologic and urologic procedures stayed 60% and 26% longer, respectively. Patients undergoing general, orthopedic, and otorhinolaryngological (ENT) surgery also stayed longer than patients undergoing gynecologic surgery. Patients undergoing ENT and ophthalmologic procedures with GA experienced the highest frequency of PONV (Figure 1), whereas 18% of the patients with excessive bleeding underwent urologic procedures, although only 1.5% of patients receiving GA underwent urologic surgery.

Six types of postoperative adverse events were associated with a significantly prolonged postoperative stay among patients receiving GA. Patients experiencing dizziness stayed 31% longer than patients without dizziness. Patients with PONV, cardiovascular events, and pain stayed 25%, 23%, and 22% longer, respectively, than patients without these adverse events. Drowsiness and shivering were also associated with a significant increase in the length of stay (16% and 12%, respectively).

Multiple linear regression analysis among patients receiving MAC showed that, after adjustment, similarly to the results among patients receiving GA, there was no difference in the length of stay between men and women, but increasing age was associated with increasing length of postoperative stay (Table 2). A 10-yr difference in age was associated with a 2% change in the length of stay. The duration of a procedure showed no association with length of stay.

Of the 13 preexisting medical conditions, only CHF showed an association with length of stay among patients receiving MAC. Patients with CHF stayed approximately 11% longer than patients without CHF

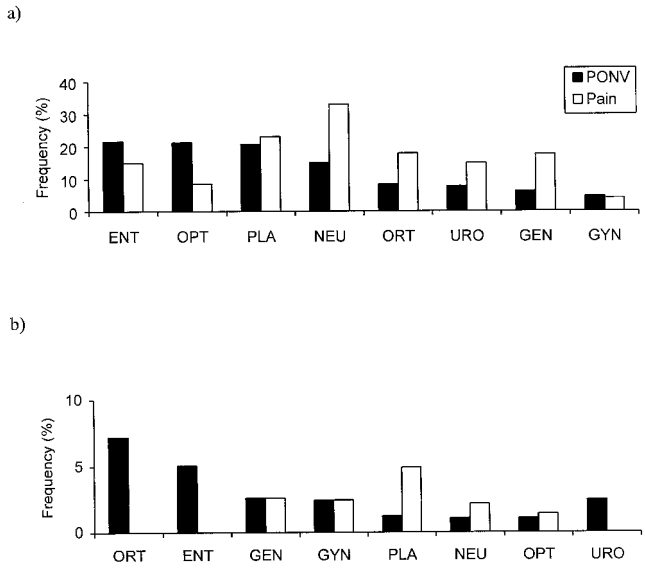

Fig. 1. 1 Frequency of postoperative nausea and vomiting and excessive postoperative pain by type of surgery among patients receiving (a) general anesthesia and (b) monitored anesthesia care. ENT = otorhinolaryngological, GEN = general, GYN = gynecologic, NEU = neurosurgical, OPT = ophthalmologic, ORT = orthopedic, PLA = plastic surgery, URO = urologic.

(relative length of stay 1.11). Patients with CHF had a higher than average incidence of intraoperative and postoperative cardiovascular events (11% and 2.1%, respectively).

Compared with patients undergoing ophthalmologic surgery (reference group for other types of surgery among patients receiving MAC), patients undergoing urologic and ENT procedures stayed 64% and

Table 2. Variable Estimates from the Multiple Linear Regression Models Among Patients Receiving Monitored Anesthesia Care

	Variable estimate (β) ± SE	Relative length of stay (e^{β}) and 99.9% CI	*P* value
Age (10-yr difference)	0.019 ± 0.003	1.02 (1.01–1.03)	0.0001
Sex (M/F)	−0.021 ± 0.009	0.98 (0.95–1.01)	0.03
Congestive heart failure	0.104 ± 0.032	1.11 (1.00–1.23)	0.001
Duration of surgery (30-min difference)	−0.012 ± 0.006	0.99 (0.97–1.01)	0.07
Type of surgery			
Urologic	0.496 ± 0.057	1.64 (1.36–1.98)	0.0001
Otorhinolaryngological-dental	0.429 ± 0.083	1.54 (1.17–2.01)	0.0001
Gynecologic	0.310 ± 0.059	1.36 (1.13–1.65)	0.0001
Neurosurgical	0.301 ± 0.028	1.35 (1.23–1.48)	0.0001
Orthopedic	0.262 ± 0.057	1.30 (1.08–1.56)	0.0001
Plastic	0.257 ± 0.041	1.29 (1.13–1.48)	0.0001
General	0.097 ± 0.041	1.10 (0.96–1.26)	0.019
Ophthalmologic (reference group)	0.000	1.00	
Intraoperative events			
Cardiovascular	0.087 ± 0.023	1.09 (1.01–1.18)	0.0002
Postoperative events			
Nausea/vomiting	0.585 ± 0.043	1.79 (1.56–2.06)	0.0001
Cardiovascular	0.422 ± 0.051	1.53 (1.29–1.80)	0.0001
Excessive pain	0.277 ± 0.039	1.32 (1.16–1.50)	0.0001

$n = 6{,}301$.

54% longer, respectively. Patients undergoing gynecologic, neurosurgical, orthopedic, and plastic surgical procedures also stayed longer than patients undergoing urologic procedures with MAC.

Four types of adverse events were associated with a significantly prolonged postoperative stay among patients receiving MAC. Intraoperative and postoperative cardiovascular events were associated with 9% and 53% increases in the length of stay, respectively. Patients experiencing PONV or excessive pain stayed 79% or 32% longer than patients without these events.

Using the same multiple linear regression models, we also obtained R^2 values for the whole model and the individual variables (Table 3). The R^2 values show what fraction of the variability observed in the outcome variable is explained by the independent variables. R^2_{crude} in Table 3 represents the fraction of variability in the outcome variable explained by the independent variables when these variables were included in the regression models alone, whereas R^2_{adj} represents the fraction of variability in the outcome variable uniquely explained by the given independent variable after adjusting for all other variables included in the model. The full model explained 32% of the variability in length of postoperative stay among patients receiving GA, but it explained only 10% of the variability in the length of stay among patients receiving MAC. Intraoperative and postoperative adverse events had the largest unique contribution to the variability in length of postoperative stay (6% and 5%), followed by type of surgery (5% and 4%) among GA and patients receiving MAC. The duration of surgery accounted for 2% of the variability in length of stay among patients receiving GA. All other variables explained <1% of the variability in length of stay.

The hypothetical elimination of all intraoperative and postoperative adverse events resulted in 9.6% and 3.8% decreases in the mean length of postoperative stay among patients receiving GA and MAC, respectively (Table 4). The hypothetical elimination of all postoperative events resulted in 9.0% and 2.8% decreases in the mean length of stay among patients receiving GA and MAC, respectively. Individual adverse events with the greatest impact among patients receiving GA were excessive pain and PONV, with 4.7% and 4.3% associated decreases in the mean length of stay, respectively. Among patients receiving MAC, the elimination of PONV and intraoperative cardiovascular events had the greatest impact, with 1.3% and 1.2% decreases, respectively.

Discussion

Among the preoperatively available patient-related variables, type of surgery showed the strongest association with length of stay among patients receiving both GA and MAC. Patients undergoing strabismus surgery experienced the longest postoperative stay, followed by patients undergoing transurethral urologic, general surgical, arthroscopic, and ENT/dental procedures among patients receiving GA. A significantly longer stay was associated with procedures resulting in a high incidence of excessive pain and PONV.

Table 3. Percent Variability in Discharge Time Explained by Predictive Variables Based on the Multiple Linear Regression Analysis

	Patients receiving general anesthesia (n = 10,110)	Patients receiving monitored anesthesia care (n = 6,301)
Age	$R^{2crude} = 0.04$, $P = 0.0001$ $R^{2adj} = 0.003$, $P = 0.0001$	$R^{2crude} = 0.001$, $P = 0.03$ $R^{2}_{adj} = 0.005$, $P = 0.0001$
Sex	$R^{2crude} = 0.06$, $P = 0.0001$ $R^{2adj} = 0.0001$, $P = 0.17$	$R^{2crude} = 0.003$, $P = 0.0001$ $R^{2adj} = 0.001$, $P = 0.03$
Preexisting medical conditions	$R^{2crude} = 0.001$, $P = 0.69$ $R^{2adj} = 0.001$, $P = 0.0001$	$R^{2crude} = 0.003$, $P = 0.0001$ $R^{2adj} = 0.002$, $P = 0.001$
Duration of surgery	$R^{2crude} = 0.20$, $P = 0.0001$ $R^{2adj} = 0.02$, $P = 0.0001$	$R^{2crude} = 0.001$, $P = 0.17$ $R^{2adj} = 0.0005$, $P = 0.07$
Type of surgery	$R^{2crude} = 0.21$, $P = 0.0001$ $R^{2adj} = 0.05$, $P = 0.0001$	$R^{2crude} = 0.04$, $P = 0.0001$ $R^{2adj} = 0.04$, $P = 0.0001$
Intraoperative and postoperative adverse events	$R^{2crude} = 0.13$, $P = 0.0001$ $R^{2adj} = 0.06$, $P = 0.0001$	$R^{2crude} = 0.06$, $P = 0.0001$ $R^{2adj} = 0.05$, $P = 0.0001$
Full model	$R^2 = 0.32$, $P = 0.0001$	$R^2 = 0.10$, $P = 0.0001$

Table 4. Percent Decrease in the Mean Length of Postoperative Stay in the Total Population After Hypothetically Eliminating Adverse Events

	Patients receiving general anesthesia (n = 10,110)	Patients receiving monitored anesthesia care (n = 6,301)
Intraoperative		
Cardiovascular		1.2% (0.9%–1.5%)
Postoperative		
Cardiovascular	0.3% (0.2%–0.4%)	0.7% (0.5%–1.0%)
Excessive pain	4.7% (4.3%–5.1%)	0.9% (0.6%–1.2%)
Nausea/vomiting	4.3% (3.9%–4.8%)	1.3% (1.0%–1.7%)
Dizziness	1.3% (1.1%–1.5%)	
Drowsiness	0.2% (0.1%–0.4%)	
All postoperative events	9.0% (8.5%–9.6%)	2.8% (2.3%–3.3%)
All intraoperative and postoperative events	9.6% (9.0%–10.1%)	3.8% (3.3%–4.3%)

In the adult population, strabismus surgery is associated with a relatively high incidence of PONV (20%–30%) (12), which can delay discharge. The frequency of PONV was 20% among ophthalmologic patients under GA in our population. In our center, strabismus patients also underwent a final suture adjustment by the ophthalmologist after he finished his operating room list. Therefore, the duration of stay was partly lengthened for practical reasons. Orthopedic and ENT/dental procedures are frequently painful because of associated bone injury and periosteal damage (7,13,14). Excessive pain can significantly lengthen the postoperative stay. Pain itself, as well as the medications used to alleviate pain, can also induce PONV, which could further delay discharge.

Among the patients receiving MAC, those undergoing urologic and ENT/dental procedures experienced the longest postoperative stay, followed by those undergoing gynecologic, neurosurgical, orthopedic, and plastic surgical procedures. Patients undergoing orthopedic and ENT surgery experienced the highest frequency of PONV, whereas those undergoing plastic surgery and urologic surgery had the highest frequency of excessive pain among patients receiving MAC. Ophthalmologic procedures under MAC (cataract removal) are relatively painless (15), resulting in a fast, complication-free recovery and a short postoperative stay.

Of the 13 preexisting medical conditions, 2 (smoking status and CHF) were significantly associated with length of stay. Smokers were discharged earlier than nonsmokers among patients receiving GA. Smoking is associated with a higher frequency of perioperative respiratory and cardiovascular events, which is seemingly in contrast to our results (16,17), because the occurrence of these events could delay discharge. However, the delay caused by these adverse events could be offset by the antiemetic effect of smoking (16,18), decreasing the frequency of PONV and resulting in a shorter postoperative stay.

Among patients receiving MAC, those with CHF stayed approximately 11% longer than patients without CHF. This corresponds to findings by other investigators, which suggests that cardiac patients have a higher risk of perioperative cardiovascular events

than noncardiac patients (16,17). In our study, patients with CHF also experienced a high frequency of perioperative cardiovascular events. The occurrence of cardiovascular adverse events might require monitoring, therapeutic intervention, or medical consultations, thus significantly extending the postoperative stay.

Occurrence of adverse events had the strongest association with length of stay among patients receiving both GA and MAC. Dizziness, PONV, postoperative cardiovascular events, and excessive pain were the strongest predictors of prolonged stay among patients receiving GA, whereas PONV was the strongest predictor among patients receiving MAC, followed by the occurrence of perioperative cardiovascular events and excessive pain.

Postoperative bleeding did not predict prolonged stay, probably because of its rare occurrence (documented in only 0.1% of the patients). Intubation-related events, respiratory events, and excessive agitation did not interfere with rapid discharge.

Patient characteristics, type of surgery, and type of anesthesia are fixed variables, and although they have a strong influence on the length of stay, they cannot be controlled by the anesthesiologist. The identification of these fixed variables as predictors may be important in planning the operating room schedule.

The seven types of adverse events identified as predictors of prolonged stay are potentially modifiable variables. Excessive pain and PONV are the most common postoperative events predicting prolonged stay, which suggests the importance of appropriate management of these symptoms. The association between length of stay and postoperative cardiovascular events emphasizes the importance of preoperative preparations of cardiac patients.

The sample size of 16,411 patients in our study is substantially larger than that in studies reported earlier, which gives greater robustness to our estimates. In our previous study (7), we studied the recovery pattern of 500 patients and provided descriptive data on specific reasons for delayed discharge. Pavlin et al. (19) examined the determinants of length of postoperative stay in 1,088 patients. Using multiple linear regression models, they determined which patient-, surgery-, or anesthesia-related factors influenced the length of postoperative stay (19). In addition to identifying predictors for prolonged postoperative stay, we also calculated numeric estimates of the impact of perioperative adverse events on the mean length of postoperative stay.

The hypothetical elimination of all adverse events resulted in a substantial decrease (9.6%) in the mean length of postoperative stay among patients receiving GA. The two most significant adverse events contributing to a prolonged stay were excessive postoperative pain and PONV. Among patients receiving MAC, the hypothetical elimination of all adverse events would result in only a moderate decrease (3.8%) in the mean length of stay.

The limitations of our study are that there was no specific information on the prompt availability of an escort and on nursing variables, which were independently associated with length of stay (19). Although we detected a 50-minute difference in the median length of stay among patients receiving GA and MAC, patients receiving GA and MAC differed in patient characteristics and in the type of procedures they underwent; therefore, a meaningful, unbiased comparison of the two patient groups was not possible and was not attempted. Furthermore, the patient population in our center could be different from that in other centers; therefore, our results should be interpreted and generalized with caution.

In conclusion, type of surgery and development of adverse events, such as excessive pain, PONV, dizziness, drowsiness, and cardiovascular events, have the strongest influence on the length of postoperative stay. Patients with CHF and patients undergoing long procedures had a higher risk of a prolonged stay. Optimal preoperative management of patients with cardiovascular risk factors is essential to minimize their likelihood of developing perioperative cardiovascular events. Finally, decreasing the frequency of postoperative symptoms such as pain, PONV, and dizziness will decrease the length of postoperative stay of patients receiving GA. This will remain the greatest challenge and the most important area for anesthesiologists to target.

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