Comparative Effectiveness of Regional *versus* General Anesthesia for Hip Fracture Surgery in Adults

Mark D. Neuman, M.D., M.Sc.,* Jeffrey H. Silber, M.D., Ph.D.,† Nabil M. Elkassabany, M.D.,‡ Justin M. Ludwig, M.A.,§ Lee A. Fleisher, M.D.‖

ABSTRACT

Background: Hip fracture is a common, morbid, and costly event among older adults. Data are inconclusive as to whether epidural or spinal (regional) anesthesia improves outcomes after hip fracture surgery.

Methods: The authors examined a retrospective cohort of patients undergoing surgery for hip fracture in 126 hospitals in New York in 2007 and 2008. They tested the association of a record indicating receipt of regional *versus* general anesthesia with a primary outcome of inpatient mortality and with secondary outcomes of pulmonary and cardiovascular complications using hospital fixed-effects logistic regressions. Subgroup analyses tested the association of anesthesia type and outcomes according to fracture anatomy.

Results: Of 18,158 patients, 5,254 (29%) received regional anesthesia. In-hospital mortality occurred in 435 (2.4%). Unadjusted rates of mortality and cardiovascular complications did not differ by anesthesia type. Patients receiving regional anesthesia experienced fewer pulmonary complications (359 [6.8%] *vs.* 1,040 [8.1%], $P < 0.005$). Regional anesthesia was associated with a lower adjusted odds of mortality (odds ratio: 0.710, 95% CI 0.541, 0.932, $P = 0.014$) and pulmonary complications (odds ratio: 0.752, 95% CI 0.637, 0.887, $P < 0.0001$) relative to general anesthesia. In subgroup analyses, regional anesthesia was associated with improved survival and fewer pulmonary complications among patients with intertrochanteric fractures but not among patients with femoral neck fractures.

Conclusions: Regional anesthesia is associated with a lower odds of inpatient mortality and pulmonary complications among all hip fracture patients compared with general anesthesia; this finding may be driven by a trend toward improved outcomes with regional anesthesia among patients with intertrochanteric fractures.

What We Already Know about This Topic

- Some prospective and observational studies demonstrate reduced major morbidity and mortality with regional compared with general anesthesia for hip fractures
- No large observational study in the general, nonveteran population, has examined this issue

What This Article Tells Us That Is New

- In a review of more than 18,000 patients having surgery for hip fracture in New York in 2007 and 2008, use of regional anesthesia was associated with a 25–29% reduction in major pulmonary complications and death

◇ This article is featured in "This Month in Anesthesiology." Please see this issue of ANESTHESIOLOGY, page 9A.

* Assistant Professor, Department of Anesthesiology and Critical Care, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania, and Senior Fellow, Leonard Davis Institute of Health Economics, University of Pennsylvania, Philadelphia, Pennsylvania. † Professor, Departments of Pediatrics and Anesthesiology and Critical Care, University of Pennsylvania School of Medicine; Director, Center for Outcomes Research, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania; and Senior Fellow, Leonard Davis Institute of Health Economics, University of Pennsylvania. ‡ Assistant Professor, Department of Anesthesiology and Critical Care, University of Pennsylvania School of Medicine. § Statistical Programmer, Center for Outcomes Research, Children's Hospital of Philadelphia. ‖ Professor and Chair, Department of Anesthesiology and Critical Care, University of Pennsylvania School of Medicine, and Senior Fellow, Leonard Davis Institute of Health Economics, University of Pennsylvania.

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Address correspondence to Dr. Neuman: Department of Anesthesiology and Critical Care, University of Pennsylvania, 1117 Blockley Hall, 423 Guardian Drive, Philadelphia, Pennsylvania 19104. neumanm@mail.med.upenn.edu. This article may be accessed for personal use at no charge through the Journal Web site, www.anesthesiology.org.

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FRAGILITY fractures of the hip present an urgent need for better information to guide perioperative care. Hip fractures are a global public health problem, occurring 1.6 million times worldwide each year, and their incidence is anticipated to grow rapidly during the next three decades because of the aging of the population.[1–5] After indicated surgical treatment, hip fracture patients experience high rates of morbidity, mortality, and disability, with approximately 5% dying during hospitalization and 10% dying within 30 days because of high rates of pulmonary and cardiovascular complications.[6–9] Few interventions exist to reduce mortality after hip fracture,[10,11] so identifying new opportunities to improve outcomes in this population is of urgent public health importance.

Use of regional anesthesia, *via* epidural, spinal, or peripheral neural blockade, as a principal anesthetic technique has been hypothesized to reduce the risks of postoperative complications among patients undergoing surgery for hip fracture.[10,12] Proposed reasons for improved outcomes with regional anesthesia include the avoidance of intubation and mechanical ventilation, decreased blood loss, and improved postoperative analgesia.[13] Conversely, general anesthesia may offer improved hemodynamic stability relative to regional anesthesia.[13]

Past clinical trials comparing outcomes of regional *versus* general anesthesia for hip fracture offer insufficient insights to guide current practice because of small sample sizes[14–19] and exclusion of key patient groups, including those with delirium or dementia,[14,20] and those undergoing hemiarthroplasty or total hip arthroplasty.[21] In this context, research using observational data may offer unique strengths for comparing the effectiveness of anesthesia type for hip fracture surgery.[22,23] Nonetheless, past observational studies have produced conflicting results regarding the association between anesthesia type and mortality after hip fracture, alternately showing no difference in outcomes according to anesthesia type[24] and decreased mortality with regional anesthesia.[8] In addition, little is known about how associations between anesthesia type and outcomes may differ among clinically relevant subgroups of hip fracture patients.

To compare the effectiveness of regional *versus* general anesthesia for preventing mortality and major complications after hip fracture surgery, we undertook an analysis of a large, population-based cohort. Specifically, we aimed to compare the probability of in-hospital death and selected pulmonary and cardiovascular complications among hip fracture patients receiving regional *versus* general anesthesia, and to evaluate whether the association between anesthesia type and outcome varied according to fracture anatomy. Our overall hypothesis was that the probability of inpatient mortality, major pulmonary complications, and major cardiovascular complications would be lower among patients receiving regional techniques as their principal anesthetic modality; we also hypothesized that the association of anesthesia type with outcomes would differ between patients with femoral neck fractures and those with intertrochanteric fractures.

Materials and Methods

Data Sources and Study Sample

This study was exempted from review by the Institutional Review Board of the University of Pennsylvania, Philadelphia, Pennsylvania. We examined data on adults aged 50 yr and older undergoing hip fracture repair at hospitals in New York state between January 1, 2007, and December 31, 2008, made publically available through the U.S. Agency for Healthcare Quality's Health Care Utilization Project as the New York State Inpatient Database. This database includes discharge records for all patients treated in general acute-care hospitals in the state of New York and contains information on patient demographics, discharge diagnoses, inpatient procedures, anesthesia type, discharge status, and hospital identifiers.

To create a cohort of adults undergoing surgery for hip fracture, we selected all discharges with a principal or secondary diagnosis code for hip fracture, including pathologic fractures of the femoral neck (International Classification of Diseases-9-Clinical Modification [ICD-9-CM] diagnosis codes 820.00–820.9, 733.14); within this group, we excluded patients without a principal procedure code corresponding to open reduction, internal fixation, hemiarthroplasty, or total hip arthroplasty (ICD-9-CM codes 00.70–7; 79.15, 79.25, 79.35, 81.40, 81.51–3). We excluded patients undergoing closed reduction without internal fixation (79.05). To restrict our sample to a group of patients with low-energy fragility fractures, we excluded patients younger than 50 yr and those presenting with a diagnosis-related group code indicating multiple trauma (diagnosis-related groups 280, 418, 444–5, 484–7, 506, 508, or 510).

Validation of Exposure Variable

The New York State Inpatient Database has made data on anesthesia type available since 1994, as collected and reported by individual hospitals. Anesthesia type is reported as a categorical variable with values corresponding to general, regional, local, other, or no anesthesia. Each discharge record in the New York State Inpatient Database contains a maximum of one value for anesthesia type; anesthesia care for patients receiving more than one type of anesthesia during their hospital stay is reported in the following hierarchical order: general, regional, other, and local. Thus, patients receiving both general and regional anesthesia for a single procedure or across multiple procedures within one hospitalization are listed as having received general anesthesia. For the purposes of this analysis, we confined our comparisons of outcomes to patients treated in hospitals where at least one hip fracture discharge record included a valid anesthesia type code; we also examined only those patients listed as receiving either general or regional anesthesia, excluding patients coded as receiving other, local, or no anesthesia. We also excluded patients who underwent a secondary surgical procedure likely to require general anesthesia during their hospital stay (appendix 1) because the anesthesia type received

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for hip fracture surgery could not be determined reliably for these patients because of the coding structure of the study data set.

The anesthesia type variables in the New York State Inpatient Database have been used in previous efforts to define predictors of postoperative outcomes.[25] However, we are not aware of previous research validating these variables, so our initial analyses explored the validity of anesthesia coding within the study data set. Notably, the New York State Inpatient Database lacks patient-specific identifiers or calendar dates, precluding validation by comparison with external chart review. Thus, we initially assessed the face validity of the database's anesthesia type codes by qualitatively examining those ICD-9-CM procedure codes most frequently associated with regional and general anesthesia within the data set.

Next, we examined the distribution of missing and invalid anesthesia type codes for patients meeting our inclusion criteria across all hospitals in our set. We compared hospital characteristics, as recorded in the 2006 American Hospital Association member survey, annual hip fracture volume, selected patient characteristics, and clinical outcomes, between hospitals in which all anesthesia codes were missing or invalid and all remaining hospitals in our sample.

Outcome Variables

The primary outcome for the current study was in-hospital mortality as recorded in the study database. Secondary outcomes included major pulmonary and cardiovascular complications, which represent common causes of postoperative mortality among hip fracture patients[6] with previously hypothesized mechanistic associations with anesthesia type.[13] We examined the following complications: pneumonia/empyema, aspiration, respiratory failure, acute myocardial infarction, congestive heart failure, and cardiac arrest. In addition, we created indicator variables for occurrence of any pulmonary complication (*i.e.*, pneumonia/empyema, aspiration, or respiratory failure) and occurrence of any cardiovascular complication (*i.e.*, acute myocardial infarction, congestive heart failure, or cardiac arrest). These variables were equal to one if one or more complications within the relevant organ system (*i.e.*, cardiac or pulmonary) occurred, and zero otherwise. We identified complications using ICD-9-CM diagnosis and procedure codes based on algorithms originally outlined by Romano *et al.*[26] and Silber *et al.*[27] (appendix 2). The New York State Inpatient Database contains a present-on-admission indicator to distinguish preexisting conditions from complications developing during hospitalization. Past research has demonstrated that use of present-on-admission indicators can minimize bias in assessments of hospital outcomes by distinguishing between preexisting conditions and complications[28–30]; thus, we deemed a complication to have occurred if a discharge record contained a relevant secondary ICD-9-CM code not identified as being present on admission.

Control Variables

Control variables for patient sex, age in years, and race as reported by the hospital were taken directly from the New York State Inpatient Database. Race was categorized as black, white, or other[31] and examined as a potential confounder because of known differences in hip fracture treatment and outcomes occurring as a function of race.[32,33] Based on ICD-9-CM diagnosis and procedure codes, we developed variables indicating fracture location (femoral neck, intertrochanteric, subtrochanteric, and other location/multiple fractures), pathologic fracture, and surgery type (hemiarthroplasty, total hip arthroplasty, or internal fixation). Comorbidities were defined according to algorithms outlined by Elixhauser *et al.*,[34] as adapted for ICD-9-CM diagnoses by Quan *et al.*,[35] as well as algorithms outlined by Silber *et al.*[27] Comorbidities were considered present if the relevant ICD-9-CM diagnosis was present in a secondary diagnosis field and indicated as being present on admission.

Statistical Analyses

Initial analyses used the Wilcoxon rank sum test and the chi-square test to compare characteristics of patients receiving regional and general anesthesia. Chi-square tests were used to compare unadjusted rates of inpatient mortality and respiratory and cardiovascular complications according to anesthesia type. Next, we developed hospital fixed-effects logistic regression models to measure the association of anesthesia type with our study outcomes while controlling for potential patient- and hospital-level confounders. To select variables for inclusion in models predicting each of our three outcomes (mortality, pulmonary complications, and cardiovascular complications), we first constructed three separate logistic regression models without hospital fixed-effects. These models used backward elimination[36] with a threshold for variable removal of $P > 0.2$. Variables considered for inclusion were: age, sex, fracture location, type of surgery, presence of pathologic fracture, race, and 35 indicator variables for comorbidities; an indicator variable that equaled one for patients receiving regional anesthesia was forced into the model. Model discrimination was evaluated using the c-statistic.

We constructed additional control variables for inclusion in our regression models based on a propensity score to improve balance on observed covariates between patients receiving regional *versus* general anesthesia.[37,38] This score indicated the probability of receiving regional anesthesia, based on a logistic regression model that included all patient-level covariates considered in development of our initial regression models, along with a quadratic term for age. We stratified patients into five groups of equal size by values of the propensity score and developed indicator variables for each propensity score quintile. For each of our outcomes, we developed hospital fixed-effects logistic regressions using Stata's xtlogit and clogit commands, setting the New York State Inpatient Database's unique hospital identifier as the cluster-

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Table 1. Comparison of Hospitals Reporting Data on Anesthesia Type for Hip Fracture Surgery to Nonreporting Hospitals, New York State, 2007–2008

—	Reporting Hospitals (126)	Nonreporting Hospitals (47)	*P* Value
Facility characteristics			
Median bed count (IQR)	263 (163, 441)	275 (143, 398)	0.996
Teaching hospital (%)	30 (23.8)	11 (23.4)	0.956
Urban/rural status*	—	—	0.0123
Large metropolitan (%)	56 (44.4)	34 (72.3)	—
Small metropolitan (%)	48 (38.1)	9 (19.2)	—
Micropolitan (%)	19 (15.1)	3 (6.4)	—
Rural (%)	3 (2.4)	1 (2.1)	—
Level 1 or 2 trauma center (%)	31 (24.6)	11 (23.4)	0.946
Median hip fracture discharges per facility, 2007 (IQR)	70 (36, 120)	48 (23, 79)	0.004
Median hip fracture discharges per facility, 2008 (IQR)	72 (36, 121)	49 (14, 80)	0.002
Patient characteristics: hip fracture discharges			
Total discharges	23,043	5,612	—
Median age (IQR)	83 (76, 88)	83 (76, 88)	0.883
Male (%)	6,136 (26.6)	1,549 (27.6)	0.141
Mortality (%)	597 (2.6)	131 (2.3)	0.273

* Urban/rural status classified according to U.S. Office of Management and Budget Core Based Statistical Area classifications: large metropolitan = population > 2,500,000; small metropolitan = population 50,000–2,500,000; micropolitan: population 10,000–50,000; rural = population < 10,000.

IQR = interquartile range.

ing variable; these models included the regional anesthesia indicator, all variables selected by the relevant backward elimination procedure, and indicators for propensity score stratum. We anticipated that outcomes for patients treated at a single hospital would be potentially correlated, so we adjusted all standard errors for clustering at the hospital level.[39]

To assess the robustness of our results to model specification and to the variables included in the regression model, we replicated all analyses in logistic regression models that treated hospital as a random factor rather than a fixed factor and in fixed and random effects models that omitted the indicator for propensity score quintile.

We conducted subgroup analyses to test the association of anesthesia type with outcomes among patients with femoral neck and intertrochanteric fractures by reestimating each fixed-effects regression model within the relevant patient subgroup. All analyses used a threshold of $P < 0.05$ for statistical significance and were conducted using Stata 10.0 (StataCorp, College Station, TX) and SAS 9.2 (SAS Institute, Cary, NC).

Results

Validation of Exposure Variable

We initially made qualitative assessments of the distribution of anesthesia codes across procedures listed in the New York State Inpatient Database as a whole. We found codes for regional anesthesia to be most common among the procedures in which our clinical experience suggested regional anesthesia would be likely to be used. Among all discharges for 2007 and 2008, the three most common procedures associated with regional anesthesia were cesarean section (ICD-9-CM procedure code 74.1), manually assisted delivery (code 73.59), and repair of obstetrical laceration (code 75.69). The three procedures most frequently associated with a code for general anesthesia were laparoscopic cholecystectomy (code 51.23), total knee replacement (code 81.54), and laparoscopic appendectomy (code 47.01).

We next examined the frequency of missing or invalid values for anesthesia type among patients meeting our inclusion criteria. Beginning with the universe of discharges from New York hospitals in 2007 and 2008 (5,237,998 discharges), we identified 38,605 patients with a relevant ICD-9-CM diagnosis code for hip fracture; of these, we excluded 8,746 discharges without a relevant listed surgical procedure, 1,048 discharges among patients younger than 50 yr or with a missing value for age, 155 hospitalizations for care of multiple trauma, and 1 discharge without a valid hospital identifier. This resulted in a sample of 28,655 discharges from 173 hospitals; of these hospitals, all anesthesia type codes were missing or invalid for 47, accounting for 5,612 discharges. Within the remaining 126 hospitals, anesthesia type was missing or invalid for 11% of discharges. Comparison of the 47 hospitals not reporting anesthesia type to the remaining facilities in the sample (table 1) showed nonreporting facilities to be less frequently located in metropolitan areas and to have lower annual hip fracture volumes. Hip fracture patients receiving care at reporting *versus* nonreporting facilities did not differ in terms of age, gender, or unadjusted in-hospital mortality.

Unadjusted Analyses

From our sample of 28,655 discharges, we excluded 10,122 patients with missing or invalid anesthesia codes, or an anes-

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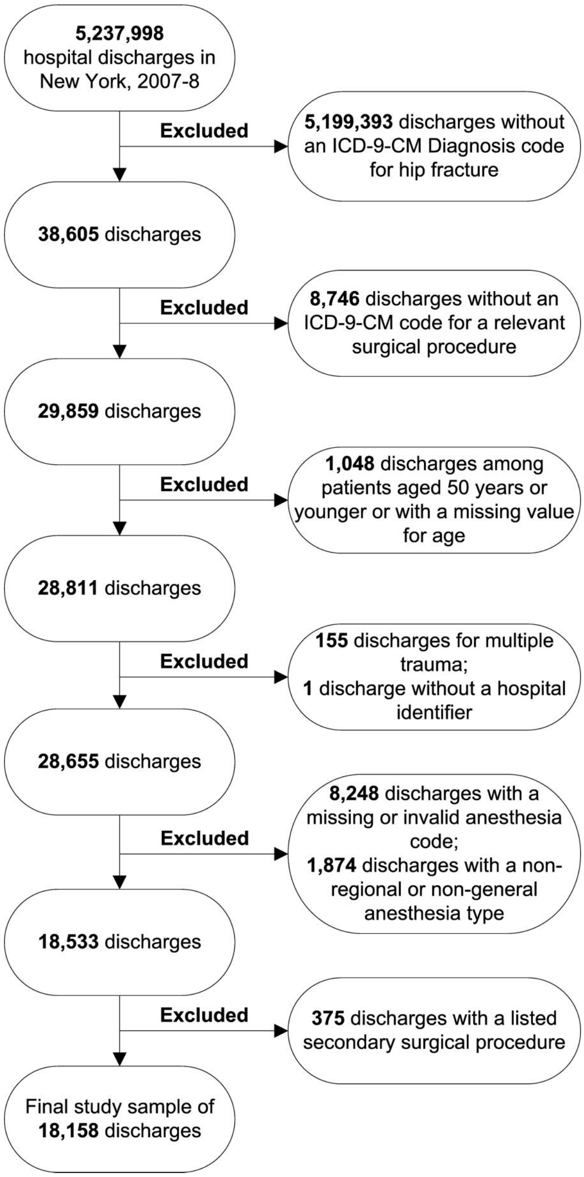

Fig. 1. Creation of the study sample. ICD-9-CM = International Classification of Diseases-9-Clinical Modification.

thesia type of local, none, or other. We also excluded 375 patients with a listed major secondary surgical procedure, obtaining a final study cohort of 18,158 patients. A diagram depicting our process of defining our study sample appears in figure 1. Of 18,158 patients in our sample, 5,254 (28.9%) received regional anesthesia (table 2). The median percentage of patients receiving regional anesthesia at a given hospital was 25.7%, and the interquartile range was from 4.4% to 53.3%. The median number of cases discharged per facility during the period was 119.5 (range: 1–739). Patients receiving regional anesthesia were older, more frequently of white race, and less often had pathologic fractures. Chronic obstructive pulmonary disease and dementia were more common among those receiving regional anesthesia; malignancy, diabetes, and chronic renal disease were more often present among patients receiving general anesthesia.

Unadjusted comparisons of outcomes (table 3) showed no significant differences in mortality according to anesthesia type. Although we found no differences in rates of aspiration or infectious pneumonia by anesthesia type, patients receiving regional anesthesia experienced fewer episodes of respiratory failure (3.4% compared with 5.0% for patients with general anesthesia, $P < 0.0001$) and had a lower rate of any pulmonary complication (6.8% *vs.* 8.1%, $P = 0.005$). Unadjusted rates of cardiovascular complications did not vary according to anesthesia type.

Adjusted Regression Analyses

We developed hospital fixed-effects logistic regressions to predict in-hospital mortality, occurrence of any pulmonary complication, and occurrence of any cardiac complication. Selected model results are shown in table 4 and discussed here; refer to appendices 3 through 11 for full model results.

For our mortality model, we began by developing a logistic regression model without adjustment for hospital effects. This model included an indicator for regional anesthesia and 21 control variables selected by backward elimination. These were: sex, age, lymphoma, psychosis, metastatic cancer, pathologic fracture, neurologic disorder, alcohol abuse, arrhythmia, hypothyroidism, congestive heart failure, weight loss, chronic obstructive pulmonary disease, valvular disease, depression, diabetes (uncomplicated), renal disease, liver disease, electrolyte abnormality, hypertension (uncomplicated), and hypertension (complicated); the model c-statistic was 0.77. We then developed a logistic regression model to predict mortality based on these covariates, an indicator for the propensity score quintile, and hospital fixed effects. Using this model, we found regional anesthesia to be associated with a lower odds of in-hospital mortality relative to general anesthesia (odds ratio [OR]: 0.710, 95% CI 0.541, 0.932, $P = 0.014$).

We followed the same procedure to determine the adjusted odds of a pulmonary complication with regional *versus* general anesthesia. We began by developing a logistic model, without adjustment for hospital effects, to predict occurrence of a pulmonary complication. This model included the regional anesthesia indicator and the following control variables: sex, age, liver disease, fracture location, surgery type, paralysis, hypothyroidism, renal disease, neurologic disorder, peptic ulcer disease, congestive heart failure, hypertension (complicated), hypertension (uncomplicated), chronic obstructive pulmonary disease, weight loss, and diabetes (uncomplicated); the model c-statistic was 0.67. A hospital fixed-effects logistic regression model including these covariates and an indicator for propensity score quintile showed regional anesthesia to be associated with a lower odds of pulmonary complications relative to general anesthesia (OR: 0.752, 95% CI 0.637, 0.887, $P < 0.0001$).

To predict cardiovascular complications, we began by developing a logistic regression model, without adjustment for hospital effects. In addition to the regional anesthesia in-

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Table 2. Comparison of Patient Characteristics by Anesthesia Type within 126 Hospitals in New York State, 2007–2008

—	General Anesthesia	Regional Anesthesia	*P* Value
Discharges (%)	12,904 (71.1)	5,254 (28.9)	—
Demographics	—	—	—
Age (median, IQR)	82 (76, 88)	83 (77, 89)	<0.0001
Male (%)	3,411 (26.4)	1,352 (25.7)	0.333
Race: White (%)	11,028 (85.5)	4,613 (87.8)	<0.0001
Black (%)	456 (3.5)	122 (2.3)	—
Other (%)	1,420 (11.0)	519 (9.9)	—
Fracture characteristics/surgical treatment			—
Femoral neck fracture (%)	6,213 (48.2)	2,553 (48.6)	0.213
Intertrochanteric fracture (%)	5,691 (44.1)	2,340 (44.5)	
Subtrochanteric fracture (%)	575 (4.5)	201 (3.8)	—
Multiple locations/other (%)	425 (3.3)	160 (3.1)	—
Pathological fracture (%)	344 (2.7)	97 (1.9)	0.001
Surgery type: Internal fixation (%)	8,101 (62.8)	3,205 (61.0)	0.063
Hemiarthroplasty (%)	4,218 (32.7)	1,787 (34.0)	—
Total hip arthroplasty (%)	585 (4.5)	262 (5.0)	—
Comorbidities	—	—	—
Congestive heart failure (%)	1,886 (14.6)	783 (14.9)	0.620
Valvular disease (%)	1,523 (11.8)	580 (11.0)	0.145
Prior myocardial infarction (%)	550 (4.3)	228 (4.3)	0.816
Arrhythmia (%)	2,749 (21.3)	1,129 (21.5)	0.783
Chronic obstructive pulmonary disease (%)	2,604 (20.2)	1,280 (24.4)	<0.0001
Stroke (%)	544 (4.2)	204 (3.9)	0.306
Dementia (%)	2,427 (18.8)	1,084 (20.6)	0.005
Diabetes (%)	2,660 (20.6)	1,001 (19.1)	0.017
Electrolyte disorder (%)	2,090 (16.2)	870 (16.6)	0.549
Renal dysfunction (%)	1,508 (11.7)	532 (10.1)	0.003
Liver disease (%)	171 (1.3)	57 (1.1)	0.187
Malignancy (%)	839 (6.5)	277 (5.3)	0.002
Weight loss (%)	270 (2.1)	104 (2.0)	0.627

IQR = interquartile range.

dicator, this model included control variables for sex, age, race, fracture location, surgery type, rheumatoid arthritis, hypertension, neurologic disorder, liver disease, electrolyte abnormality, congestive heart failure, coagulopathy, chronic obstructive pulmonary disease, dementia, depression, hypothyroidism, hypertension (complicated), and valvular disease. The model c-statistic was 0.66. After including these covariates and an indicator for propensity score quintile in a hospital fixed-effects logistic regression model, we found no difference in cardiovascular complications according to anesthesia type (OR: 0.877, 95% CI 0.748, 1.029, $P = 0.107$).

We obtained similar results when we replicated these analyses in hierarchical logistic models that used identical sets of control variables but treated hospital as a random factor, rather than a fixed factor; these models are reported in full in appendices 12 through 20. Finally, we repeated all regressions in fixed-effects and random-effects logistic mod-

Table 3. Comparison of Unadjusted In-hospital Outcomes by Anesthesia Type within 126 Hospitals in New York State, 2007–2008

	General Anesthesia	Regional Anesthesia	*P* Value
Discharges (%)	12,904 (71.1)	5,254 (28.9)	—
Mortality (%)	325 (2.5)	110 (2.1)	0.090
Cardiac complications	—	—	—
Congestive heart failure (%)	230 (1.8)	93 (1.8)	0.955
Acute myocardial infarction (%)	266 (2.1)	97 (1.9)	0.348
Cardiac arrest (%)	410 (3.2)	142 (2.7)	0.091
Any cardiac complication (%)	688 (5.3)	250 (4.8)	0.113
Pulmonary complications	—	—	—
Aspiration (%)	333 (2.6)	133 (2.5)	0.849
Infectious pneumonia (%)	359 (2.8)	153 (2.9)	0.631
Respiratory failure (%)	641 (5.0)	180 (3.4)	<0.0001
Any pulmonary complication (%)	1,040 (8.1)	359 (6.8)	0.005

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Table 4. Adjusted Outcomes by Anesthesia Type: Hospital Fixed-effects Models

—	Odds Ratio	95% CI	*P* Value
Death (primary outcome)	0.710	0.541, 0.932	0.014
Any pulmonary complication	0.752	0.637, 0.887	<0.0001
Any cardiovascular complication	0.877	0.748, 1.029	0.107

els that omitted the indicator for propensity score quintile, obtaining similar results (not shown).

Subgroup Analyses

We repeated all of our regression analyses in subgroups restricted to patients with femoral neck fractures and patients with intertrochanteric fractures of the femur. Among patients with femoral neck fractures, our full hospital fixed-effects models (table 5) indicated no difference in inpatient mortality, pulmonary complications, or cardiovascular complications by anesthesia type. In contrast, regional anesthesia was associated with significantly lower odds of mortality and pulmonary complications for patients with intertrochanteric fractures.

Discussion

Among patients undergoing hip fracture surgery, we found a 29% lower adjusted odds of mortality among patients receiving a regional technique as their principal anesthetic modality relative to patients receiving general anesthesia. We found a 24% decrease in the adjusted odds of any inpatient pulmonary complication among patients receiving regional anesthesia, and both of these findings were consistent across regression models that used a variety of approaches to risk adjustment. In contrast, we did not observe a difference in the odds of a major inpatient cardiovascular complication according to anesthesia type. Finally, we found the association of anesthesia type and outcomes to vary according to fracture location; regional anesthesia was consistently associated with a lower odds of inpatient mortality and pulmonary complications among patients with intertrochanteric fractures, but we found no similar association between anesthesia type and outcomes among patients with femoral neck fractures.

Table 5. Subgroup Analysis: Adjusted Outcomes by Fracture Location

—	Odds Ratio	95% CI	*P* Value
Femoral neck fractures			
Death (in-hospital)	0.815	0.544, 1.222	0.323
Any pulmonary complication	0.823	0.652, 1.040	0.103
Any cardiovascular complication	0.876	0.675, 1.135	0.316
Intertrochanteric fractures			
Death (in-hospital)	0.572	0.368, 0.889	0.013
Any pulmonary complication	0.632	0.481, 0.830	0.001
Any cardiovascular complication	0.821	0.628, 1.072	0.147

Our findings regarding mortality and complications are similar in direction and magnitude to those reported by Radcliff *et al.*[8] in research on hip fracture outcomes among community-dwelling male veterans in the United States. This previous study, using data from the Veterans Affairs–National Surgical Quality Improvement Program, found general anesthesia to be associated with a 27% increased odds of mortality and a 33% increased odds of any complication at 30 days relative to regional anesthesia. Although our analyses are confined to inpatient outcomes, we extend on this previous work in four key ways: first, by examining a population-based sample of patients, we present data that may be more generalizable to populations not included in the previous study, such as female patients and non-community-dwelling individuals. Second, our use of fixed-effect regression allows us to compare outcomes among patients receiving regional or general anesthesia within a given hospital. As such, our findings regarding differences in mortality and respiratory complications are unlikely to be explained by variations in the quality of care between hospitals that differ in their use of regional anesthesia. Third, our main regression models incorporated control variables based on a propensity score that indicated the probability of receiving regional anesthesia. Propensity score adjustment potentially decreases bias in regression models by balancing the distributions of observed covariates across patient groups receiving different treatments[37,38]; thus, our use of a propensity score for risk adjustment reduces the likelihood that our findings can be attributed to imbalances in observed covariates between patients receiving regional *versus* general anesthesia. Fourth, we performed subgroup analyses to understand how the association between anesthesia care and outcome might differ according to fracture characteristics. Mortality and functional impairment are greater after intertrochanteric fractures than after femoral neck fractures,[40,41] although these differences may be attributable to baseline differences in functional status and illness severity between patients experiencing each fracture type.[42,43] Although it is important to note that our subgroup analyses should be regarded as preliminary until replicated in future work, the observation that certain groups of hip fracture patients may have more to gain from the use of regional anesthesia highlights the need for additional research to define subsets of the hip fracture population in which this technique may be beneficial; these subsets may include the oldest-old, patients with advanced functional disability or

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frailty, and patients with baseline risk factors for pulmonary complications.

The current work must be interpreted in the context of multiple limitations. First, because of the observational nature of the study, we cannot fully exclude the possibility that unobserved differences may have existed between the groups we compare here. Specifically, if sicker patients were more likely to receive general anesthesia, our findings of a lower odds of mortality and complications with regional anesthesia may reflect selection bias. Although our statistical models controlled for a range of observed confounders, the possibility of confounding attributable to unobserved differences between patients receiving regional or general anesthesia precludes determination of a causal effect of anesthesia type on outcome from the current data. In addition, our data do not offer insight into why the prevalence of selected conditions, such as malignancy and renal dysfunction, varied according to anesthesia type. Additional research is needed to characterize the decision-making processes that underlie these variations.

Second, our findings are limited by the nature of anesthesia variable coding in the study data set, which lists patients receiving anesthetics that combine regional and general techniques as having received general anesthesia alone. As a result, our findings are best interpreted as a comparison between patients receiving regional anesthesia, without general anesthesia, to patients undergoing general anesthesia, with or without an accompanying regional technique. Thus, we cannot comment on the potential effects on outcomes of adding a regional technique to a general anesthetic for hip fracture care or the relative advantages of different types of regional anesthesia. At the same time, it is important to note that this pattern of coding was likely to have biased the comparisons we present here toward the null hypothesis by diluting any direct effect of regional anesthesia on outcome. As such, our reported measures of association may underestimate the true effect of regional anesthesia on mortality and major complications after hip fracture. Because the coding structure of the study database prevented accurate identification of anesthesia type among patients undergoing multiple procedures during a single hospital stay, we chose to exclude these patients from our analysis. Nonetheless, because these patients are likely to be sicker than the overall hip fracture population, our exclusion of them may limit the generalizability of our results.

Lastly, we note that 47 of the 173 hospitals we examined initially did not provide information on anesthesia type, with lower-volume hospitals and hospitals located outside of metropolitan areas being less likely to report anesthesia type. Thus, our findings may not be fully generalizable to these types of hospital settings or to facilities located outside of New York state. These considerations indicate that future research using alternate data sources remains necessary to confirm our findings.

Despite these limitations, this study has important implications for practice, policy, and research related to the treatment of older adults with hip fracture. Our findings suggest that the management of hip fracture surgery using regional anesthesia may offer benefits in terms of inpatient mortality and respiratory complications and that these benefits may vary according to fracture type. Given the high rate of mortality associated with hip fracture[9,44] and the large and growing worldwide public health burden attributed to complications of hip fracture care,[1,2,5] our findings highlight a potential opportunity to improve outcomes among a growing population of vulnerable surgical patients. A rapid increase is projected for the coming decades in the need for health services to treat hip fractures among older adults, so we urge additional research to confirm these findings and better determine the extent to which, and among whom, regional anesthesia may improve the outcomes of hip fracture care.

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Appendix 1. International Classification of Diseases-9-Clinical Modification (ICD-9-CM) Procedure Codes for Abdominal, Cardiac, Thoracic, Vascular, and Neurosurgical Procedures, Grouped by Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project Clinical Classification Software (CCS) Group*

CCS 1 Incision and excision of central nervous system
0,101 0,109 0,121 0,122 0,123 0,124 0,125 0,126 0,127 0,128 0,131 0,132 0,139 0,141 0,142 0,151 0,152 0,153 0,159
CCS2 Insertion; replacement; or removal of extracranial ventricular shunt
0,231 0,232 0,233 0,234 0,235 0,239 0,242 0,243
CCS 3 Laminectomy; excision intervertebral disc
0,302 0,309 805 8,050 8,051 8,059 8,459 8,460 8,461 8,462 8,463 8,464 8,465 8,466 8,467 8,468 8,469 8,480 8,481 8,482 8,483 8,484 8,485
CCS 9 Other operating room therapeutic nervous system procedures
016 0,201 0,202 0,203 0,204 0,205 0,206 0,207 0,211 0,212 0,213 0,214 022 0,291 0,292 0,293 0,294 0,296 0,299 0,301 031 0,329 034 0,351 0,352 0,353 0,359 036 0,371 0,372 0,379 0,397 0,398 0,399 0,401 0,402 0,403 0,404 0,405 0,406 0,407 042 043 0,441 0,442 045 046 0,471 0,472 0,473 0,474 0,475 0,476 0,479 0,491 0,492 0,493 0,499 050 0,521 0,522 0,523 0,524 0,525 0,529 0,581 0,589 059 1,761 8,053 8,054 8,458 8,694 8,695 8,696 8,697 8,698
CCS 34 Tracheostomy; temporary and permanent
311 3,121 3,129
CCS 36 Lobectomy or pneumonectomy
3,220 3,221 3,222 3,223 3,224 3,225 3,226 3,229 323 3,230 3,239 324 3,241 3,249 325 3,250 3,259
CCS 42 Other operating room therapeutic procedures on respiratory system and mediastinum
3,001 3,009 301 3,021 3,022 3,029 303 304 313 315 3,161 3,162 3,163 3,164 3,169 3,171 3,172 3,173 3,174 3,175 3,179 3,191 3,192 3,198 3,199 320 3,209 321 326 329 330 331 3,334 3,339 3,341 3,342 3,343 3,348 3,349 3,392 3,393 3,398 3,399 3,401 3,403 3,405 341 343 344 3,451 3,452 3,459 346 3,473 3,474 3,479 3,481 3,482 3,483 3,484 3,485 3,489 3,493 3,499
CCS 43 Heart valve procedures
3,500 3,501 3,502 3,503 3,504 3,510 3,511 3,512 3,513 3,514 3,520 3,521 3,522 3,523 3,524 3,525 3,526 3,527 3,528 3,596 3,599
CCS 44 Coronary artery bypass graft
3,610 3,611 3,612 3,613 3,614 3,615 3,616 3,617 3,619 362 363 3,631 3,632 3,633 3,634 3,639
CCS 49 Other operating room heart procedures
3,531 3,532 3,533 3,534 3,535 3,539 3,541 3,542 3,550 3,551 3,552 3,553 3,554 3,555 3,560 3,561 3,562 3,563 3,570 3,571 3,572 3,573 3,581 3,582 3,583 3,584 3,591 3,592 3,593 3,594 3,595 3,598 3,600 3,603 3,609 3,691 3,699 3,710 3,711 3,712 3,731 3,732 3,733 3,734 3,735 3,736 374 3,741 3,749 3,752 3,753 3,754 3,755 3,760 3,761 3,762 3,763 3,764 3,765 3,766 3,767 3,768 3,790 3,791 3,799
CCS 50 Extracorporeal circulation auxiliary to open heart procedures
3,961 3,962 3,963 3,964 3,965 3,966
CCS 51 Endarterectomy; vessel of head and neck
3,811 3,812
CCS 52 Aortic resection; replacement or anastomosis
3,834 3,844 3,864 3,971 3,973
CCS 55 Peripheral vascular bypass
3,925 3,929
CCS 56 Other vascular bypass and shunt; not heart
390 391 3,921 3,922 3,923 3,924 3,926 3,928
CCS 59 Other operating room procedures on vessels of head and neck
0,061 0,062 0,063 0,064 0,065 3,801 3,802 3,831 3,832 3,841 3,842 3,851 3,852 3,861 3,862 3,881 3,882 3,972 3,974 3,975 3,976
CCS 61 Other operating room procedures on vessels other than head and neck
0,040 0,041 0,042 0,043 0,044 0,045 0,046 0,047 0,048 0,055 3,800 3,803 3,804 3,805 3,806 3,807 3,809 3,810 3,813 3,814 3,815 3,816 3,830 3,833 3,835 3,836 3,837 3,838 3,839 3,840 3,843 3,845 3,846 3,847 3,848 3,849 3,850 3,853 3,855 3,857 3,860 3,863 3,865 3,866 3,867 3,868 3,869 387 3,880 3,883 3,884 3,885 3,886 3,887 3,888 3,889 3,930 3,931 3,932 3,941 3,949 3,950 3,951 3,952 3,953 3,954 3,955 3,956 3,957 3,958 3,959 397 3,979 398 3,990 3,991 3,992 3,994 3,998 3,999
CCS 74 Gastrectomy; partial and total
435 436 437 4,381 4,389 4,391 4,399
CCS 75 Small bowel resection
4,561 4,562 4,563

(*continued*)

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Appendix 1. Continued

CCS 78 Colorectal resection
1,731 1,732 1,733 1,734 1,735 1,736 1,739 4,571 4,572 4,573 4,574 4,575 4,576 4,579 458 4,581 4,582 4,583 4,840 4,841 4,842 4,843 4,849 485 4,850 4,851 4,852 4,859 4,861 4,862 4,863 4,864 4,865 4,866 4,869
CCS 79 Local excision of large intestine lesion (not endoscopic)
4,541
CCS 80 Appendectomy
470 4,701 4,709 471 4,711 4,719
CCS 84 Cholecystectomy and common duct exploration
5,121 5,122 5,123 5,124 5,141 5,142 5,143 5,149 5,151 5,159
CCS 85 Inguinal and femoral hernia repair
1,711 1,712 1,713 1,721 1,722 1,723 1,724 5,300 5,301 5,302 5,303 5,304 5,305 5,310 5,311 5,312 5,313 5,314 5,315 5,316 5,317 5,321 5,329 5,331 5,339
CCS 86 Other hernia repair
5,341 5,342 5,343 5,349 5,351 5,359 5,361 5,362 5,363 5,369 537 5,371 5,372 5,375 5,380 5,381 5,382 5,383 5,384 539
CCS 87 Laparoscopy (gastrointestinal only)
5,421
CCS 88 Abdominal paracentesis
5,491
CCS 89 Exploratory laparotomy
5,411
CCS 90 Excision; lysis peritoneal adhesions
545 5,451 5,459
CCS 94 Other operating room upper gastrointestinal therapeutic procedures
4,201 4,209 4,210 4,211 4,212 4,219 4,231 4,232 4,239 4,240 4,241 4,242 4,251 4,252 4,253 4,254 4,255 4,256 4,258 4,259 4,261 4,262 4,263 4,264 4,265 4,266 4,268 4,269 427 4,282 4,283 4,284 4,285 4,286 4,287 4,289 4,299 430 433 4,342 4,349 4,400 4,401 4,402 4,403 442 4,421 4,429 4,431 4,438 4,439 4,440 4,441 4,442 445 4,461 4,463 4,464 4,465 4,466 4,467 4,468 4,469 4,491 4,492 4,495 4,496 4,497 4,498 4,499
CCS 96 Other operating room lower gastrointestinal therapeutic procedures
4,500 4,501 4,502 4,503 4,531 4,532 4,533 4,534 4,549 4,550 4,551 4,552 4,590 4,591 4,592 4,593 4,594 4,595 4,601 4,602 4,603 4,604 4,640 4,641 4,642 4,643 4,650 4,651 4,652 4,660 4,661 4,662 4,663 4,664 4,671 4,672 4,673 4,674 4,675 4,676 4,679 4,680 4,681 4,682 4,691 4,692 4,693 4,694 4,699 472 4,791 4,792 4,799 480 481 4,835 4,871 4,872 4,873 4,874 4,875 4,876 4,879 4,881 4,882 4,891 4,892 4,893 4,899 4,901 4,902 4,904 4,911 4,912 493 4,939 4,951 4,952 4,959 496 4,971 4,972 4,973 4,974 4,975 4,976 4,979 4,991 4,992 4,993 4,994 4,995 4,999
CCS 99 Other operating room gastrointestinal therapeutic procedures
1,763 500 5,021 5,022 5,023 5,024 5,025 5,026 5,029 503 504 5,061 5,069 5,102 5,103 5,104 5,131 5,132 5,133 5,134 5,135 5,136 5,137 5,139 5,161 5,162 5,163 5,169 5,171 5,172 5,179 5,181 5,182 5,183 5,189 5,191 5,192 5,193 5,194 5,195 5,199 5,201 5,209 522 5,222 523 524 5,251 5,252 5,253 5,259 526 527 5,292 5,295 5,296 5,299 540 5,412 5,419 543 544 5,461 5,462 5,463 5,464 5,471 5,472 5,473 5,474 5,475 5,492 5,493 5,494 5,495

* Healthcare Cost and Utilization Project. Clinical Classifications Software for Services and Procedures. 2009; http://www.hcup-us.ahrq.gov/toolssoftware/ccs_svcsproc/ccssvcproc.jsp. Accessed October 26, 2011.

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Appendix 2. Coding Algorithms for Adverse Cardiac and Pulmonary Events

Acute Myocardial Infarction: ICD-9-CM diagnosis codes 410.00–1; 410.10–1; 410.20–1; 410.30–1; 410.40–1; 410.50–1; 410.60–1; 410.70–1; 410.80–1; 410.90–1; 411.1, 411.81–9; 413.9
Congestive Heart Failure: ICD-9-CM diagnosis codes 428.0; 4,281; 428.20–1,3; 428.30–1,3; 428.40–1,3; 428.9; 785.51; 402.01; 402.11; 402.91
Cardiac Arrest: ICD-9-CM diagnosis codes 997.1; 427.5; 427.4; 427.41; 427.42
ICD-9-CM procedure codes 37.61; 37.91; 99.61; 99.60; 99.62; 99.63; 99.69
Pneumonia/empyema: ICD-9-CM diagnosis codes 480.0–487.0; 510.0–9; 513.0–1; 514
Aspiration: ICD-9-CM diagnosis codes 507.0–1; 507.8; 997.3
Respiratory Failure: ICD-9-CM diagnosis codes 518.4; 518.5; 518.81; 518.84; 518.82; 518.89; 799.01; 799.02; 799.1;
ICD-9-CM procedure codes: 96.70; 96.71; 96.72; 96.04

Note: For events defined by International Classification of Diseases-9-Clinical Modification (ICD-9-CM) diagnosis codes, event recorded if: (1) code appears in secondary diagnosis field *and* (2) condition not present-on-admission, as determined by valid negative entry for present-on-admission indicator.

Appendix 3. Hospital Fixed-effects Logistic Regression to Predict In-hospital Mortality among 18,158 Hip Fracture Patients

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.710	0.541, 0.932	0.014
General anesthesia	Reference	—	—
Female sex	0.596	0.480, 0.740	<0.0001
Age	1.047	1.032, 1.062	<0.0001
Lymphoma	2.389	1.158, 4.927	0.018
Psychosis	0.373	0.089, 1.558	0.176
Metastatic cancer	4.664	2.810, 7.741	<0.0001
Pathological fracture	0.615	0.290, 1.308	0.207
Neurologic disorder	1.436	0.992, 2.080	0.055
Alcohol abuse	0.496	0.193, 1.278	0.147
Cardiac arrhythmia	1.366	1.093, 1.709	0.006
Hypothyroidism	0.870	0.656, 1.153	0.332
Congestive heart failure	2.268	1.800, 2.858	<0.0001
Weight loss	1.845	1.142, 2.980	0.012
Chronic obstructive pulmonary disease	1.329	0.980, 1.802	0.067
Cardiac valvular disease	1.385	1.033, 1.858	0.029
Depression	0.746	0.518, 1.074	0.115
Diabetes	0.725	0.539, 0.976	0.034
Liver disease	3.480	1.839, 6.586	<0.0001
Renal disease	1.920	1.225, 3.009	0.004
Electrolyte abnormality	1.226	0.929, 1.617	0.150
Hypertension (uncomplicated)	0.455	0.349, 0.594	<0.0001
Hypertension (complicated)	0.665	0.424, 1.044	0.076
Propensity score quintile 2	0.843	0.598, 1.187	0.328
Propensity score quintile 3	1.098	0.777, 1.551	0.598
Propensity score quintile 4	1.168	0.816, 1.672	0.395
Propensity score quintile 5	1.152	0.733, 1.813	0.539

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Appendix 4. Hospital Fixed-effects Logistic Regression to Predict Any In-hospital Pulmonary Complication among 18,158 Hip Fracture Patients

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.752	0.637, 0.887	0.001
General anesthesia	Reference	—	—
Female sex	0.659	0.581, 0.746	<0.0001
Age	1.079	1.020, 1.032	<0.0001
Liver disease	1.492	0.942, 2.364	0.088
Fracture type: intertrochanteric	1.079	0.902, 1.292	0.405
Fracture type: subtrochanteric	1.466	1.077, 1.994	0.015
Fracture type: multiple/other	1.029	0.741, 1.429	0.864
Fracture type: femoral neck	Reference	—	—
Surgery: internal fixation	1.067	0.741, 1.536	0.726
Surgery: total hip arthroplasty	1.375	1.145, 1.651	0.001
Surgery: hemiarthroplasty	Reference	—	—
Paralysis	1.631	0.757, 3.514	0.211
Hypothyroidism	0.833	0.703, 0.988	0.036
Renal disease	1.160	0.895, 1.504	0.262
Ulcer	1.945	1.194, 3.168	0.008
Neurologic disorder	1.309	1.077, 1.592	0.007
Congestive heart failure	1.838	1.626, 2.077	<0.0001
Hypertension (complicated)	0.822	0.624, 1.082	0.162
Hypertension (uncomplicated)	0.653	0.575, 0.741	<0.0001
Chronic obstructive pulmonary disease	1.830	1.573, 2.129	<0.0001
Weight loss	1.856	1.241, 2.776	0.003
Diabetes	0.809	0.694, 0.943	0.007
Propensity score quintile 2	0.923	0.752, 1.133	0.445
Propensity score quintile 3	0.962	0.777, 1.191	0.720
Propensity score quintile 4	0.976	0.794, 1.199	0.818
Propensity score quintile 5	1.003	0.778, 1.294	0.979

Appendix 5. Hospital Fixed-effects Logistic Regression to Predict Any In-hospital Cardiovascular Complication among 18,158 Hip Fracture Patients

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.877	0.748, 1.029	0.107
General anesthesia	Reference	—	—
Female sex	0.860	0.731, 1.012	0.069
Age	1.041	1.033, 1.049	<0.0001
Race: white	0.798	0.468, 1.359	0.406
Race: black	1.151	0.849, 1.561	0.364
Race: other	Reference	—	—
Fracture type: intertrochanteric	1.357	1.086, 1.696	0.007
Fracture type: subtrochanteric	1.548	1.032, 2.325	0.035
Fracture type: multiple/other	1.486	1.025, 2.154	0.037
Fracture type: femoral neck	Reference	—	—
Surgery: internal fixation	1.385	0.931, 2.063 0.108	—
Surgery: total hip arthroplasty	1.470	1.192, 1.814	<0.0001
Surgery: hemiarthroplasty	Reference	—	—
Rheumatoid arthritis	0.576	0.359, 0.926	0.023
Hypertension (uncomplicated)	0.772	0.651, 0.915	0.003
Neurologic disorder	0.814	0.599, 1.105	0.187
Liver disease	1.643	0.920, 2.934	0.093
Electrolyte abnormality	0.814	0.648, 1.022	0.077
Congestive heart failure	1.456	1.202, 1.765	<0.0001
Coagulopathy	0.683	0.390, 1.198	0.183
Chronic obstructive pulmonary disease	1.358	1.127, 1.637	0.001
Dementia	0.737	0.613, 0.887	0.001
Depression	0.758	0.614, 0.937	0.010
Hypothyroidism	0.812	0.666, 0.991	0.041
Hypertension (complicated)	1.254	0.982, 1.602	0.069
Cardiac valvular disease	1.488	1.240, 1.784	<0.0001
Propensity score quintile 2	1.193	0.926, 1.538	0.172
Propensity score quintile 3	1.003	0.786, 1.280	0.980
Propensity score quintile 4	1.052	0.805, 1.375	0.712
Propensity score quintile 5	1.118	0.827, 1.510	0.469

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Appendix 6. Hospital Fixed-effects Logistic Regression to Predict In-hospital Mortality among 8,766 Patients with Femoral Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.815	0.544, 1.221	0.322
General anesthesia	Reference	—	—
Female sex	0.745	0.538, 1.032	0.076
Age	1.030	1.008, 1.052	0.008
Lymphoma	2.806	0.967, 8.143	0.058
Psychosis	0.408	0.051, 3.247	0.397
Metastatic cancer	5.577	2.603, 11.951	<0.0001
Pathological fracture	0.632	0.283, 1.410	0.263
Neurologic disorder	1.343	0.771, 2.340	0.298
Alcohol abuse	0.615	0.179, 2.107	0.439
Cardiac arrhythmia	1.540	1.104, 2.149	0.011
Hypothyroidism	0.792	0.535, 1.173	0.244
Congestive heart failure	2.632	1.849, 3.745	<0.0001
Weight loss	1.429	0.585, 3.486	0.433
Chronic obstructive pulmonary disease	1.322	0.844, 2.071	0.223
Cardiac valvular disease	1.390	0.878, 2.202	0.160
Depression	0.627	0.368, 1.069	0.086
Diabetes	0.610	0.389, 0.957	0.031
Liver disease	3.952	1.576, 9.908	0.003
Renal disease	2.054	1.067, 3.954	0.031
Electrolyte abnormality	1.058	0.706, 1.585	0.785
Hypertension (uncomplicated)	0.508	0.335, 0.770	0.001
Hypertension (complicated)	0.836	0.428, 1.634	0.600
Propensity score quintile 2	0.954	0.572, 1.592	0.857
Propensity score quintile 3	1.166	0.671, 2.026	0.587
Propensity score quintile 4	1.144	0.647, 2.024	0.643
Propensity score quintile 5	1.554	0.725, 3.332	0.257

Appendix 7. Hospital Fixed-effects Logistic Regression to Predict Any In-hospital Pulmonary Complication among 8,766 Patients with Femoral Neck Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.823	0.652, 1.040	0.103
General anesthesia	Reference	—	—
Female sex	0.690	0.571, 0.834	<0.0001
Age	1.026	1.015, 1.036	<0.0001
Liver disease	1.575	0.859, 2.887	0.142
Surgery: internal fixation	1.046	0.728, 1.503	0.807
Surgery: total hip arthroplasty	1.406	1.119, 1.741	0.003
Surgery: hemiarthroplasty	Reference	—	—
Paralysis	1.189	0.363, 3.898	0.775
Hypothyroidism	0.890	0.711, 1.116	0.313
Renal disease	1.052	0.704, 1.574	0.804
Peptic ulcer disease	2.114	0.904, 4.942	0.084
Neurologic disorder	1.217	0.956, 1.548	0.111
Congestive heart failure	2.022	1.677, 2.438	<0.0001
Hypertension (complicated)	0.971	0.621, 1.519	0.897
Hypertension (uncomplicated)	0.654	0.555, 0.771	<0.0001
Chronic obstructive pulmonary disease	1.707	1.378, 2.115	<0.0001
Weight loss	1.674	1.020, 2.747	0.041
Diabetes	0.780	0.616, 0.987	0.038
Propensity score quintile 2	1.028	0.763, 1.386	0.855
Propensity score quintile 3	1.079	0.770, 1.513	0.658
Propensity score quintile 4	1.023	0.718, 1.457	0.901
Propensity score quintile 5	1.094	0.774, 1.546	0.609

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Appendix 8. Hospital Fixed-effects Logistic Regression to Predict Any In-hospital Cardiovascular Complication among 8,766 Patients with Femoral Neck Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.876	0.675, 1.135	0.316
General anesthesia	Reference	—	—
Female sex	0.977	0.789, 1.211	0.834
Age	1.044	1.030, 1.058	<0.0001
Race: white	0.727	0.414, 1.279	0.269
Race: black	1.308	0.822, 2.082	0.258
Race: other	Reference	—	—
Surgery: internal fixation	1.536	0.988, 2.388	0.056
Surgery: total hip arthroplasty	1.440	1.101, 1.883	0.008
Surgery: hemiarthroplasty	Reference	—	—
Rheumatoid arthritis	0.686	0.364, 1.291	0.242
Hypertension (uncomplicated)	0.890	0.710, 1.115	0.311
Neurologic disorder	1.148	0.782, 1.687	0.481
Liver disease	2.233	1.062, 4.696	0.034
Electrolyte abnormality	0.772	0.557, 1.071	0.122
Congestive heart failure	1.815	1.395, 2.363	<0.0001
Coagulopathy	0.608	0.269, 1.374	0.231
Chronic obstructive pulmonary disease	1.437	1.108, 1.865	0.006
Dementia	0.646	0.494, 0.845	0.001
Depression	0.609	0.423, 0.875	0.007
Hypothyroidism	0.706	0.517, 0.964	0.029
Hypertension (complicated)	1.261	0.878, 1.812	0.210
Cardiac valvular disease	1.254	0.973, 1.615	0.080
Propensity score quintile 2	1.198	0.834, 1.721	0.329
Propensity score quintile 3	0.956	0.650, 1.407	0.821
Propensity score quintile 4	1.018	0.691, 1.500	0.928
Propensity score quintile 5	1.147	0.727, 1.809	0.555

Appendix 9. Hospital Fixed-effects Logistic Regression to Predict In-hospital Mortality among 8,031 Patients with Intertrochanteric Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.572	0.368, 0.889	0.013
General anesthesia	Reference	—	—
Female sex	0.478	0.342, 0.668	<0.0001
Age	1.058	1.033, 1.083	<0.0001
Lymphoma	1.924	0.572, 6.480	0.291
Psychosis	0.458	0.056, 3.748	0.466
Metastatic cancer	3.750	1.452, 9.682	0.006
Neurologic disorder	1.536	0.836, 2.821	0.167
Alcohol abuse	0.340	0.052, 2.219	0.260
Cardiac arrhythmia	1.102	0.758, 1.604	0.610
Hypothyroidism	0.979	0.611, 1.570	0.931
Congestive heart failure	2.120	1.520, 2.956	<0.0001
Weight loss	2.915	1.542, 5.513	0.001
Chronic obstructive pulmonary disease	1.231	0.801, 1.892	0.342
Cardiac valvular disease	1.419	0.890, 2.263	0.141
Depression	0.982	0.624, 1.544	0.936
Diabetes	0.911	0.598, 1.388	0.665
Liver disease	3.086	0.972, 9.795	0.056
Renal disease	2.744	1.318, 5.710	0.007
Electrolyte abnormality	1.495	1.032, 2.165	0.033
Hypertension (uncomplicated)	0.379	0.266, 0.540	<0.0001
Hypertension (complicated)	0.423	0.209, 0.859	0.017
Propensity score quintile 2	0.697	0.366, 1.327	0.272
Propensity score quintile 3	1.123	0.658, 1.917	0.671
Propensity score quintile 4	1.195	0.662, 2.158	0.554
Propensity score quintile 5	0.983	0.483, 1.998	0.962

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Appendix 10. Hospital Fixed-effects Logistic Regression to Predict Any in-hospital Pulmonary Complication among 8,031 Patients with Intertrochanteric Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.632	0.482, 0.830	0.001
General anesthesia	Reference	—	—
Female sex	0.608	0.491, 0.752	<0.0001
Age	1.026	1.016, 1.037	<0.0001
Liver disease	1.373	0.660, 2.859	0.397
Surgery: internal fixation	1.391	0.392, 4.933	0.609
Surgery: total hip arthroplasty	1.546	1.045, 2.288	0.029
Surgery: hemiarthroplasty	Reference	—	—
Paralysis	2.893	0.819, 10.215	0.099
Hypothyroidism	0.799	0.601, 1.062	0.122
Renal disease	1.426	0.974, 2.087	0.068
Peptic ulcer disease	2.007	1.077, 3.741	0.028
Neurologic disorder	1.483	1.108, 1.984	0.008
Congestive heart failure	1.630	1.361, 1.951	<0.0001
Hypertension (complicated)	0.680	0.464, 0.995	0.047
Hypertension (uncomplicated)	0.675	0.549, 0.832	<0.0001
Chronic obstructive pulmonary disease	1.928	1.506, 2.469	<0.0001
Weight loss	2.221	1.236, 3.994	0.008
Diabetes	0.848	0.662, 1.086	0.191
Propensity score quintile 2	0.846	0.620, 1.154	0.291
Propensity score quintile 3	0.783	0.583, 1.051	0.104
Propensity score quintile 4	0.951	0.692, 1.307	0.758
Propensity score quintile 5	0.971	0.671, 1.406	0.878

Appendix 11. Hospital Fixed-effects Logistic Regression to Predict Any In-hospital Cardiovascular Complication among 8,031 Patients with Intertrochanteric Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.821	0.628, 1.072	0.147
General anesthesia	Reference	—	—
Female sex	0.727	0.593, 0.892	0.002
Age	1.038	1.023, 1.054	<0.0001
Race: white	0.604	0.250, 1.457	0.262
Race: black	1.046	0.708, 1.547	0.821
Race: other	Reference	—	—
Surgery: internal fixation	1.003	0.104, 9.622	0.998
Surgery: total hip arthroplasty	1.844	1.099, 3.092	0.020
Surgery: hemiarthroplasty	Reference	—	—
Rheumatoid arthritis	0.351	0.130, 0.952	0.040
Hypertension (uncomplicated)	0.693	0.552, 0.869	0.002
Neurologic disorder	0.457	0.267, 0.781	0.004
Liver disease	1.257	0.526, 3.004	0.607
Electrolyte abnormality	0.922	0.646, 1.318	0.657
Congestive heart failure	1.196	0.914, 1.565	0.192
Coagulopathy	0.692	0.317, 1.510	0.355
Chronic obstructive pulmonary disease	1.342	0.995, 1.810	0.054
Dementia	0.886	0.652, 1.203	0.438
Depression	0.937	0.699, 1.255	0.662
Hypothyroidism	0.966	0.717, 1.302	0.821
Hypertension (complicated)	1.273	0.935, 1.733	0.125
Cardiac valvular disease	1.606	1.210, 2.133	0.001
Propensity score quintile 2	1.219	0.820, 1.813	0.328
Propensity score quintile 3	0.993	0.674, 1.463	0.972
Propensity score quintile 4	0.984	0.613, 1.578	0.946
Propensity score quintile 5	1.057	0.620, 1.803	0.838

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Appendix 12. Hospital Random-effects Logistic Regression to Predict In-hospital Mortality among 18,158 Hip Fracture Patients

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.762	0.607, 0.958	0.020
General anesthesia	Reference	—	—
Female sex	0.600	0.488, 0.739	<0.0001
Age	1.047	1.033, 1.062	<0.0001
Lymphoma	2.372	1.111, 5.064	0.026
Psychosis	0.382	0.092, 1.581	0.184
Metastatic cancer	4.439	2.638, 7.469	<0.0001
Pathological fracture	0.626	0.303, 1.294	0.206
Neurologic disorder	1.455	1.026, 2.064	0.035
Alcohol abuse	0.498	0.205, 1.207	0.123
Cardiac arrhythmia	1.407	1.133, 1.747	0.002
Hypothyroidism	0.840	0.633, 1.116	0.229
Congestive heart failure	2.191	1.748, 2.745	<0.0001
Weight loss	1.837	1.136, 2.972	0.013
Chronic obstructive pulmonary disease	1.365	1.047, 1.780	0.021
Cardiac valvular disease	1.287	0.977, 1.696	0.073
Depression	0.769	0.544, 1.087	0.137
Diabetes	0.749	0.562, 0.997	0.048
Liver disease	3.628	1.968, 6.688	<0.0001
Renal disease	1.837	1.219, 2.769	0.004
Electrolyte disorder	1.271	1.001, 1.613	0.049
Hypertension (uncomplicated)	0.462	0.367, 0.582	<0.0001
Hypertension (complicated)	0.682	0.465, 1.001	0.050
Propensity score quintile 2	0.812	0.566, 1.165	0.258
Propensity score quintile 3	1.034	0.704, 1.518	0.866
Propensity score quintile 4	1.092	0.728, 1.638	0.670
Propensity score quintile 5	1.093	0.684, 1.745	0.711

Appendix 13. Hospital Random-effects Logistic Regression to Predict Any In-hospital Pulmonary Complication among 18,158 Hip Fracture Patients

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.757	0.658, 0.870	<0.0001
General anesthesia	Reference	—	—
Female sex	0.655	0.580, 0.740	<0.0001
Age	1.025	1.018, 1.033	<0.0001
Liver disease	1.545	1.006, 2.371	0.047
Fracture type: intertrochanteric	1.083	0.908, 1.293	0.374
Fracture type: subtrochanteric	1.500	1.115, 2.019	0.007
Fracture type: multiple/other	1.070	0.759, 1.508	0.698
Fracture type: femoral neck	Reference	—	—
Surgery: internal fixation	1.082	0.776, 1.507	0.644
Surgery: total hip arthroplasty	1.391	1.163, 1.663	<0.0001
Surgery: hemiarthroplasty	Reference	—	—
Paralysis	1.737	0.841, 3.588	0.136
Hypothyroidism	0.839	0.714, 0.987	0.034
Renal disease	1.184	0.904, 1.549	0.220
Peptic ulcer disease	1.909	1.088, 3.349	0.024
Neurologic disorder	1.299	1.063, 1.586	0.010
Congestive heart failure	1.833	1.599, 2.102	<0.0001
Hypertension (complicated)	0.819	0.630, 1.064	0.135
Hypertension (uncomplicated)	0.662	0.583, 0.751	<0.0001
Chronic obstructive pulmonary disease	1.849	1.591, 2.148	<0.0001
Weight loss	1.863	1.377, 2.520	<0.0001
Diabetes	0.813	0.695, 0.952	0.010
Propensity score quintile 2	0.925	0.758, 1.129	0.444
Propensity score quintile 3	0.959	0.777, 1.184	0.696
Propensity score quintile 4	0.971	0.778, 1.211	0.792
Propensity score quintile 5	0.997	0.776, 1.281	0.981

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Appendix 14. Hospital Random-effects Logistic Regression to Predict Any In-hospital Cardiovascular Complication among 18,158 Hip Fracture Patients

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.847	0.720, 0.998	0.047
General anesthesia	Reference	—	—
Female sex	0.853	0.733, 0.993	0.041
Age	1.041	1.031, 1.051	<0.0001
Race: white	0.823	0.516, 1.310	0.411
Race: black	1.183	0.942, 1.484	0.148
Race: other	Reference	—	—
Fracture type: intertrochanteric	1.364	1.097, 1.696	0.005
Fracture type: subtrochanteric	1.586	1.095, 2.298	0.015
Fracture type: multiple/other	1.494	1.013, 2.203	0.043
Fracture type: femoral neck	Reference	—	—
Surgery: internal fixation	1.455	0.988, 2.143	0.058
Surgery: total hip arthroplasty	1.490	1.193, 1.862	<0.0001
Surgery: hemiarthroplasty	Reference	—	—
Rheumatoid arthritis	0.569	0.347, 0.933	0.025
Hypertension (uncomplicated)	0.778	0.668, 0.906	0.001
Neurologic disorder	0.798	0.593, 1.074	0.136
Liver disease	1.620	0.924, 2.841	0.092
Electrolyte disorder	0.809	0.669, 0.978	0.028
Congestive heart failure	1.477	1.250, 1.744	<0.0001
Coagulopathy	0.666	0.413, 1.074	0.095
Chronic obstructive pulmonary disease	1.382	1.144, 1.670	0.001
Dementia	0.748	0.622, 0.900	0.002
Depression	0.763	0.605, 0.962	0.022
Hypothyroidism	0.815	0.672, 0.989	0.038
Hypertension (complicated)	1.243	1.004, 1.540	0.046
Cardiac valvular disease	1.467	1.209, 1.780	<0.0001
Propensity score quintile 2	1.156	0.902, 1.480	0.252
Propensity score quintile 3	0.964	0.734, 1.264	0.789
Propensity score quintile 4	0.999	0.745, 1.339	0.992
Propensity score quintile 5	1.052	0.760, 1.457	0.759

Appendix 15. Hospital Random-effects Logistic Regression to Predict Any In-hospital Mortality among 8,766 Patients with Femoral Neck Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.800	0.570, 1.122	0.196
General anesthesia	Reference	—	—
Female sex	0.740	0.546, 1.002	0.051
Age	1.031	1.011, 1.052	0.003
Lymphoma	3.185	1.179, 8.609	0.022
Psychosis	0.438	0.059, 3.268	0.421
Metastatic cancer	5.450	2.677, 11.096	<0.0001
Pathological fracture	0.585	0.264, 1.298	0.187
Neurologic disorder	1.360	0.808, 2.288	0.247
Alcohol abuse	0.581	0.169, 1.995	0.388
Cardiac arrhythmia	1.638	1.195, 2.245	0.002
Hypothyroidism	0.796	0.525, 1.207	0.283
Congestive heart failure	2.535	1.824, 3.523	<0.0001
Weight loss	1.487	0.660, 3.349	0.338
Chronic obstructive pulmonary disease	1.347	0.926, 1.959	0.119
Cardiac valvular disease	1.263	0.839, 1.903	0.263
Depression	0.660	0.394, 1.106	0.115
Diabetes	0.637	0.412, 0.985	0.043
Liver disease	3.798	1.582, 9.120	0.003
Renal disease	2.072	1.154, 3.718	0.015
Electrolyte disorder	1.146	0.798, 1.644	0.461
Hypertension (uncomplicated)	0.516	0.366, 0.725	<0.0001
Hypertension (complicated)	0.811	0.475, 1.382	0.441
Propensity score quintile 2	0.935	0.552, 1.584	0.803
Propensity score quintile 3	1.069	0.596, 1.918	0.823
Propensity score quintile 4	1.067	0.578, 1.969	0.835
Propensity score quintile 5	1.470	0.744, 2.906	0.268

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Appendix 16. Hospital Random-effects Logistic Regression to Predict Any In-hospital Pulmonary Complication among 8,766 Patients with Femoral Neck Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.843	0.697, 1.020	0.079
General anesthesia	Reference	—	—
Female sex	0.688	0.580, 0.817	<0.0001
Age	1.025	1.014, 1.036	<0.0001
Liver disease	1.587	0.846, 2.976	0.150
Surgery: internal fixation	1.084	0.748, 1.572	0.670
Surgery: total hip arthroplasty	1.399	1.141, 1.716	0.001
Surgery: hemiarthroplasty	Reference	—	—
Paralysis	1.375	0.475, 3.981	0.557
Hypothyroidism	0.915	0.732, 1.144	0.437
Renal disease	1.085	0.748, 1.574	0.665
Peptic ulcer disease	2.040	0.873, 4.769	0.100
Neurologic disorder	1.202	0.903, 1.602	0.207
Congestive heart failure	1.992	1.641, 2.419	<0.0001
Hypertension (complicated)	0.939	0.659, 1.338	0.727
Hypertension (uncomplicated)	0.653	0.545, 0.783	<0.0001
Chronic obstructive pulmonary disease	1.730	1.406, 2.128	<0.0001
Weight loss	1.683	1.056, 2.683	0.029
Diabetes	0.787	0.626, 0.990	0.041
Propensity score quintile 2	1.041	0.779, 1.393	0.785
Propensity score quintile 3	1.085	0.800, 1.471	0.599
Propensity score quintile 4	1.039	0.756, 1.426	0.815
Propensity score quintile 5	1.122	0.790, 1.592	0.520

Appendix 17. Hospital Random-effects Logistic Regression to Predict Any In-hospital Cardiovascular Complication among 8,766 Patients with Femoral Neck Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.894	0.708, 1.128	0.345
General anesthesia	Reference	—	—
Female sex	0.970	0.777, 1.212	0.791
Age	1.043	1.028, 1.058	<0.0001
Race: white	0.685	0.350, 1.338	0.268
Race: black	1.202	0.848, 1.703	0.302
Race: other	Reference	—	—
Surgery: internal fixation	1.662	1.076, 2.567	0.022
Surgery: total hip arthroplasty	1.475	1.135, 1.918	0.004
Surgery: hemiarthroplasty	—	—	—
Rheumatoid arthritis	0.700	0.376, 1.306	0.263
Hypertension (uncomplicated)	0.889	0.709, 1.114	0.305
Neurologic disorder	1.050	0.707, 1.557	0.810
Liver disease	2.178	1.021, 4.645	0.044
Electrolyte disorder	0.766	0.576, 1.020	0.068
Congestive heart failure	1.853	1.455, 2.361	<0.0001
Coagulopathy	0.585	0.276, 1.241	0.162
Chronic obstructive pulmonary disease	1.454	1.112, 1.902	0.006
Dementia	0.670	0.507, 0.887	0.005
Depression	0.620	0.433, 0.886	0.009
Hypothyroidism	0.724	0.539, 0.972	0.031
Hypertension (complicated)	1.219	0.886, 1.677	0.224
Cardiac valvular disease	1.209	0.898, 1.626	0.211
Propensity score quintile 2	1.127	0.773, 1.643	0.535
Propensity score quintile 3	0.893	0.592, 1.348	0.590
Propensity score quintile 4	0.939	0.611, 1.444	0.776
Propensity score quintile 5	1.064	0.667, 1.697	0.794

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Appendix 18. Hospital Random-effects Logistic Regression to Predict In-hospital Mortality among 8,031 Patients with Intertrochanteric Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.697	0.494, 0.984	0.040
General anesthesia	Reference	—	—
Female sex	0.498	0.364, 0.682	<0.0001
Age	1.056	1.033, 1.080	<0.0001
Lymphoma	1.975	0.563, 6.920	0.288
Psychosis	0.410	0.054, 3.125	0.389
Metastatic cancer	3.941	1.657, 9.372	0.002
Neurologic disorder	1.564	0.930, 2.630	0.092
Alcohol abuse	0.341	0.074, 1.570	0.167
Cardiac arrhythmia	1.117	0.802, 1.556	0.512
Hypothyroidism	0.878	0.575, 1.340	0.545
Congestive heart failure	1.951	1.394, 2.731	<0.0001
Weight loss	2.629	1.420, 4.868	0.002
Chronic obstructive pulmonary disease	1.261	0.823, 1.932	0.286
Cardiac valvular disease	1.420	0.939, 2.147	0.097
Depression	0.959	0.589, 1.562	0.867
Diabetes	0.918	0.611, 1.380	0.682
Liver disease	3.332	1.205, 9.214	0.020
Renal disease	2.497	1.318, 4.729	0.005
Electrolyte disorder	1.525	1.083, 2.147	0.016
Hypertension (uncomplicated)	0.392	0.277, 0.556	<0.0001
Hypertension (complicated)	0.476	0.261, 0.868	0.015
Propensity score quintile 2	0.673	0.382, 1.185	0.170
Propensity score quintile 3	1.139	0.645, 2.012	0.655
Propensity score quintile 4	1.179	0.635, 2.188	0.602
Propensity score quintile 5	0.950	0.448, 2.018	0.895

Appendix 19. Hospital Random-effects Logistic Regression to Predict Any In-hospital Pulmonary Complication among 8,031 Patients with Intertrochanteric Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.668	0.540, 0.827	<0.0001
General anesthesia	Reference	—	—
Female sex	0.609	0.503, 0.738	<0.0001
Age	1.026	1.014, 1.038	<0.0001
Liver disease	1.420	0.712, 2.833	0.320
Surgery: internal fixation	1.396	0.485, 4.014	0.536
Surgery: total hip arthroplasty	1.511	0.944, 2.418	0.085
Surgery: hemiarthroplasty	Reference	—	—
Paralysis	3.053	0.971, 9.605	0.056
Hypothyroidism	0.780	0.603, 1.010	0.060
Renal disease	1.479	0.968, 2.260	0.070
Peptic ulcer disease	2.040	0.941, 4.422	0.071
Neurologic disorder	1.446	1.069, 1.955	0.017
Congestive heart failure	1.644	1.333, 2.028	<0.0001
Hypertension (complicated)	0.699	0.460, 1.062	0.093
Hypertension (uncomplicated)	0.686	0.564, 0.836	<0.0001
Chronic obstructive pulmonary disease	1.941	1.527, 2.468	<0.0001
Weight loss	2.255	1.486, 3.420	<0.0001
Diabetes	0.859	0.677, 1.090	0.212
Propensity score quintile 2	0.848	0.622, 1.156	0.296
Propensity score quintile 3	0.785	0.565, 1.089	0.147
Propensity score quintile 4	0.911	0.648, 1.281	0.592
Propensity score quintile 5	0.934	0.630, 1.386	0.736

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Appendix 20. Hospital Random-effects Logistic Regression to Predict Any In-hospital Cardiovascular Complication among 8,031 Patients with Intertrochanteric Fractures

Covariate	Odds Ratio	95% CI	*P* Value
Regional anesthesia	0.766	0.602, 0.975	0.030
General anesthesia	Reference	—	—
Female sex	0.734	0.585, 0.922	0.008
Age	1.038	1.023, 1.054	<0.0001
Race: white	0.749	0.345, 1.627	0.466
Race: black	1.205	0.875, 1.658	0.253
Race: other	Reference	—	—
Surgery: internal fixation	0.911	0.213, 3.894	0.900
Surgery: total hip arthroplasty	1.862	1.126, 3.078	0.015
Surgery: hemiarthroplasty	Reference	—	—
Rheumatoid arthritis	0.335	0.123, 0.913	0.032
Hypertension (uncomplicated)	0.706	0.561, 0.887	0.003
Neurologic disorder	0.468	0.274, 0.799	0.005
Liver disease	1.269	0.501, 3.213	0.616
Electrolyte disorder	0.904	0.689, 1.186	0.468
Congestive heart failure	1.208	0.940, 1.553	0.139
Coagulopathy	0.703	0.355, 1.394	0.313
Chronic obstructive pulmonary disease	1.381	1.031, 1.851	0.030
Dementia	0.901	0.694, 1.170	0.435
Depression	0.954	0.690, 1.320	0.776
Hypothyroidism	0.961	0.728, 1.268	0.778
Hypertension (complicated)	1.332	0.975, 1.821	0.072
Cardiac valvular disease	1.618	1.224, 2.138	0.001
Propensity score quintile 2	1.202	0.827, 1.747	0.336
Propensity score quintile 3	0.994	0.663, 1.490	0.977
Propensity score quintile 4	0.972	0.623, 1.516	0.900
Propensity score quintile 5	0.993	0.601, 1.643	0.979

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