Published in final edited form as:

J Cardiothorac Vasc Anesth. 2016 June ; 30(3): 671–679. doi:10.1053/j.jvca.2015.12.019.

Ambulatory Medical Follow-Up in the Year After Surgery and Subsequent Survival in a National Cohort of Veterans Health Administration Surgical Patients

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Abstract

Objectives—Among a national cohort of surgical patients, the authors analyzed the association between medical follow-up during the first postsurgical year and survival during the second postsurgical year.

Design—Retrospective cohort study.

Setting—US Veterans Hospitals.

Participants—The study included adults who received surgical care in any Veterans Health Administration facility from 2006 to 2011 who were discharged within 10 days of surgery and who survived for at least 1 year postoperatively.

Interventions—None.

Measurements and Main Results—The association between the receipt of nonsurgical ambulatory medical care during the first postoperative year and the hazard of death during postsurgical year 2 was measured. Among 236,200 veterans, 93.2% received a nonsurgical medical follow-up visit in postsurgical year 1; of those, 5.1% died during postsurgical year 2. This compares with 9.4% year-2 mortality among patients lacking year-1 medical follow-up ($p < 0.0001$). After adjustment for confounders, medical follow-up in postoperative year 1 again was associated with a significantly lower hazard of death in postoperative year 2 (hazard ratio 0.71; 95% confidence interval 0.66–0.78). Sensitivity analyses examining patient subgroups stratified by procedural specialty demonstrated comparable findings. The results were robust under a variety of simulated scenarios of unmeasured confounding.

Conclusions—Within a national cohort of US veterans who presented for surgery, those who received nonsurgical ambulatory follow-up during the first postoperative year demonstrated lower all-cause mortality in the subsequent postoperative year than those who did not receive the same type of follow-up care. Interventions focused on postoperative care coordination of outpatient medical follow-up may have the potential to improve long-term postoperative survival.

Keywords

care transitions; healthcare delivery; postoperative care; perioperative surgical home

Improving preventive medical care within the US healthcare system is a public health priority,¹ and recent research has highlighted possible contributions that the surgical care episode can provide to a patient's larger preventive care medical team. For example, studies of "prehabilitation,"² preoperative smoking cessation,^{3–7} and postoperative referral for identification and treatment of poorly controlled hypertension^{8–10} have suggested that an opportunity exists for substantial longitudinal cardiovascular risk factor reduction when the scope of concern by perioperative physicians is expanded beyond their traditional focus on the intraoperative and intensive care periods. This expanded scope of concern, as one component of the emerging concept of the perioperative surgical home,^{11–15} represents a new practice paradigm for anesthesiologists and other perioperative care providers, but it lacks significant long-term outcomes data examining the relationship among surgical care episodes, medical follow-up, and mortality.

The Institute of Medicine has long recognized the specialty of anesthesiology as a leader in the effort to improve patient safety, but the focus of Anesthesiology's efforts largely has been patient safety during the immediate perioperative period.¹⁶ Yet, many chronic health factors that either go unrecognized or undertreated in the outpatient setting also may be apparent during the perioperative care period, and it remains unknown whether expanding the scope of perioperative medicine to include post-surgical care coordination to address such chronic health problems potentially could improve long-term outcomes.

The attempt to improve long-term health is of particular relevance for cardiothoracic and vascular anesthesiologists because cardiovascular disease remains the leading cause of death among anesthesiologists' patients both perioperatively and long after the surgical encounter. Moreover, several cardiovascular risk factors, including smoking, high blood pressure, and hyperlipidemia, are common and potentially modifiable through care coordination efforts initiated by anesthesiologists. In the process of studying the feasibility and efficacy of such interventions, the association between postsurgical outpatient medical care and subsequent outcomes has not been studied sufficiently. Accordingly, in this observational study, the authors sought to determine whether nonsurgical medical follow-up during the first postoperative year was associated with a subsequent difference in all-cause mortality during postoperative year 2.

METHODS

After appropriate Institutional Review Board approval (HIC Protocol 1002006277), the authors created an electronic health record (EHR)-based historic cohort of patients >21 years

who received surgical care at a Veterans Health Administration (VHA) healthcare facility between September 2006 and August 2011, using the VHA Corporate Data Warehouse national surgeries extract for cohort identification. The resulting cohort is being used in several studies examining the relationship between perioperative assessments and postoperative outcomes.¹⁰ For this study, the exposure of interest was whether the patient had at least 1 nonsurgical medical visit (described in the following) within the VHA in the 365 days after surgery. To minimize confounding due to perioperative morbidity and mortality, only patients who were discharged within 10 days of surgery and who survived for 365 days after surgery were included in the analysis. For patients who were alive at the end of this 1-year exposure period, the outcome of interest was death occurring within the subsequent 365-day period (ie, a total of 2 years after each index surgery). Unadjusted and adjusted Cox proportional hazard ratios (HRs) were calculated to determine whether medical clinic follow-up during the first postoperative year would be associated with a difference in subsequent all-cause mortality during postoperative year 2.

Data Sources and Variables

Patients were identified by their unique Patient Integration Control Number assigned by the VHA Master Veteran Index; and for patients with multiple surgeries, 1 encounter per patient was selected at random. Demographic information, surgical specialty, American Society of Anesthesiologists (ASA) Physical Status score,¹⁷ International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) inpatient diagnostic codes dating from January 2000 to the index surgery date were extracted from the VHA Corporate Data Warehouse for inclusion in this analysis. Body mass index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters using the most proximate values to the date of surgery. Extreme heights and weights considered to be clinical outliers (ie, heights <58 inches or >80 inches and weights <80 pounds or >499 pounds) were excluded from BMI calculations. Date of death was determined as listed in the VHA Vital Status Master File using data as provided from the Social Security Administration (SSA). Comparisons between mortality data from the SSA Death Master File and the National Death Index have demonstrated good reliability.¹⁸ Specifically, 92.1% of National Death Index deaths were found in the SSA Death Master File with 95.9% concordance by date and 99.6% concordance by month and year.¹⁸

Ambulatory visit data for the 365-day postoperative period were collected by querying the VHA National Patient Care Database Medical SAS Outpatient Datasets¹⁹ as has been described in prior reports.²⁰ Clinic types were identified by the stop codes associated with each visit. A stop code for any of the following clinics was considered positive for the exposure of interest: primary care, cardiology, pulmonology, endocrinology, diabetes, hypertension, women's, infectious disease, and geriatric primary care. This outpatient clinic list was based on the NEXUS clinic group as defined by the VHA External Peer Review Program, with the addition of infectious disease clinics. NEXUS clinic visits are used to determine which veterans are receiving primary care across the VHA system. Infectious disease clinics were included because they are the primary care source for many veterans with human immunodeficiency virus.

Statistical Analysis

An unadjusted survival analysis was performed to determine survival during postsurgical day 366 through postsurgical day 730, comparing the group of patients who received nonsurgical medical clinic follow-up in the 365 days after surgery with those who did not. For the unadjusted analysis, the Kaplan-Meier method with a log-rank test for comparison was used. To account for the intracluster correlation of observations within each VHA facility, a Cox regression model with a shared frailty (ie, random effect) factor²¹ was fit with adjustment for demographics (age, sex, self-identified race, and Hispanic ethnicity), BMI, length of stay, and the surgical specialty of the proceduralist. Race was coded as black versus all others, and ethnicity was coded as Hispanic versus all others. The authors also adjusted for smoking status as an ever/never variable. In addition to chronologic age in years, the authors included a variable to adjust for age ≥ 65 years as a dichotomous variable. This variable was included to account for previously described discontinuities in survival and insurance status that have been documented to occur at age 65 coincident with the sharp increase in Medicare enrollment.^{22,23}

To account for baseline comorbid status, the authors controlled for the following 3 types of variables: (a) ASA Physical Status score as recorded on the day of surgery by the treating anesthesiologist, (b) the Charlson Comorbidity Index²⁴ (CCI), and (c) the Veterans Aging Cohort Study (VACS) comorbidity groupings.²⁵ The CCI was calculated using pre-operative inpatient ICD-9-CM comorbidity data beginning from the year 2000 through the index surgery date. Whereas the CCI calculation relied on a cumulative measurement of ICD-9-CM codes, the ASA Physical Status score was provided by the treating anesthesiologist on the day of surgery as a single overall representation of the patient's comorbid status. Thus, the 2 scores represented independent determinants of a patient's overall comorbid burden that were derived from separate administrative and clinical data. For the VACS comorbidity groupings, the following conditions were included in the model: alcoholism, anemia, anxiety disorder, atrial fibrillation, bipolar disorder, cerebrovascular disease, congestive heart failure, coronary artery disease, diabetes, hyperlipidemia, hypertension, human immunodeficiency virus, liver disease, lung disease, depression, peripheral vascular disease, post-traumatic stress disorder, psychosis, renal disease, and substance abuse.

For each of these conditions, the authors required at least 2 outpatient ICD9-CM codes or 1 inpatient code for each comorbid grouping to qualify as positive for the condition, as has been described previously.^{26,27}

Finally, the year of surgery was included in the primary analysis to control for increases in EHR penetrance and other potential time-dependent confounders during the study period. Statistical analyses were conducted with the use of SAS software, version 9.4 (SAS Institute, Cary, NC).

Sensitivity Analyses

Several sensitivity analyses were performed to assess the robustness of the findings as follows: additional random-effects Cox regression models were performed separately for 7 subsets of patients undergoing cardiothoracic, vascular, otolaryngologic, orthopedic, general

surgical, neurosurgical, and urologic procedures to determine whether observed associations would be specific to one particular surgical population. Those separate HRs then were pooled together using a random-effects meta-analysis technique²⁸ and visualized graphically by a forest plot implemented in the “meta” R package.²⁹ The degree of heterogeneity among different specialties was quantified using the I^2 statistic. These 7 specialty subsets were chosen because each contained at least 500 mortality events, ensuring stability (ie, enough events to ensure precise parameter estimates) of the models. Cardiac and thoracic patients were grouped into this analysis because of the small number of cardiac patients who lacked internal medicine follow-up.

Finally, in an additional sensitivity analysis, the authors sought to address distortion from unmeasured and poorly measured confounders³⁰ by applying the method of Lin et al,³¹ as has been done in prior reports.³² The simulation sought to answer the question of how prevalent and powerful an unmeasured confounder would have needed to be to erase the observed differences. In modeling the characteristics of a hypothetical unmeasured binary confounder that could have accounted for observed survival differences between patients with ambulatory follow-up versus those without, a broad range of plausible values for the effect size and prevalence of such an unmeasured confounder were simulated.

RESULTS

Primary Analysis

A total of 385,790 patients were included in the original surgical cohort. Of those, 261,159 had a valid discharge date within 10 days after the date of surgery, 236,200 of whom survived the full 1-year exposure period to be eligible for the year-2 survival analysis (Fig 1). The mean ($\pm$ standard deviation) age at surgery was 62.0 ($\pm$ 12.2), 93.3% were male, the mean ($\pm$ standard deviation) BMI was 29.3 ($\pm$ 6.2) kg/m², and 17.2% self-identified as black or African American. The majority of subjects (59.7%) scored an ASA Physical Status of 3. A description of the included cohort stratified by exposure status is listed in Table 1.

Among the 236,200 patients included in the analysis, 219,942 (93.1%) had a nonsurgical medical follow-up visit in postsurgical year 1. The patients who had medical follow-up in the first postoperative year tended to be older; more frequently underwent cardiac, thoracic, or vascular surgery; and were more likely to be rated an ASA Physical Status of 3 or higher than those who lacked follow-up (see Table 1). Nevertheless, among the group with medical follow-up in year 1, 11,217 (5.1%) died during year 2. This compared with the group of 16,258 patients who lacked medical follow-up, among whom year-2 mortality was observed in 1,528 (9.4%) (see Kaplan-Meier survival curve in Fig 2; $p < 0.0001$).

After adjustment for confounders in the Cox frailty model, patients who received medical follow-up in year 1 demonstrated a significantly lower hazard of death in postoperative year 2 compared with those who lacked such follow-up (HR: 0.71; 95% confidence interval [CI] 0.66–0.77, $p < 0.0001$) (Table 2). The effect sizes (ie, HR [95% CI]) of medical follow-up on mortality were similar and comparable in patients presenting for cardiothoracic (HR: 0.72, 95% CI: 0.67–0.77, $p < 0.0001$) or vascular procedures (HR: 0.73, 95% CI: 0.61–0.88, $p = 0.0006$) and in the other 5 specialties included in the sensitivity analysis (see Table 2).

The overall pooled HR for year-2 mortality among those who received medical follow-up in year 1 was 0.70 (95% CI: 0.67–0.74) as shown in the forest plot in Fig 3. No heterogeneity among specialties was identified ($I^2 = 0$, Cochran's Q test $p = 0.79$).

Regarding unmeasured confounding, the authors conducted a simulation to determine the HRs for a hypothetical confounder, whose prevalence in both groups of patients (with follow-up v without follow-up) varied over a wide range of possible values and that could have accounted for the observed survival difference in the cohort (Fig 4). As an example, the authors determined in the simulation that if an unmeasured confounder had been present in 10% of patients who received medical follow-up care during the year after surgery and had been present in 30%, 40%, or 50% of the patients who did not have a follow-up visit, it would have had to carry a relative hazard of death of 3.5, 2.6, or 2.1, respectively, to account for the observed survival differences. The simulation demonstrated that the observed lower hazard of death in patients receiving medical follow-up was robust in the face of a variety of relatively extreme scenarios of unmeasured confounding.

DISCUSSION

In this examination of postsurgical mortality among a national cohort of veterans receiving care at VHA facilities, nonsurgical medical follow-up in the year after surgery was associated with a substantially lower hazard of all-cause mortality in the subsequent postsurgical year. These findings were consistent across subsets of patients undergoing cardiothoracic, vascular, otolaryngologic, orthopedic, general surgical, neurosurgical, and urologic procedures and were strongly resistant to simulated conditions of unmeasured confounding.

These data should not be interpreted to suggest that there is a simple and direct causal effect between medical follow-up during the first postsurgical year and longer life. Nevertheless, care coordination to promote medical follow-up after a surgical encounter is one aspect of patient care that is both amenable to intervention and worth investigating to define its possible effects on long-term postoperative morbidity and mortality. System-level interventions directed toward improving care coordination of surgical patients so that observations and assessments made by perioperative care providers can be integrated into the larger care of the patient deserve further study. Possible interventions could include, for example, initiatives to screen surgical patients for a range of modifiable health risk factors including smoking,⁴ hypertension,^{8–10} diabetes, and mental health disorders such as depression³³ that affect the perioperative course but that may not have been fully addressed by primary care providers or that have remained poorly controlled due to patterns of patient nonadherence or treatment resistance that emerge during the perioperative period.³⁴ Such a shift in practice standards among perioperative clinicians thereby might contribute to the prevention of preventable morbidity distant in time from the surgical care episode.

A recent study provided additional suggestive evidence in this regard.⁹ In that study, it was observed that 6.8% of surgical patients who lacked timely ambulatory follow-up demonstrated mean preoperative systolic blood pressures ≥ 160 mmHg. It would be reasonable to speculate that such patients might obtain a survival advantage if a care

coordination intervention promoting ambulatory follow-up for improved longitudinal blood pressure control could be implemented successfully.³⁵ Another study using the present dataset documented that more than 14% of patients lacking a preoperative history of hypertension subsequently demonstrated blood pressures in the hypertensive range in the year after surgery.¹⁰ Prior studies have demonstrated improved survival after implementation of programs to improve preventive healthcare.³⁶

The authors conjectured that the decreased mortality observed in this study was in part due to the fact that people who make medical appointments and see their doctor tend to exhibit a variety of related healthy lifestyle factors that together contribute to improved outcomes. A similar type of effect perhaps was seen most famously in the apparent causal association between estrogen replacement therapy and cardiovascular protection, demonstrated in the Nurses Health Study, that subsequently was ascribed to other healthy behaviors more commonly present among women who went to the doctor and were taking estrogen replacement.^{37,38} However, unlike in the Nurses Health Study, this study did not suggest the benefit of a new pharmacologic treatment. Rather, if indeed healthy behaviors including better preventive healthcare postoperatively explain part of the observed survival benefit, then the potential for promoting such medical visits would represent an important interventional opportunity for anesthesiologists and other perioperative clinicians to improve long-term survival outcomes among surgical patients.

Prospective interventional trials studying the feasibility and efficacy of care coordination interventions to improve postoperative primary care follow-up are needed. As a group, anesthesiologists have shown a high degree of concern for issues of public health, but they lag behind other specialties in the proportion of practitioners reporting engagement in specific actions devoted to public health promotion in their individual practice.³⁹ This study suggested that care coordination interventions at the time of surgery provide a promising avenue to merge anesthesiologists' public health concerns into their future anesthesia practice.

Several limitations of this study deserve mention. As with all retrospective, observational database research, the validity of the data sources is of paramount importance.³⁰ In assessing validity of the data used, it was reassuring to note that the findings reported here were based on models that adjusted for measures of preoperative comorbid burden derived from the following independent data sources: ASA Physical Status score, which was based on day-of-surgery clinician assessment, and CCI and VACS comorbidities were determined on the basis of administrative disease coding. Using these methods together, the primary association was less likely to be confounded by baseline comorbidity. It also is worth noting that follow-up appeared to be lower in earlier years, among females and African-Americans, and higher among patients who had cardiothoracic or vascular procedures. Regarding year of surgery, it is known that increased EHR penetrance has occurred over the course of the study period, and this fact likely explained the apparent increase in follow-up seen in later years. Regarding females, it also is known that they are less likely to receive primary care within the VHA compared with males. The finding of a significant effect of race on follow-up deserves further dedicated study, and the finding of increased follow-up among cardiothoracic and vascular surgery patients was consistent with the observation that patients

who were sicker at baseline were more likely to seek ambulatory follow-up in the year after surgery. Each of the aforementioned factors (eg, year of surgery, sex, race, and type of surgery) were included in the models, and thus it should be expected that bias from these patterns was addressed within the analyses.

To further address the possibility of confounding, the final sensitivity analysis provided some reassurance that the reported HR demonstrated substantial resistance to distortion by a hypothetical unmeasured confounder (see Fig 4). Still, the results should be interpreted as a hypothetical association rather than as a confirmed causal relationship. Secondly, the analysis was limited to care episodes that occurred within the VHA system. Patients who sought postoperative care outside of the VHA may have been misclassified in the analysis and potentially could have led to bias in the results. However, due to the magnitude of the observed effect and its resistance to unmeasured confounding in the simulations, the mortality differences observed herein were unlikely to disappear with the inclusion of any additional variable of plausible prevalence and effect size.

In conclusion, within a national cohort of US veterans presenting for surgery, medical follow-up within the VHA in the year after surgery was associated with a lower hazard of all-cause mortality in the subsequent postoperative year. Care coordination interventions aimed at integrating the surgical care episode into subsequent medical follow-up care have the potential to improve long-term postoperative survival.

Acknowledgments

This work was supported in part by the National Heart, Lung, and Blood Institute of the National Institutes of Health (NIH) under award number K23HL116641. This work also was supported by the Veterans Health Administration and by CTSA Grant UL1 RR024139 from the National Center for Advancing Translational Sciences at the NIH. The content is solely the responsibility of the authors and does not necessarily represent the policy or views of the NIH, the Veterans Health Administration, or the US Government.

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Fig. 1.
Flow diagram of patient selection and analysis.

Fig. 2.
Kaplan-Meier unadjusted survival curve comparing year-1 survival among patients with and without postoperative medical follow-up.

Fig. 3.

Forest plot of hazard ratios for death in year 2 among patients with versus without postoperative medical follow-up in year 1. The size of the *grey square* indicates weights assigned to each specialty in the pooling of the estimates from 7 specialties in the meta-analysis. There was no significant heterogeneity ($I^2 = 0\%$, Cochran's Q test $p = 0.79$) among specialties.

Fig. 4. Sensitivity analysis illustrating the robustness of the Cox frailty model results from the full cohort in the face of a hypothetical unmeasured confounder. Colored lines represent the hazard ratios at various prevalence differences for a hypothetical unmeasured binary confounder that could have accounted for observed survival differences.

Table 1**Patient Characteristics Stratified by Visit Status**

Variable	Follow-up Visit n (%) or Mean (SD)	No Visit n (%) or Mean (SD)	Total n (%) or Mean (SD)
Total (n)	219,942 (93.1%)	16,258 (6.9%)	23,6200
Age (yr)	62.4 (11.7)	56.7 (16.1)	62.0 (12.2)
Age <65 years	4,558 (28%)	84,823 (38.6%)	89,381 (37.8%)
Sex			
Male	13,396 (82.4%)	206,995 (94.1%)	220,391 (93.3%)
Female	2,862 (17.6%)	12,947 (5.9%)	15,809 (6.7%)
Body mass index (kg/m ²)	29.4 (6.2)	27.8 (6.1)	29.3 (6.2)
Hispanic ethnicity			
Unknown	9,785 (60.2%)	119,035 (54.1%)	128,820 (54.5%)
Yes	6,026 (37.1%)	93,456 (42.5%)	99,482 (42.1%)
No	447 (2.8%)	7,451 (3.4%)	7,898 (3.3%)
Race			
Unknown	1,415 (8.7%)	10,844 (4.9%)	12,259 (5.2%)
White	10,933 (67.3%)	166,939 (75.9%)	177,872 (75.3%)
Black or African-American	3,490 (21.5%)	37,205 (16.9%)	40,695 (17.2%)
Asian or Pacific Islander	245 (1.5%)	2,810 (1.3%)	3,055 (1.3%)
American Indian/Alaskan Native	175 (1.1%)	2,144 (1%)	2,319 (1%)
Year of surgery			
2006	1,192 (7.3%)	13,511 (6.1%)	14,703 (6.2%)
2007	3,454 (21.2%)	41,719 (19%)	45,173 (19.1%)
2008	3,093 (19%)	41,581 (18.9%)	44,674 (18.9%)
2009	3,009 (18.5%)	44,195 (20.1%)	47,204 (20%)
2010	3,218 (19.8%)	46,185 (21%)	49,403 (20.9%)
2011	2,292 (14.1%)	32,751 (14.9%)	35,043 (14.8%)
Surgical service			
Cardiac surgery	116 (0.7%)	15,453 (7%)	15,569 (6.6%)
Ear, nose, and throat	756 (4.7%)	9,474 (4.3%)	10,230 (4.3%)
General surgery	4,845 (29.8%)	50,009 (22.7%)	54,854 (23.2%)
Gynecology	806 (5%)	2,778 (1.3%)	3,584 (1.5%)
Neurosurgery/spine	1,137 (7%)	17,714 (8.1%)	18,851 (8%)
Ophthalmology	152 (0.9%)	1,204 (0.6%)	1,356 (0.6%)
Oral surgery	171 (1.1%)	1,004 (0.5%)	1,175 (0.5%)
Orthopedics	3,466 (21.3%)	45,914 (20.9%)	49,380 (20.9%)
Plastic surgery	293 (1.8%)	3,328 (1.5%)	3,621 (1.5%)
Podiatry	398 (2.5%)	2,914 (1.3%)	3,312 (1.4%)
Thoracic surgery	260 (1.6%)	3,409 (1.6%)	3,669 (1.6%)
Urology	281 (1.7%)	10,046 (4.6%)	10,327 (4.4%)
Vascular surgery	2,314 (14.2%)	29,749 (13.5%)	32,063 (13.6%)
Other	1,263 (7.8%)	26,946 (12.3%)	28,209 (11.9%)

Variable	Follow-up Visit n (%) or Mean (SD)	No Visit n (%) or Mean (SD)	Total n (%) or Mean (SD)
ASA Physical Status Score			
Missing	2,203 (13.6%)	16,082 (7.3%)	18,285 (7.7%)
1–2	5,559 (34.2%)	44,962 (20.4%)	50,521 (21.4%)
3–5	8,496 (52.2%)	158,898 (72.2%)	167,394 (70.9%)
Charlson Comorbidity Index			
Missing	1 (0%)	17 (0%)	18 (0%)
0–4	15,510 (95.4%)	208,960 (95%)	224,470 (95%)
5–9	681 (4.2%)	10,089 (4.6%)	10,770 (4.6%)
10–14	64 (0.4%)	863 (0.4%)	927 (0.4%)
15–19	2 (0%)	13 (0%)	15 (0%)
Veterans Aging Cohort Study groupings			
Coronary artery disease			
No	13,686 (84.2%)	146,600 (66.7%)	160,286 (67.9%)
Yes	2,572 (15.8%)	73,342 (33.4%)	75,914 (32.1%)
Congestive heart failure			
No	15,202 (93.5%)	198,354 (90.2%)	213,556 (90.4%)
Yes	1,056 (6.5%)	21,588 (9.8%)	22,644 (9.6%)
Diabetes mellitus			
No	13,255 (81.5%)	147,615 (67.1%)	160,870 (68.1%)
Yes	3,003 (18.5%)	72,327 (32.9%)	75,330 (31.9%)
Hypertension			
No	8,207 (50.5%)	53,483 (24.3%)	61,690 (26.1%)
Yes	8,051 (49.5%)	166,459 (75.7%)	174,510 (73.9%)
Vascular disease			
No	14,234 (87.6%)	177,724 (80.8%)	191,958 (81.3%)
Yes	2,024 (12.4%)	42,218 (19.2%)	44,242 (18.7%)
Pulmonary disease			
No	12,524 (77%)	150,831 (68.6%)	163,355 (69.2%)
Yes	3,734 (23%)	69,111 (31.4%)	72,845 (30.8%)
Cerebral/cerebrovascular disease			
No	14,999 (92.3%)	204,171 (92.8%)	219,170 (92.8%)
Yes	1,259 (7.7%)	15,771 (7.2%)	17,030 (7.2%)
Alcohol abuse			
No	13,272 (81.6%)	178,776 (81.3%)	192,048 (81.3%)
Yes	2,986 (18.4%)	41,166 (18.7%)	44,152 (18.7%)
Drug abuse			
No	14,482 (89.1%)	198,054 (90.1%)	212,536 (90%)
Yes	1,776 (10.9%)	21,888 (10%)	23,664 (10%)
Thought disorder, any			
No	13,687 (84.2%)	197,986 (90%)	211,673 (89.6%)
Yes	2,571 (15.8%)	21,956 (10%)	24,527 (10.4%)

Variable	Follow-up Visit n (%) or Mean (SD)	No Visit n (%) or Mean (SD)	Total n (%) or Mean (SD)
Depression			
No	11,611 (71.4%)	145,667 (66.2%)	157,278 (66.6%)
Yes	4,647 (28.6%)	74,275 (33.8%)	78,922 (33.4%)
Bipolar disorder			
No	15,190 (93.4%)	205,895 (93.6%)	221,085 (93.6%)
Yes	1,068 (6.6%)	14,047 (6.4%)	15,115 (6.4%)
Post-traumatic stress disorder			
No	14,454 (88.9%)	185,186 (84.2%)	199,640 (84.5%)
Yes	1,804 (11.1%)	34,756 (15.8%)	36,560 (15.5%)
Anemia or hemoglobinopathy			
No	12,659 (77.9%)	170,469 (77.5%)	183,128 (77.5%)
Yes	3,599 (22.1%)	49,473 (22.5%)	53,072 (22.5%)
Hyperlipidemia			
No	10,040 (61.8%)	72,111 (32.8%)	82,151 (34.8%)
Yes	6,218 (38.3%)	147,831 (67.2%)	154,049 (65.2%)
Renal disease			
No	13,558 (83.4%)	183,114 (83.3%)	196,672 (83.3%)
Yes	2,700 (16.6%)	36,828 (16.7%)	39,528 (16.7%)
Liver disease			
No	14,930 (91.8%)	201,794 (91.8%)	216,724 (91.8%)
Yes	1,328 (8.2%)	18,148 (8.3%)	19,476 (8.2%)
Anxiety			
No	14,518 (89.3%)	188,833 (85.9%)	203,351 (86.1%)
Yes	1,740 (10.7%)	31,109 (14.1%)	32,849 (13.9%)
Atrial fibrillation/flutter			
No	15,361 (94.5%)	198,383 (90.2%)	213,744 (90.5%)
Yes	897 (5.5%)	21,559 (9.8%)	22,456 (9.5%)
HIV			
No	16,218 (99.8%)	218,250 (99.2%)	234,468 (99.3%)
Yes	40 (0.3%)	1,692 (0.8%)	1,732 (0.7%)
Inpatient days			
Postoperative stay 0–1	5,331 (32.8%)	59,356 (27%)	64,687 (27.4%)
Postoperative stay 2–4	6,430 (39.6%)	87,401 (39.7%)	93,831 (39.7%)
Postoperative stay 5–7	3,095 (19%)	52,556 (23.9%)	55,651 (23.6%)
Postoperative stay 8–10	1,402 (8.6%)	20,629 (9.4%)	22,031 (9.3%)

Abbreviations: ASA, American Society of Anesthesiologists; SD, standard deviation.

Table 2

Random-Effect Cox Regression Results Showing Relative Hazard of Death in Year 2 among Patients Who Survived the Full 1-Year Exposure Period

Model	Hazard Ratio (95% CI) With v Without Follow-up	p Value
Overall cohort *	0.712 (0.663–0.765)	<0.0001
Specialties		
Cardiac/thoracic surgery	0.717 (0.667–0.770)	<0.0001
ENT	0.649 (0.494–0.854)	0.002
General surgery	0.684 (0.594–0.789)	<0.0001
Neurosurgery	0.651 (0.454–0.934)	0.0197
Orthopedic	0.624 (0.526–0.741)	<0.0001
Urology	0.728 (0.604–0.879)	0.0009
Vascular surgery	0.732 (0.612–0.876)	0.0006
Combined †	0.701 (0.665–0.739)	<0.0001

NOTE: Covariates included surgery type (in overall model only), year of surgery, body mass index, age, age ≥ 65, sex, race, Hispanic ethnicity, smoking, length of stay after surgery, ASA Physical Status Score, Charlson Comorbidity Index, and Veterans Aging Cohort Study disease groupings. VA station was treated as a random effect in all models.

Abbreviation: ENT, ear, nose and throat.

* Results from patients undergoing all types of surgeries listed in Table 1.

† Results from a random-effect meta-analysis combining information from the 7 surgical specialties listed in this table.