A Novel Index of Elevated Risk of Inpatient Hospital Admission Immediately Following Outpatient Surgery

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ABSTRACT

Hypothesis  Patients with increasing comorbidities are at increased risk of admission to an inpatient facility after outpatient surgery.

Design and Setting  Data from operations performed in hospital-based and freestanding ambulatory surgery centers in New York during 1997 were obtained under the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project.

Patients  Of the 783 558 patients eligible for inclusion in this study, 4351 were discharged directly for short-term hospitalization (1:180), and 19 died (1:41 240). We performed a split-half analysis by randomly assigning the study sample to an analysis half for estimation or a holdout half for testing.

Main Outcome Measures  We developed an outpatient surgery admission index from independent predictors of immediate hospital admission using the following point values: 65 years or older (1), operating time longer than 120 minutes (1), cardiac diagnoses (1), peripheral vascular disease (1), cerebrovascular disease (1), malignancy (1), seropositive findings for human immunodeficiency virus (1), and regional (1) or general anesthesia (2).

Results  Increasing scores were associated with higher odds of admission relative to scores of 0 or 1. For scores of 4 or higher, the odds ratio was 31.96 (95% confidence interval, 26.29-38.86), and 2.8% of these patients were discharged to the hospital. For the holdout half of the data set, scores of 4 or higher had an odds ratio of 34.62 (95% confidence interval, 28.55-41.97).
Conclusion  The proposed outpatient surgery admission index provides an evidence-based guide to assist clinicians and the health care systems in which they work in identifying patients at higher risk of immediate hospital admission.

INTRODUCTION

Outpatient surgery has increased dramatically in the United States during the past 2 decades, from 16% in 1980 and 50% in 1990 to an estimated 63% in 2000. During this period, the patients' medical complexity and the range of alternate ambulatory procedure settings grew. The advantages of surgery outside the hospital setting, such as greater convenience and often less expense, are considerable for those who may safely be discharged to home. However, these potential advantages disappear when patients require emergency care or unplanned admissions following ambulatory surgery. Relentless pressures to cut costs and to provide services in the least costly setting may, in the absence of contrary evidence, constrain clinical judgments regarding the most appropriate location for a patient's surgical care. Although the risk of hospital admission after outpatient surgery is low, the time to response may be critical for those patients requiring intensive care. Surgical settings distant from a hospital may be convenient for patients; however, some patients may require transport to the hospital, and that may entail additional risk owing to the delay in treatment. In contrast, hospital-based facilities contain an entire code team with specialty medical and surgical personnel available to respond to unplanned critical events. Media accounts of adverse events and state-level actions have drawn attention to the safety of procedures performed in "surgicenters" and physicians' offices. Consequently, identification of factors associated with higher rates of hospital admission immediately following ambulatory surgery would provide critical information to clinicians and the health systems managing patient care regarding the most appropriate surgical setting.

Unplanned admissions after ambulatory surgery are thought to occur in approximately 0.5% to 1.5% of cases. As the volume and complexity of procedures performed in outpatient settings increase, the accuracy of this reference standard and its applicability to subsets of current patients with possibly more medically complex conditions are questionable. Previous research has demonstrated patient distress lasting 1 week or longer following ambulatory surgery; for some patients, their condition is more acute and results in a direct hospital admission. One hospital population–based study reported a 0.85% rate of unplanned admissions covering 3 fiscal years. Most reports, however, are specific to procedures or to specialties, such as laparoscopic cholecystectomy (3.4% of 731 consecutive patients resulted in admissions) and tonsillectomy and adenoidectomy (0.487% hemorrhage rate based on 3 years of data from 2 hospitals). Direct admissions from a surgical day-case unit during a 5-year study varied by service: 0.80% for gynecologic, 0.79% for orthopedic, and 0.57% for general surgery services. The main reported risk factors for hospital admission are general anesthesia, duration of the procedure, uncontrolled pain, and bleeding. Some of these risk factors may be proxies for surgical and/or case complexity; however, no generally accepted measure of surgical complexity currently exists.

Although the absolute rate of adverse events following ambulatory surgery has been low, the increasing number and complexity of cases performed in the outpatient arena make the identification of factors associated with elevated relative risk critical. Using outpatient surgical encounter data from the Agency for Healthcare Research and Quality (AHRQ), we report (1) the rates of direct admission to a short-term hospital facility, (2) death rates during the ambulatory procedure, and (3) a novel index to identify individuals at highest risk for hospital admission immediately following ambulatory surgery.

METHODS

The AHRQ sponsors a federal and state industry initiative, the Hospital Cost and
Utilization Project (HCUP), to construct annual state ambulatory surgery databases. New York State data for 1997 contain more than 1.1 million discharges, with information on each patient's discharge status, age, medical diagnoses, type of anesthesia used, and procedure; the AHRQ also provided an algorithm to identify freestanding vs hospital-based ambulatory surgery centers. The AHRQ provides an additional diagnostic coding system to facilitate aggregating these data into clinically meaningful groups: the Clinical Classification Software. To our knowledge, this was the only publicly available data set that includes such an extensive number of procedures, amount of perioperative information, and number of patients across broad age and insurance categories when the analysis was initially undertaken.

Reporting options for the patients' immediate disposition at discharge from the outpatient surgery facility range from "routine" and "short-term hospitalization" to "against medical advice" and "died." There are no data on the patients' origins; consequently, discharges to skilled nursing facilities, intermediate care facilities, another type of facility, or home health care may reflect a return to the patient's situation prior to their ambulatory surgery rather than a decrement from the patient's presurgical situation. To assess and to quantify risk factors for an adverse disposition at discharge, we excluded all discharges other than routine or short-term hospitalization to reduce this potential for bias and to provide a conservative estimate of the extent of and associated risk factors for such discharges. We evaluated the reported deaths (n = 19) separately; these were deaths during the same-day procedure, not the often-cited 30-day surgical mortality. Although the HCUP data set included cardiac catheterizations and endoscopies, they are excluded from the present analyses because they do not represent surgical procedures routinely performed in an operating room or with the assistance of an anesthesia provider. Similarly, cataract operations are excluded because of their previously reported low rate of major morbidity and mortality.

To describe this study population's illness burden and to control for differences in risk potentially attributable to medical condition(s), an index of chronic conditions was developed from administrative data using the modification by Deyo et al (the Deyo modification or replication) of the Charlson Comorbidity Index. Deyo et al assessed medical comorbidities by International Classification of Diseases, Ninth Revision, Clinical Modification codes in Medicare medical services claims data for the year before an index hospital admission. The HCUP data do not identify conditions as preexisting. The Deyo replication, which used only admission data, resulted in similar findings (although with fewer scores at the high end of the range); consequently, we used the diagnosis recorded on the procedure day. Data were analyzed using SAS System statistical software (release 8.2 for Windows; SAS Institute Inc, Cary, NC).

RESULTS

The total HCUP data set of ambulatory surgery in New York State for 1997 contained 1,107,103 discharges, of which 95.0% were routine and 0.4% were for short-term hospitalization. After excluding cardiac catheterizations, endoscopies, cataract operations, and discharges other than routine or short-term hospitalization, we included 783,539 patients in this study and an additional 19 patients who died. Using the full data set, the modified Deyo comorbidity score ranged from 0 to 5 and was substantially less for freestanding (0.040) vs hospital-affiliated (0.154) surgical centers. Mean operating time was shorter in freestanding facilities (48 vs 63 minutes), although the average patient age was similar (46.1 vs 45.4 years).

The data set was subsequently randomized into the following 2 subsets: one half, the analysis data set (392,107), was used for analysis and model development; the other half, the holdout data set (391,415), was used for validation. Descriptive data are reported for the analysis data set, and the validation data set is similar.

Most of the subjects were female (57.0%), the overall mean age was 45 years, and the preponderance of
cases (95.0%) were performed in a hospital-based facility (Table 1). General anesthesia was used to perform 35.9% of the cases (n = 140,615). Operative time was 1 to 2 hours in 31.3% of the cases, and 10.1% of the cases exceeded 2 hours.

### Table 1. Descriptive Statistics of the Analysis Half of the Data Set Ambulatory Surgery Center Patients in New York State in 1997

Most of the patient discharges in the analysis data set were routine (99.5%); however, 2,178 patients were discharged directly for short-term hospitalization (0.6%), and an additional 8 died (1 in 49,012).

Single factors with elevated odds for hospital admission include duration of operative procedure, use of regional or general anesthesia, and certain medical conditions similar to those in the Deyo modification of the Charlson Comorbidity Index: myocardial infarction, peripheral vascular disease, cerebrovascular disease, malignancy, and seropositive human immunodeficiency virus (HIV-positive) status. As an individual risk factor, being 65 years or older was not associated with a higher risk for hospitalization; however, in models that controlled for operative duration, anesthesia, and specific medical conditions, the odds for hospital admission increased at each 5-year increment in age starting at 65 years. For subsequent analyses, recorded diagnoses of myocardial infarction, heart failure, dysrhythmias, nonspecific chest pain, and atherosclerotic heart disease were grouped as a single cardiac category because of the small number of patients with these specific diagnoses.

Logistic regression equations modeling short-term hospitalization were calculated using SAS statistical software (version 8.02; SAS Institute Inc). The complete model (Table 2) includes independent variables for age (≥65 years), operating time (60-120 or >120 minutes), medical diagnoses (cardiac disease, peripheral vascular disease, cerebrovascular disease, malignancy, or HIV-positive status), and type of anesthetic (regional or general).

Based on a prior belief that this is an established clinical risk factor, coronary artery disease was included, despite the statistically nonsignificant finding for it as a risk factor in the analysis data set. Based on the results of these models, a summary score was developed to identify patients at elevated risk for short-term hospitalization. Similar to the index developed by Boersma et al, this outpatient surgery admission index (OSAI) is calculated by assigning 1 point each for being 65 years or older; having an operating time longer than 120 minutes, cardiac diagnoses, peripheral vascular disease, cerebrovascular disease, malignancy, and HIV-positive status; and using regional anesthesia. Because of the higher odds ratio for using general anesthesia, 2 points are assigned for it. The OSAI (Table 3) quickly identifies patients with higher risk for immediate hospital admission: patients with a score of 3 (9.1% of the sample) have 21 times the odds of those with a score of 0 or 1, and patients with scores of 4, 5, or 6 (1.9% of the sample) have 32 times the odds of the reference group. The OSAI for the analysis half is calculated and reported in Table 3 as the following 4 separate levels: 0 and 1 (taken together as the reference values), 2, 3, and 4 through 6 (taken together because of the small sample size at the extremes). Each odds ratio is for that level or for an OSAI compared with a score of 0 or 1, where 0 or 1 constitutes a single category and the reference value. The same program was applied to the holdout data set and resulted in the odds ratios for the holdout half reported in Table 3.
but to demonstrate that the scores determined by the weights given in the legend of Table 3 produce a similar result for odds ratios with both the analysis and the holdout data sets. In addition, the relative distribution (similarity) of the number of subjects can be compared by each OASI level between the analysis and the holdout data sets.

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Table 3. Odds Ratios for Short-term Hospitalization Based on the OSAI, Comparing the Analysis and Holdout Data Sets*

The OSAIs calculated for the holdout half of the data set produced comparable increases in the odds of immediate admission to a hospital for each higher index (Table 3).

**COMMENT**

Public health policy and corporate incentives have encouraged ambulatory surgery; its growth has been one of the most rapid and fundamental changes in medical care during the past 20 years. In addition to ambulatory surgery's effect in North America, it is beginning to accelerate in other countries as a means to enhance access and control costs. However, this extraordinary diffusion of technology has occurred without the outcome assessments that are usually associated with so fundamental a change in health care practice and policy. Research into issues ranging from appropriate preoperative assessment to delineation of risk factors has consistently lagged behind the clinical expansion of this phenomenon.

Adverse surgical outcomes are a manifestation of several factors, including the patient's medical status, the specific anticipated surgery, and the anesthetic technique. The OSAI, based on data available from an administrative data set, is a summary index that identifies patients at high risk for an adverse disposition after ambulatory surgery. Adding the number of risk factors present in each of the patients included in the HCUP data set resulted in the highest score of 6; the OSAI identifies increasing risk for a patient's discharge to the hospital rather than home. This is not to suggest that patients with an OSAI of 4 or higher should universally undergo inpatient surgery; rather, clinicians should consider performing surgery on these patients in a setting where there is additional medical support to treat acute adverse events and to permit rapid transfer to an inpatient hospital. For this small subset of patients, less than 2% in our analysis data set of outpatient operations, the outpatient hospital may represent appropriate risk management and be the preferable locale. Some of these admissions may have been planned and do not represent an adverse outcome. Surgery in locations distant from a hospital, such as freestanding ambulatory surgical centers or physicians' offices, might result in increased, avoidable morbidity or mortality, although such findings are difficult to demonstrate given our predominantly outpatient hospital data set. Based on the observed differences in comorbidity scores between the outpatient hospital and freestanding centers in the total sample, there appears to have been appropriate patient selection in the surgical locations selected. The absence of deaths in the freestanding centers is consistent with the much smaller number of procedures performed in them and the lower comorbidity in their patient cohort.

In a diverse group of procedures and outpatient centers, all-cause mortality in the operating room or postanesthesia care unit after outpatient surgery was 1 in 49 012. All deaths occurred in outpatient hospital-based surgical centers. All-cause mortality in these data is 8-fold higher than informal estimates of anesthetic-related mortality of 1 in 200 000 to 400 000. However, although this is the first large-scale empirical estimate of mortality in a diverse group of outpatient operations, it is consistent with data from an Internet-based quality improvement survey (1 death in 58 810 procedures) and lower than mortality estimates in ambulatory surgery centers in the state of Florida.17-19 A review of the primary procedures in
which fatalities occurred revealed no underlying theme; they included such minor procedures as hernia repair and cataract surgery, which should remind the clinician that any patient may be at risk. In addition, the cause of mortality could not be determined from the data set. The diversity of surgical procedures and small number of deaths make it impossible to define predictors in this cohort of patients. The data provide a minimal rate of adverse events or death immediately following outpatient surgery; as such, this study provides a benchmark to evaluate future outpatient surgery disposition rates.

Our focus has been admission to an inpatient facility immediately following outpatient surgery. The actual rate of admission (0.6%) is similar to that of previous studies; however, this data set allows us to define a subset of patients at highest risk for admission. The analyses identified a set of risk factors associated with increased odds that a patient would require hospital admission immediately following surgery in the outpatient setting. These factors were used to develop a risk index for hospital admission, wherein increasing numbers of factors are associated with a markedly increased risk. The low absolute rate of direct hospital admissions means that a substantial increase in the odds ratio, as identified by the OSAI, will still be a low proportion of all possible cases. Consequently, the number of false-positive findings require this model to be a supplement to clinical judgment, suggesting cases where a higher level of evidence concerning the safety of ambulatory surgery is appropriate. The limited specificity of this model is offset by its simplicity and reliance on commonly available data. Because the original Charlson Comorbidity Index was developed for medical patients, we attempted to identify those individual conditions within our modified morbidity index that were associated with higher rates of hospitalization in ambulatory surgical patients. Specifically, the presence of neoplastic disease, advanced age, and cerebrovascular disease accounted for much of the relationship. This is consistent with other studies in which these conditions have been shown to influence the risk of morbidity and mortality after surgery.\textsuperscript{20-22} With respect to neoplastic disease, it may also reflect the nature of the procedures, eg, line insertion for chemotherapy, in which there may be a planned admission. The presence of HIV also represents a higher risk stratum, which may reflect the more systemic nature of these patients' disease. The one exception to the association between comorbidity and adverse outcomes relates to cataract surgery.\textsuperscript{23} For this particular surgical procedure, there was no association. A recent large-scale randomized clinical trial was unable to document the value of routine preoperative testing for patients undergoing cataract surgery.\textsuperscript{24} Taken together, these studies and our findings suggest that cataract surgery is unique and may represent a very-low-risk procedure in which the presence of significant comorbidity does not influence the need for hospital admission or the risk of death from the procedure.

In addition, the absence of diseases that may have been expected to be associated with higher risk for hospital admission is, at first, counterintuitive. Our study sample results from a prior triaging of patients by clinicians who have judged these specific individuals to be candidates for successful ambulatory surgery; consequently, they may represent healthier persons with the reported diagnoses. Given the multiple studies that document higher perioperative morbidity and mortality for patients with cardiovascular disease, we chose to leave this risk factor in the final model, despite the absence of statistical significance.\textsuperscript{25}

We identified surgical time longer than 120 minutes and the need for general anesthesia as strong predictors for the risk of admission. This finding may reflect actual increased risk related to these factors or may reflect some underlying, more complex surgical process requiring a longer general anesthetic. Our sample included a wide range of procedures, but there is no well-defined summary measure of surgical complexity available. These 2 factors (operating time and general anesthesia) taken together may represent a surrogate for surgical complexity. Postoperative nausea and vomiting constitute one of the most common causes of admission and occur more frequently with general anesthesia.\textsuperscript{26} Therefore, caution is indicated when extrapolating the implications of these risks factors.

Our analysis of the influence of the type of anesthesia is limited by the large number of patients with the category "other." The specific type of anesthesia—or whether any anesthesia was administered to this group of patients—is unknown. Therefore, the actual importance of anesthesia as a risk factor also should be assessed with caution.
This work has several limitations. Our data set represented facilities predominantly associated with outpatient hospital settings. This might influence the type of patients and procedures observed, as well as the practice patterns concerning the acceptance of direct admissions from these facilities. Most of these procedures are from outpatient hospital settings, and they may therefore not reflect findings for freestanding facilities. Second, we used public access databases, which are focused on discharge diagnosis and are not prospective in nature. Therefore, the accuracy and completeness of procedural and diagnostic codes may vary among facilities, and that could influence the final results. Third, approximately 20% of the anesthetics were classified as "other" without any clear indication of the presence or type of anesthesia used. Finally, we cannot determine whether these admissions were planned or unplanned, which may explain the inclusion of HIV-positive status as a risk factor, because the surgery may be part of a planned admission. Subsequent prospective studies using this index would address some of these shortcomings.

In conclusion, we have identified factors that may be associated with increased rates of hospital admission immediately after surgery in the outpatient setting. Based on these factors, we have developed a risk index in which increasing scores are associated with increasing odds of direct hospital admission following ambulatory surgery. Including this information in physician and patient decisions regarding the surgical setting may lead to enhanced patient safety and high-quality care. In addition, this scale could be used for risk adjustment as a means of benchmarking the admission rates in different outpatient surgical settings. As the first of what we hope will be many reports on this topic, the findings of this study point to the need to consider these factors in deciding the appropriate location for care and the importance of a structured preoperative evaluation system that provides this information in a complete form and on a timely basis for review.

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