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Total Hip Arthroplasty for Femoral Neck Fractures: Improved Outcomes with Higher Hospital Volumes

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Abstract

Objectives—To determine if hospital arthroplasty volume affects patient outcomes after undergoing total hip arthroplasty for displaced femoral neck fractures.

Methods—The Statewide Planning and Research Cooperative System database from the New York State Department of Health was used to group hospitals into quartiles based on overall total hip arthroplasty (THA) volume from 2000–2010. The database was then queried to identify all patients undergoing THA specifically for femoral neck fracture during this time period. The data

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was analyzed to investigate outcomes between the four volume quartiles in 30-day and 1-year mortality, 1-year revision rate, and 90-day complication rate (readmission for dislocation, deep vein thrombosis, pulmonary embolism, prosthetic joint infection, or other complications related to arthroplasty in the treatment of femoral neck fractures with total hip arthroplasty).

Results—Patients undergoing THA for femoral neck fracture at hospitals in the top volume quartile had significantly lower 30-day (0.9%) and 1-year (7.51%) mortality than all other volume quartiles. There were no significant differences on pairwise comparisons between the second, third, and fourth quartiles with regard to post-operative mortality. There was no significant difference in revision arthroplasty at 1 year between any of the volume quartiles. On Cox regression analysis, THA for fracture at the lowest volume (4th) quartile (Hazard Ratio (HR) 1.91; $p=0.016$, 95% Confidence Interval (CI) [1.13–3.25]), second lowest volume (3rd) quartile (HR 2.01; $p=0.013$, 95% CI [1.16–3.5]) and third lowest volume (2nd) quartile (HR 2.13; $p=0.005$, 95% CI [1.26–3.62]) were associated with increased risk for a 1-year postoperative mortality event. Hospital volume quartile was also a significant risk factor for increased 90-day complication (PE/DVT, acute dislocation, prosthetic joint infection) following THA for femoral neck fracture. Having surgery in the fourth quartile (HR 2.71; $p<0.001$, 95% CI [1.7–4.31]), third quartile (HR 2.61; $p<0.001$, 95% CI [1.61–4.23]) and second quartile (HR 2.41; $p<0.001$, 95% CI [1.51–3.84]) all were significant risk factors for increased 90-day complication risk.

Conclusions—The results of this population-based study indicate that THA for femoral neck fractures at high-volume arthroplasty centers is associated with lower mortality and 90-day complication rates but does not influence 1-year revision rate. THA for femoral neck fractures at top arthroplasty volume quartile hospitals are performed on healthier patients more quickly. Patient health is a critical factor that influences mortality outcomes following THA for femoral neck fractures.

Keywords

femoral neck fracture; total hip arthroplasty; complication; prosthetic dislocation; infected total hip arthroplasty; post operative mortality; Hip Fracture; geriatric fracture

INTRODUCTION

Femoral neck fractures are common in the geriatric population and are associated with high morbidity and mortality. The worldwide incidence of hip fractures is expected to approach 6.26 million by 2050.¹ Displaced femoral neck fractures in elderly patients are typically treated with hemiarthroplasty (HA)², however, rates of total hip arthroplasty (THA) are increasing for femoral neck fractures in the active elderly.³ Purported benefits of THA over HA include improved functional outcome scores^{4–9} and decreased pain.^{4,10,11} However, THA risks increased operative time, blood loss, and dislocation risk.^{8,9,12–14}

The arthroplasty literature regarding elective cases suggests that complication rates are lowest when surgery is performed in centers with higher operative volume and experience with the procedure.^{15–18} In these studies, 6-month revision rates¹⁵, postoperative mortality¹⁶, and hip dislocation are lowest at high-volume centers.^{17,18} We are aware of no

study to date that has examined whether increased arthroplasty experience translates into improved outcome for hip replacement after fracture.

This study uses population-based data from the New York Statewide Planning and Research Cooperative System (SPARCS) to compare mortality and complications of femoral neck fractures treated with THA. The hospital demographic information obtained from this data set allows for a comparison between different hospital quartiles based on hip arthroplasty volume. We hypothesized a lower complication and mortality rate for patients with femoral neck fracture treated with THA at high-volume arthroplasty hospitals.

PATIENTS AND METHODS

The New York Department of Health Statewide Planning and Research Cooperative System (SPARCS) provided data for this study. SPARCS is an administrative database established in 1979 which collects patient-level data from all non-federal acute care facilities in the State of New York and contains information on patient demographics, diagnoses, treatments, and charges for every hospital discharge, ambulatory surgical procedure, and emergency department admission. Each patient is assigned a unique, encrypted identification code to allow for longitudinal analyses. Estimated reporting completeness obtained from SPARCS annual reports from 2000–2010 ranged from 95–100% with an average of 98.7% completeness.¹⁹ Mortality data was obtained through SPARCS linkage with the New York State Department of Health, Office of Vital Records and New York City Department of Health and Mental Hygiene.

Using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis and ICD-9 procedural codes we identified 3,986 records in patients 60 years of age with inpatient hospital admissions from January 1, 2000 through December 31, 2010 with a diagnosis code for femoral neck fracture (ICD-9, 821.0–821.09) who underwent total hip arthroplasty (procedure code 81.51). Follow-up cutoff date for complications or mortality was December 31, 2011. The analysis included 189 hospitals in the State of New York where total hip arthroplasty was performed.

To determine individual hospital volume of THA we identified 87,558 hospitalizations in New York State during the study period for THA without a diagnosis code for hip fracture. These records were used to group hospitals into quartiles based on overall volume of THA for the study period. The highest volume centers were defined as top or 1st quartile (high-volume) while the lowest volume centers were defined as bottom or 4th quartile (low-volume). To this aim, all hospital volume comparison groups as mentioned in the text refer specifically to a center's THA volume for all indications other than femoral neck fracture. (Table 1)

We then identified instances of THA specifically for femoral neck fracture within each of the hip arthroplasty volume quartiles. Outcomes of the hip fracture cases were then compared with respect to the overall volume of THA performed at that center.

Comorbid conditions, using the method reported by Charlson et al were assigned with use of a Stata interpretation of SAS software program obtained from the Boston College

Department of Economics in its series Statistical Software Components.^{20–22} Other methods for assessing risk of mortality include the all-patient refined diagnosis-related group (APR-DRG) risk of mortality (ROM) index developed by 3M.²³ Many patients in this dataset did not have APR-DRG ROM data included; however, a separate analysis (presented in Appendices 1 and 2) evaluates the relationship of mortality (30 day and 1 year) with quartiles, race, and ROM index, and quartile-Rom interaction, where appropriate.

Study Comparison Groups

Univariate analysis was conducted to investigate pairwise comparisons between the four volume quartiles in 30-day and 1-year mortality, 1-year revision rate, and 90-day complication rate (readmission for dislocation, deep vein thrombosis, pulmonary embolism, prosthetic joint infection, or other complications related to arthroplasty (ICD-9 code 996.77) in the treatment of femoral neck fractures with THA. Multivariate logistic regression and multivariate Cox proportional hazard models were then performed to identify risk factors associated with 1-year mortality as well as 90-day complication rate following THA for femoral neck fracture.

Statistical Methods

Analyses comparing patient demographics among the quartiles, which served as the predictor, used an analysis of variance or logistic regression, depending on whether the outcome was continuous or categorical. A generalized estimating equations (GEE) approach, utilizing chi-square tests, was employed to account for clustering effects due to patients within the same hospital. The GEE also provides more robust inference than parametric models such as the generalized linear mixed-effects model (GLMM) based on maximum likelihood estimation. Similarly, for the two multivariate Cox proportional hazard models, inference was also based on the estimating equations approach to account for potential clustering effects induced by patients from the same hospital. The Cox regression employed a backward selection procedure to determine the best set of predictors for death at 1-year as well as 90-day complication rate. The backward selection started with all predictors in the model and, in turn, eliminated the variable that was least significant and refitted the model until all variables remaining had individual p -values ≤ 0.05 . No adjustments for multiple comparisons were made. All analyses were carried out using SAS/STAT software, (Version 9.4, 2013, SAS Institute Inc).

RESULTS

From 2000–2010 there were 87,558 THA procedures performed at hospital centers in New York State. From this total, quartiles were created based on the average yearly primary THA volume and were evenly distributed by the total number of primary THA performed during the study period. As such, there were 23,020 primary THA in the top quartile, 20,694 in the second, 21,638 in the third and 22,206 in the fourth. The top-quartile included 5 hospitals and averaged 419 primary THA per year, the second quartile included 16 hospitals and averaged 118 THA, the third quartile included 32 hospitals and averaged 61 THA, and the bottom-quartile encompassed 136 hospitals averaging 14 yearly THA. (Table 1).

During the study period 3,986 THA for femoral neck fractures were performed in New York State. The top THA volume quartile performed 333 THA for femoral neck fracture, 899 in the second quartile, 905 in the third quartile, and 1849 in the fourth quartile. Patients undergoing THA for femoral neck fracture at top quartile hospitals were significantly younger (77.42 years) than those in the second quartile (80.74 years, $p=0.02$) but only trended toward significance against the third quartile (78.04 years, $p=0.57$) and fourth quartile (79.34 years, $p=0.06$). The time from admission to surgery was significantly shorter in the top quartile (1.4 days) compared to all other quartiles (2nd = 1.85 days, $p=0.02$; 3rd = 2.03 days, $p=0.01$; 4th = 2.3 days, $p<.0001$). Surgery was also performed sooner when comparing the second quartile to the fourth ($p=0.002$). In addition, length of stay was significantly longer in the fourth quartile compared to all other quartiles. (Table 2)

The mean Charlson comorbidity index was significantly lower in patients undergoing THA for fracture at top quartile hospitals (0.72) compared to all other volume quartiles (2nd = 0.93, $p=0.04$; 3rd = 0.96, $p=0.02$, 4th = 0.93, $p=0.03$). There was no significant difference in Charlson comorbidity index between the second, third and fourth volume quartiles. Patients in the undergoing THA for femoral neck fracture at top quartile arthroplasty hospitals were less likely to carry a diagnosis of COPD or diabetes than all other volume quartiles but were more likely to carry a diagnosis for rheumatoid arthritis. (Table 2).

Univariate Analysis

With respect to mortality, patients undergoing THA for femoral neck fracture at hospitals in the top volume quartile had significantly lower 30-day (0.9%) and 1-year (7.51%) mortality than all other volume quartiles. (Table 3). There were no significant differences on pairwise comparisons between the second, third, and fourth quartiles with regard to post-operative mortality. There was no significant difference in revision arthroplasty at 1 year between any of the volume quartiles. Likewise, there were no significant differences in 90-day pulmonary embolism, prosthetic joint infection, dislocation, or other complication between any of the volume quartiles. The rate of deep vein thrombosis was lowest in the second quartile and this reached significance when compared to the fourth quartile (0.44 v 1.24, $p = 0.04$). (Table 3).

Multivariate Analysis

On Cox regression analysis, THA for fracture at the lowest volume (4th) quartile (Hazard Ratio (HR) 1.91; $p=0.016$, 95% Confidence Interval (CI) [1.13–3.25]), second lowest volume (3rd) quartile (HR 2.01; $p=0.013$, 95% CI [1.16–3.5]) and third lowest volume (2nd) quartile (HR 2.13; $p=0.005$, 95% CI [1.26–3.62]) were associated with increased risk for a 1-year postoperative mortality event. (Table 4). Increasing age (HR 1.066; $p<0.0001$, 95% CI [1.06–1.08]) and female sex (HR 0.67; $p<0.0001$, 95% CI [0.57–0.8]) were also notable risk factors for 1-year mortality. The mortality benefit from undergoing THA for fracture at a top arthroplasty volume hospital (1st quartile) occurred almost immediately after surgery and continued to increase throughout the first year postoperatively. Regression analysis also identified multiple patient comorbidities associated with increased 1-year post-operative mortality. (Table 4).

Hospital volume quartile was also a significant risk factor for increased 90-day complication (PE/DVT, acute dislocation, prosthetic joint infection) following THA for femoral neck fracture. Surgery in the fourth quartile (HR 2.71; $p < 0.001$, 95% CI [1.7–4.31]), third quartile (HR 2.61; $p < 0.001$, 95% CI [1.61–4.23]) and second quartile (HR 2.41; $p < 0.001$, 95% CI [1.51–3.84]) all resulted in increased 90-day complication risk. In addition, several medical comorbidities were significant risk factors for a complication event within the first 90 postoperative days including dementia (HR 1.56; $p = 0.012$, 95% CI [1.1–2.19]), heart failure (HR 2.22; $p < 0.001$, 95% CI [1.81–2.72]), moderate/severe liver disease (HR 14.22; $p < 0.001$, 95% CI [5.29–38.19]), acute myocardial infarction (HR 1.72; $p < 0.001$, 95% CI [1.34–2.2]), and metastatic cancer (HR 2.72; $p = 0.008$, 95% CI [1.29–5.71]). (Table 5).

DISCUSSION

This population-based study demonstrates significantly improved 30-day and 1-year postoperative mortality rates when THA for femoral neck fracture is performed at hospitals with the highest annual overall hip arthroplasty rate. Furthermore, on multivariate analysis, undergoing THA for femoral neck fracture at any hospital center outside the top arthroplasty volume quartile was a significant 1-year mortality and 90-day complication risk.

Prior population-based studies have reported similar rates of postoperative mortality and complications with THA for femoral neck fracture. Soohoo et al demonstrated a 10.1% 90-day mortality rate, 0.7% 90-day dislocation rate, and 1.5% 1-year major revision rate for THA after femoral neck fracture using data from California's Office of Statewide Health Planning and Development.²⁴ In the present study, using the SPARCS dataset to isolate hospitals into arthroplasty volume quartiles, we report a 15.4% 1-year mortality rate, 1.05% 90-day dislocation rate, and 0.5% 1-year major revision rate. The similarities between these two different study populations strengthen the argument that THA for femoral neck fractures results in acceptably low short-term complication rates.

The association of higher hospital procedural volume with lower mortality rates has been previously demonstrated for arthroplasty surgery^{17,18} but not specifically for THA in hip fractures. In the present study, we were able to measure the mortality rate after THA for femoral neck fracture as a function of hospital arthroplasty expertise by separating hospitals into quartiles for overall hip arthroplasty volume. We found a significantly reduced mortality rate when surgery was performed at the top quartile as compared to all other volume quartile hospitals in both the 30-day and 1-year intervals. Regression analysis further confirmed that THA for femoral neck fracture at hospitals in any of the lower three volume quartiles was a significant risk factor for 1-year mortality. There was not a significant difference in 1-year mortality rate between the bottom three quartiles; however, multivariate analysis demonstrated a linear relationship between volume quartile and postoperative mortality.

Contemporary literature has focused on the timing of hip fracture surgery in the geriatric population with some articles advocating for fixation within a day of injury and others reporting no differences in outcomes for up to four days in the medically fit patient. In the present study, top quartile hospitals performed THA for femoral neck fracture significantly sooner than bottom quartile hospitals. However, on regression analysis quicker time to

surgery was not associated with a decreased mortality risk at 1-year postoperative, suggesting other factors are more influential toward the mortality benefit seen at the high-volume arthroplasty hospitals.

We have previously found THA is chosen for younger, healthier hip fracture patients as compared to hemiarthroplasty.²⁵ In the present study, when THA was chosen for femoral neck fracture treatment at a top volume quartile hospital the patients had significantly fewer medical comorbidities as determined by CCI and trended to be younger than at centers in the three lowest volume quartiles. On multivariate analysis, patient age and health significantly influenced postoperative mortality. Taken together, high-volume arthroplasty centers may restrict use of THA for femoral neck fractures to only the youngest, healthiest patients while lower volume arthroplasty centers may be more willing to perform THA on patients with a worse preoperative health status. This difference in resource allocation seems to be a key factor in the mortality benefit seen at higher volume arthroplasty centers.

Mortality differences may be further explained by shorter time to index surgery in the top quartile hospitals. Ryan et al used the Nationwide Inpatient Sample (NIS) to demonstrate that delay in hip fracture surgery until 2 or more days after admission resulted in increased risk of in-hospital mortality.²⁶ Moran et al reported delays in hip fracture surgery due to medical comorbidities resulted in a significantly higher 30-day mortality rate as compared to patients declared fit for surgery.²⁷ With appropriate resources and patient stability, all advocate for early operative intervention. Unfortunately, geriatric fracture patients are often medically complicated and safely streamlining the process from admission to surgery to discharge is difficult for smaller hospitals without established treatment teams and protocols. At one of the top-quartile arthroplasty hospitals defined in the present study, an organized geriatric fracture care model based upon co-management between Geriatric Medicine and Orthopaedic Surgery significantly reduced inpatient mortality and readmission rates as compared to the national average.²⁸ The substantial resources readily available at the top-quartile arthroplasty hospitals may facilitate medical optimization, early surgery and organized care throughout the inpatient stay which would explain reduced mortality rates following THA for femoral neck fracture.

In comparison to elective THA for osteoarthritis, THA for femoral neck fracture results in increased risk for mortality, acute dislocation, hematoma, and infection.²⁹ Because of these increased risks, we hypothesized that overall hospital arthroplasty expertise would reduce short-term complications following femoral neck fracture much in the same way high hospital volume exerts a protective effect in elective arthroplasty.^{18,30,31} We found no significant differences in 90-day pulmonary embolism, deep vein thrombosis, joint infection, acute dislocation, and 1-year revision arthroplasty on pairwise comparisons between the volume quartiles. The similar complication rates despite differing arthroplasty volume between the quartiles may be due to an inability to account for individual surgeon expertise. Surgeon case volume correlates more closely to dislocation and infection rates than hospital arthroplasty volume.¹⁸ Furthermore, recent evidence suggests that hospital volume is not a risk factor for revision surgery following elective THA.^{32,33} It is possible that surgeon experience mitigates any influence that the overall hospital volume could have on complication rates.

However, on regression analysis there was a significantly increased risk of 90-day complication (PE/DVT, dislocation, infection) when surgery was performed at hospitals in the lower three volume quartiles. Furthermore, increasing patient age as well as specific medical comorbidities including dementia, myocardial infarction, liver disease, metastatic cancer and heart failure were risk factors for 90-day postoperative complication. This result, which was not apparent on pairwise comparisons, lends further support that patient health is key to postoperative outcome. The significantly healthier patients in the top quartile likely contributed to the increased risk for complication when surgery was performed at centers in the bottom three volume quartiles.

The present study is subject to limitations inherent to a retrospective, administrative database. There exists the opportunity for inaccurate coding or failure to include all comorbidities present for a given patient; however, this is unlikely to be of major consequence as hospital coders are inclined to include diagnoses that increase a hospital admission acuity index and increase reimbursement.³⁴ Another potential weakness is that the top quartile THA volume hospitals performed significantly fewer THA for fracture than the bottom quartile. We did not exclude any hospitals for having too high or too low an annual THA volume and in the state of New York a select few hospitals perform the vast majority of elective THA. This contributed to the discrepancy in the number of THA for fracture between the quartiles but we also surmise that high volume arthroplasty centers may allocate resources toward elective arthroplasty more so than treating hip fractures. We also believe the data shows that high-volume centers choose THA for femoral neck fracture based on tighter indications, specifically younger and healthier patients. Thus, the quartiles are somewhat unbalanced with regard to the number of THA for femoral neck fractures but are still well balanced for overall arthroplasty volume.

An additional limitation to this study is the inability to ascertain patient pre- and postoperative functional status. These data are not available in the SPARCS database but could elucidate further differences between the volume quartiles. However, pre-operative functional status is typically used as one criteria for selecting THA over other techniques in femoral neck fracture management. Likewise the presence of multiple comorbidities can result in higher mortality rates.³⁵ In the present study, risk factors for 1-year mortality included age and comorbid conditions underscoring the importance of baseline patient health and its impact on postoperative outcome. Surgeons may weigh preoperative functional status and comorbid conditions differently when selecting treatment with THA which could create a selection bias.

Both the primary arthroplasty literature and anecdotal evidence suggest that THA for femoral neck fractures is best performed at hospitals with a high annual hip arthroplasty caseload. The results of this population-based study indicate that THA for femoral neck fractures at high volume arthroplasty centers is associated with lower mortality and lower 90-day complication rate but does not influence 1-year revision rate. THA for femoral neck fractures at top arthroplasty volume hospitals are performed on healthier patients more quickly. Patient health is a critical factor that influences mortality outcomes following THA for femoral neck fractures. The present study serves to reinforce the principle that careful

patient selection is paramount to ensuring a favorable result from THA for femoral neck fracture.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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TABLE 1

Characteristics of the Primary THA Hospital Volume Quartiles

Quartile	Number of Hospitals per Quartile N=189	Primary THA Performed 2000–2010 N=87,558	Mean Yearly THA per Hospital Center	Mean Yearly THA per Quartile
Top (most volume)	5	23,020	>171	419
Second	16	20,694	80–171	118
Third	32	21,638	47–79	61
Bottom (least volume)	136	22,206	<47	14

TABLE 2

Patient Demographics: THA for femoral neck fracture by arthroplasty volume quartile in New York State from 2000–2010

Variable mean or % (SE*)	1 ST (Top) Quartile N=333	2 nd Quartile N=899	3 rd Quartile N=905	4 TH (Bottom) Quartile N=1849	p-values							
					Overall	1 vs 2	1 vs 3	1 vs 4	2 vs 3	2 vs 4	3 vs 4	
Age (years)	77.42 (0.97)	80.74 (1.06)	78.04 (0.48)	79.34 (0.34)	0.0761	0.0207	0.5682	0.0610	0.0199	0.2076	0.0251	
Race (%)**	N=210	N=865	N=823	N=1703								
Black	3(1.91)	2(0.98)	3(1.05)	6(1.66)	0.1831	0.3857	0.9355	0.3634	0.3294	0.0485	0.1462	
Ethnicity N(%)**	N=247	N=874	N=822	N=1708								
Hispanic	8(1.7)	0.5(0.3)	3(1.0)	3(0.7)	0.0175	0.0056	0.2861	0.2953	0.0080	0.0038	0.8905	
Male (%)	25(2.02)	24 (2.40)	27 (1.47)	29 (1.15)	0.0421	0.7312	0.3489	0.0641	0.1451	0.0105	0.2700	
Time to surgery (days)	1.40 (0.16)	1.85 (0.10)	2.03 (0.16)	2.30 (0.10)	0.0265	0.0193	0.0063	<.0001	0.3501	0.0024	0.1733	
Length of Stay	7.39 (0.35)	7.38 (0.47)	8.05 (0.31)	9.06 (0.24)	0.0033	0.9843	0.1540	<.0001	0.2262	0.0014	0.0107	
Total cost (\$)	62898 (12658)	31327 (3696.67)	46941 (4431.27)	41464 (2481.38)	0.1815	0.0167	0.2341	0.0966	0.0068	0.0228	0.2809	
Mean Charlson Comorbidity Index	0.72 (0.09)	0.93 (0.04)	0.96 (0.05)	0.93 (0.03)	0.5808	0.0350	0.0240	0.0317	0.7310	0.9340	0.6529	
Comorbidities (% Yes)												
Acute Myocardial Infarction (MI)	5 (0.69)	8(0.95)	8(0.87)	6(0.65)	0.0626	0.0188	0.0360	0.3360	0.1765	0.1674	0.1888	
Congestive Heart	8 (2.12)	15 (1.93)	11 (1.19)	14 (0.96)	0.0728	0.0468	0.3071	0.0537	0.0962	0.6766	0.0825	
Peripheral Vascular Disease	2 (0.45)	3 (0.64)	5 (0.54)	3 (0.48)	0.0027	0.0497	0.0003	0.0352	0.1149	0.9624	0.0499	
Stroke	3 (0.99)	5 ((1.33)	6 (0.78)	5 (0.56)	0.2761	0.2154	0.0517	0.0903	0.5547	0.8114	0.5216	
Dementia	2 (1.93)	3 (0.67)	3 (0.78)	4 (0.71)	0.5183	0.7881	0.6990	0.4689	0.7605	0.1879	0.3512	
COPD	14 (0.70)	18 (1.17)	18 (1.40)	19 (1.06)	<.0001	0.0015	0.0051	<.0001	0.9970	0.4949	0.5381	
Rheumatoid Arthritis	7 (1.37)	4 (0.68)	4 (0.75)	3 (0.46)	0.0132	0.0266	0.0181	0.0013	0.7234	0.3407	0.6390	
Peptic Ulcer Disease	2 (0.46)	0.6(0.17)	1 (0.32)	1(0.28)	0.0046	0.0004	0.0782	0.0752	0.1020	0.0457	0.8429	
Mild liver disease	0.6(0.60)	0.4(0.26)	0.6(0.28)	0.6(0.18)	0.9767	0.7345	0.9209	0.9897	0.7808	0.6599	0.9020	
Diabetes	8 (0.84)	12 (1.19)	16 (1.32)	16 (0.90)	<.0001	0.0113	<.0001	<.0001	0.0338	0.0202	0.9143	
Diabetes with complications	2(0.37)	2(0.36)	1(0.30)	1 (0.26)	0.7749	0.9146	0.4001	0.9274	0.3347	0.8276	0.3878	
Hemiplegia/Paraplegia [‡]	---	0.1(0.08)	0.1(0.11)	0.2(0.09)	0.8247				0.8255	0.5567	0.7305	
Renal Disease	4(0.79)	5(1.39)	6(0.95)	5(0.56)	0.5124	0.6571	0.1330	0.3319	0.8463	0.5043	0.4102	

Variable mean or % (SE [*])	1 st (Top) Quartile N=333	2 nd Quartile N=899	3 rd Quartile N=905	4 th (Bottom) Quartile N=1849	p-values							
					Overall	1 vs 2	1 vs 3	1 vs 4	2 vs 3	2 vs 4	3 vs 4	
Cancer	4(1.73)	2(0.36)	3(0.53)	2(0.28)	0.1023	0.0640	0.3182	0.0472	0.1631	0.9137	0.0970	
Moderate/Severe Liver Disease [‡]	---	0.1 (0.08)	0.6 (0.55)	0.3(0.27)	0.1525				0.0810	0.2781	0.2123	
Metastatic Cancer	0.3(0.30)	2(1.56)	0.7(0.66)	0.7(0.70)	0.0212	0.1232	0.5050	0.4394	0.1192	0.0129	0.9227	

^{*} Robust Standard Error Estimate

^{**} other or missing removed from analysis

[‡] Q1 (presence of 0 cell) and Q2 combined to compare to Q3 and Q4

TABLE 3
Comparison of outcomes after THA for femoral neck fracture among quartile arthroplasty centers in New York State from 2000–2010

Complication Rate % (SE [*])	Q1 N=333	Q2 N=899	Q3 N=905	Q4 N=1849	p-values			
					1 vs 2	1 vs 3	1 vs 4	2 vs 4
Mortality								
30 day	0.90 (0.32)	4.78(0.69)	4.31(0.68)	5.30(0.63)	<.0001	<.0001	<.0001	0.5826
1 year	7.51(2.40)	20.36(1.96)	16.23(1.11)	17.36(2.54)	0.0039	0.0255	0.0111	0.2562
Revision (1 year)	0.30(0.32)	0.67(0.25)	0.55(0.28)	0.38(0.14)	0.4787	0.6050	0.8368	0.2816
Pulmonary Embolism	0.30(0.32)	0.78(0.22)	0.33(0.18)	0.81(0.19)	0.3860	0.9338	0.3601	0.9107
Deep Vein Thrombosis	0.60(0.19)	0.44(0.20)	0.99(0.41)	1.24(0.26)	0.5840	0.3281	0.0523	0.0388
Prosthetic Joint Infection	0	0	0	0.11	---	---	---	---
Hip Dislocation	0.90(0.66)	1.11(0.54)	0.99(0.47)	1.19(0.27)	0.8097	0.9004	0.7154	0.9004
Other Complication	0.30(0.22)	0.11(0.10)	0.55(0.24)	0.54(0.18)	0.3781	0.4741	0.4638	0.0868
								0.9695

* Robust Standard Error Estimate

TABLE 4

Risk factors for 1-year mortality after THA for femoral neck fracture backward selection.

Variable	Hazard Ratio	95% Confidence Limits*		p-value
Age	1.066	1.055	1.077	<.0001
Quartile				
4 vs 1	1.914	1.129	3.245	0.0159
3 vs 1	2.011	1.155	3.501	0.0136
2 vs 1	2.134	1.257	3.623	0.0050
Female vs Male	0.671	0.566	0.795	<.0001
Mild liver disease	2.452	1.174	5.120	0.0170
COPD	1.278	1.070	1.527	0.0068
Dementia	1.923	1.389	2.662	<.0001
Peripheral Vascular Disease	1.594	1.031	2.464	0.0358
Congestive Heart Failure	2.482	2.070	2.975	<.0001
Diabetes	1.365	1.102	1.692	0.0044
Renal disease	1.496	1.115	2.008	0.0072
Cancer	2.223	1.479	3.341	0.0001
Moderate/severe liver disease	6.729	1.613	28.075	0.0089
Metastatic cancer	5.273	3.094	8.986	<.0001

* Wald Robust Confidence Limits

TABLE 5

Risk Factors for 90-day complication following THA for Femoral Neck Fracture backward selection

Variable	Hazard Ratio	95% Confidence Limits*		p-value
Age	1.049	1.037	1.061	<.0001
Quartile				
4 vs 1	2.705	1.696	4.314	<.0001
3 vs 1	2.608	1.607	4.233	0.0001
2 vs 1	2.408	1.508	3.844	0.0002
Female vs Male	0.663	0.545	0.807	<.0001
Dementia	1.555	1.103	2.193	0.0117
Congestive Heart Failure	2.222	1.813	2.722	<.0001
Acute Myocardial Infarction	1.720	1.342	2.204	<.0001
Moderate/severe liver disease	14.215	5.291	38.189	<.0001
Metastatic cancer	2.717	1.293	5.707	0.0083

* Wald Robust Confidence Limits