RESEARCH ARTICLE

# Complication Rates in Intertrochanteric Fractures: A Database Analysis Comparing Sliding Hip Screw and Cephalomedullary Nail

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## Abstract

**Objectives:** In the treatment of closed intertrochanteric fractures, the two most common treatment options are intramedullary medullary nail (IMN) and dynamic hip screw (DHS), yet the best treatment method remains controversial. The purpose of this study is to determine the difference in mortality and morbidity between IMN and DHS. Secondarily, this study determines which pre-operative risk factors affect rates of morbidity and mortality.

**Methods:** American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) 2006-2016 database was used to search for patients with a closed intertrochanteric hip fracture. Bivariate analysis was performed using Pearson's Chi Square test to determine pre-operative risk factors associated with complications in fixation with IMN and DHS. Significant variables in this analysis, as well as demographic data, were analyzed via binary logistic regression. The results were recorded as odds ratio (OR) and significant differences were based on a $P<0.05$.

**Results:** After adjusting for demographics and clinical covariates, patients who underwent fixation with IMN had higher 30-day mortality, reintubation, UTI, bleeding, prolonged length of stay, and non-home discharged destination rates compared to DHS. Mortality risk was increased by ascites, disseminated cancer, impaired functional status, history of congestive heart failure, and hypoalbuminemia. Bleeding risk was increased by previous percutaneous coronary (PCI) and transfusions and was decreased by impaired functional status. Myocardial infarction risk was increased by female gender.

**Conclusion:** Our study found that IMN fixation increased risk of mortality, UTI, reintubation, bleeding, prolonged length of stay, and a non-home discharge destination compared to DHS. This study also identified patient risk factors associated with several postoperative complications. These data may better inform orthopaedic surgeons treating closed intertrochanteric fractures.

**Level of evidence:** III

**Keywords:** Database, Hip fractures, NSQIP, Open reduction internal fixation, Outcomes

## Introduction

Hip fractures are one of the most common orthopaedic injuries in the United States, with approximately 300,000 new cases each year.[1] The incidence of hip fractures is 1.66 million worldwide in 1999 and projected to rise above six million per year in 2050, due in part to the aging global population.[1,2] These fractures have considerable rates of morbidity and carry a 15% to 36% one-year mortality rate in elderly patients.[3] Such complications incur a significant burden on our healthcare system, costing the Centers for Medicare and Medicaid alone over 38 billion dollars annually.[1] Extensive

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research and investigation into the optimal treatment approach is essential to improve outcomes and mitigate patient morbidity.[4]

The term "hip fracture" is often used to refer to any fracture of the proximal femur extending from the distal extent of the femoral head to the proximal aspect of the femoral shaft. The fractures referred to in this anatomic region are classically divided into femoral neck (FN), intertrochanteric (IT), and subtrochanteric (ST) fractures, depending on their pattern and location. Proper diagnosis is an essential first step in understanding treatment options as they vary depending on which portion of the proximal femur is fractured. IT hip fractures are defined as extracapsular proximal femoral fractures located in the region between the greater and lesser trochanters. They represent approximately 50% of hip fractures in the elderly.[5]

Over the past 50 years, a wide variety of implants and fixation strategies have been utilized for the surgical stabilization of intertrochanteric hip fractures.[6] The two most common treatment options for intertrochanteric fractures are cephalomedullary nails (CMN) or sliding hip screws (SHS). Management of unstable intertrochanteric fractures remains challenging, particularly regarding fracture displacement and functional outcomes. The current evidence regarding the most appropriate treatment for such fractures remains controversial. Several studies suggest that intramedullary devices may be the more effective option for internal fixation of unstable intertrochanteric femoral fractures and that extramedullary fixation should be implemented with caution due to higher complication rates, shorter hospital stays, and lower failure rates (RR=3.7).[2,4] On the other hand, a number of recent studies have found that CMN may lead to increased reoperation rates due to greater technical difficulty.[6,7]

Furthermore, additional studies have reported no significant differences in outcomes, rate of mortality, surgical site infection, UTI, reoperation, and hospital stay between intramedullary nailing and extramedullary fixation.[6,8-12] Many of these studies are single institution studies limited due to their retrospective nature and small sample size.[11-15] Considerable heterogeneity in study design, evaluated outcomes, and location of these studies warrant further investigation into risk factors for complications in these patients on a national scale. These data can provide valuable information on the relevant risk factors for complications after both treatment modalities and guide surgeons in perioperative planning.

To date, there are no large studies of nationally representative databases that investigate the risk of complications after CMN vs. SHS in patients with IT fractures. The purpose of this study is to determine the difference in morbidity and mortality between these two treatment modalities and determine which risk factors predispose these patients to postoperative complications.

## Materials and Methods

### *Data Set*

Data was obtained from the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) participant use data file. NSQIP is an outcomes-based database representative of the United States surgical population and has been widely used in investigations of virtually all surgical specialties.[16] The database reports on over 300 HIPAA compliant clinical variables, including preoperative factors, intraoperative variables, and 30-day postoperative outcomes that are collected by a trained reviewer at each participating institution.[16] All patient information is de-identified and obtained from over 500 hospitals throughout the United States.

### *Patient Selection*

The NSQIP 2006-2016 dataset was queried for all adult patients who had a closed fracture of intertrochanteric region of the femur using the ICD-9 code 820.21. The dataset was split into two categories of patients, those undergoing fixation with CMN and SHS, using CPT codes 27245 and 27244, respectively. Procedures with missing demographic data or performed by a non-orthopaedic surgeon were excluded from the study. As our study does not qualify as human subjects research, Institutional Review Board (IRB) exemption was obtained. There were no sources of funding for this study.

### *Definitions and Outcomes*

The primary outcome interest of this study was to determine whether there was mortality. Eight other postoperative complications were selected: myocardial infarction, reintubation, bleeding, prolonged length of stay (LOS) >11 days, urinary tract infection, and non-routine discharge. Prolonged LOS was defined as >11 days as this marked the 95$^{th}$ percentile of all LOS among the patient population. Non-routine discharge was defined as discharge to a location other than the patient's home, such as skilled care, acute care, rehabilitation facilities. Hypoalbuminemia was defined as an albumin level <3.5 g/dL, and obesity was defined as BMI$\geq$30 kg/m$^2$.

### *Statistical Analysis*

Bivariate analysis was performed using Pearson's Chi Square test to determine which preoperative risk factors differed between CMN and SHS. Variables that reached significance in this analysis, as well as demographic variables, were included in a binary logistic regression analysis. This sequence was repeated for each complication. Results were recorded as odds ratios (OR) and 95% confidence intervals (95% CI) and significance was defined as $P$<0.05. Statistical Package for Social Science (SPSS) (International Business Machines, Corp., Armonk, NY), version 23 was used for data management and statistical analysis.

## Results

### *Demographics*

A total of 42,307 patients had a closed fracture of intertrochanteric region of the femur during the study period. The majority of patients were female (70.7%), Caucasian (72.2%), and above the age of 80 (57.5%) [Table 1]. Hypertension requiring medication was the most frequent comorbid condition present in the overall population (67.2%), while non-home discharge destination and bleeding were the most frequent postoperative complications (76.7% and 36.0%, respectively).

**Table 1. Demographic Data**

| Variable | Frequency |
|---|---|
| **Age** | |
| 18-40 | 408 (1%) |
| 41-60 | 2849 (7%) |
| 61-80 | 14086 (34.6%) |
| >80 | 23423 (57.5%) |
| **Sex** | |
| Female | 29926 (70.7%) |
| Male | 12381(29.3%) |
| **Race** | |
| Caucasian | 30479 (72.2%) |
| African American | 1206 (2.9%) |
| Hispanic | 841 (2%) |
| Other | 1165 (2.8%) |
| **30-Day Postoperative Complications** | |
| Mortality | 2821 (6.7%) |
| MI | 744 (1.8%) |
| Reintubation | 562 (1.3%) |
| Bleeding* | 15245 (36%) |
| Prolonged LOS | 5726 (13.5%) |
| UTI | 2211 (5.2%) |
| Not Home Discharge Destination | 30147 (76.7%) |
| **Preoperative Factors** | |
| Alcohol | 146 (0.3%) |
| Ascites | 119 (0.3%) |
| Angina | 36 (0.1%) |
| Bleeding Disorder | 7024 (16.6%) |
| COPD | 4905 (11.6%) |
| Current PNA | 286 (0.7%) |
| Dyspnea | 3091 (7.3%) |
| Disseminated Cancer | 1196 (2.8%) |
| Diabetes | 7844 (18.5%) |
| Impaired Functional Status** | 9705 (22.9%) |
| History of CHF | 1474 (3.5%) |
| History of MI | 68 (0.2%) |
| Hypertension | 28413 (67.2%) |
| Hypoalbuminemia | 12111 (28.6%) |
| Hyponatremia | 7228 (17.1%) |
| Impaired Sense | 100 (0.2%) |
| Obese | 5035 (11.9%) |
| On Ventilator | 101 (0.2%) |
| On Dialysis | 765 (1.8%) |
| Open Wound*** | 1866 (4.5%) |
| Previous PCI | 264 (0.6%) |
| Previous Cardiac Surgery | 311 (0.6%) |
| Renal Failure | 274 (0.6%) |
| Steroids | 2244 (5.3%) |
| Systemic Sepsis | 4773 (11.3%) |
| Smoking | 5374 (12.7%) |
| Transfusion | 2731 (6.5%) |
| Weight Loss | 681 (1.6%) |
| Metabolic Syndrome | 1544 (3.6%) |

* Bleeding is defined as any transfusion of packed red blood cells or whole blood given from the time the patient leaves the operating room up to and including 72 hours postoperatively. **Impaired Function Status is defined as patient is acutely confused and/or delirious and responds to verbal and/or mild tactile stimulation. *** Open wound is defined as a breach in the integrity of the skin or separation of skin edges and includes open surgical wounds, with or without cellulitis or purulent exudate.

***Complications***

After adjusting for demographics and clinical covariates, patients who underwent fixation with SHS had lower mortality (P=0.008), reintubation (P=0.018), UTI (P<0.001), bleeding (P<0.001), prolonged length of stay (P<0.001), and non-home discharged destination (P<0.001) rates compared to the CMN group in the 30-day postoperative period. SHS fixation was used as the reference group when making comparisons between CMN fixation and SHS fixation. Compared to patients who underwent SHS fixation, ascites, disseminated cancer, impaired functional status, history of congestive heart failure, and hypoalbuminemia specifically increased the risk for mortality in patients who underwent CMN fixation. Patients who underwent CMN fixation, compared to SHS fixation, with COPD, on dialysis, and diabetes had an increased risk for intubation. Previous percutaneous coronary intervention and perioperative blood transfusions increased the risk for bleeding in CMN fixation, compared to SHS fixation. CMN treated patients with pneumonia, hyponatremia, hypoalbuminemia, obesity, impaired sensorium, on dialysis, with an open wound, and sepsis had an increased risk of prolonged length of stay. A patient with CMN fixation on hypertension medications and a bleeding disorder was at an increased risk for an UTI. Finally, non-home discharge destination rates were increased when the patient was fixated with CMN and was on dialysis but decreased when the patient had renal failure. Females were at a higher risk of having a myocardial infarction [Table 2- 4].

**Table 2. Significant Preoperative Risk Factors and Associated Complications***

| Complication | Risk Factors that Increase Incidence | Risk Factors that Decrease Complication Incidence |
|---|---|---|
| Mortality | Ascites, Disseminated Cancer, Impaired Functional Status, history of CHF, hypoalbuminemia, | Female |
| MI | Female | ---------- |
| Reintubation | COPD, diabetes, dialysis, | ---------- |
| Bleeding | Previous PCI, transfusion | Impaired functional status |
| Prolonged LOS | Female, current pneumonia, hypoalbuminemia, hyponatremia, impaired sense, obesity, dialysis, open wound, systemic sepsis | ---------- |
| UTI | Other race, female, Bleeding disorder, hypertension medications, | ---------- |
| Not Home Discharge Destination | Hispanic race, dialysis | Renal Failure |

*Increased or decreased incidence in patients who underwent CMN fixation compared to those who underwent SHS fixation.

**Table 3. Predictors of Complications**

| | Mortality | MI | Reintubation | Bleeding |
|---|---|---|---|---|
| **Female** | OR[b] (95% CI[c]) | OR[b] (95% CI[c]) | OR[b] (95% CI[c]) | OR[b] (95% CI[c]) |
| | 0.519 (0.345-0.780)* | 0.681 (0.384-1.210) | 0.366 (0.170-0.787) | 1.402 (1.071-1.836)* |
| | | **Age** | | |
| 18-40 | Reference | Reference | Reference | Reference |
| 41-60 | 32077038.013 (0-infinity) | 5367761.919 (0-infinity) | 14720881.74 (0-infinity) | 2.128 (0.405-11.187) |
| 61-80 | 80914328.977 (0-infinity) | 16733158.951 (0-infinity) | 23917270.163 (0-infinity) | 2.045 (0.406-10.304) |
| >80 | 191105219.163 (0-infinity) | 30026482.961 (0-infinity) | 34327010.847 (0-infinity) | 2.884 (0.572-14.540 |
| | | **Race** | | |
| Caucasian | Reference | Reference | Reference | Reference |
| African American | (0.148-1.810) | 0 (0- infinity) | 1.145 (0.217-6.024) | 1.403 (0.780-2.524) |
| Hispanic | 0.423 (0.096-1.870) | 0 (0- infinity) | 0 (0-infinity) | 1.333 (0.691-2.574) |
| Other | 0.675 (0.080-5.726) | 1.893 (0.247-14.483) | 0 (0-infinity) | 1.074 (0.341-3.383) |

**Table 3. Continued**

| | | | | |
|---|---|---|---|---|
| Alcohol | 0.668 (0.186-2.396) | - | - | - |
| Ascites | 7.312 (1.019-52.451)* | - | 7.142 (0.614-83.031) | 1.703 (0.267-10.847) |
| Angina | 2.293 (0.609-8.635) | - | - | - |
| Bleeding Disorder | 0.853 (0.536-1.356) | 1.496 (0.804-2.786) | 1.519 (0.662-3.485) | 1.079 (0.805-1.447) |
| COPD | 1.554 (0.930-2.599) | 1.225 (0.563-2.666) | 2.545 (1.028-6.299)* | - |
| Current PNA | 1.337 (0.315-5.666) | 2.085 (0.263-16.499) | 2.034 (0.228-18.138) | - |
| Dyspnea | 1.345 (0.787-2.299) | 1.863 (0.867- 4.006) | 0.998 (0.357-2.787) | - |
| Disseminated Cancer | 3.941 (1.837-8.455)* | - | 3.366 (0.877-12.918) | - |
| Diabetes | - | 1.229 (0.631-2.395) | 2.98 (1.269-6.995)* | - |
| Impaired Functional Status | 1.518 (1.031-2.235)* | 0.871 (0.505-1.502) | - | 0.547 (0.430-0.695)* |
| History of CHF | 2.946 (1.472-5.893)* | - | 1.527 (0.402-5.793) | 0.659 (0.338-1.286) |
| History of MI | 1.443 (0.580-3.588) | - | - | - |
| Hypertension | 1.021 (0.653-1.596) | 1.208 (0.630-2.316) | 1.132 (0.450-2.849) | 1.264 (0.959-1.667) |
| Hypoalbuminemia | 2.28 (1.517-3.426)* | - | 1.151 (0.532-2.492) | 1.067 (0.842-1.352) |
| Hyponatremia | | - | 0.777 (0.284-2.128) | 1 (0.744-1.344) |
| Impaired Sensorium | 1.95 (0.844-4.504) | - | - | - |
| Obese | 0.945 (0.544-1.641) | - | - | 0.807 (0.550-1.184) |
| On Ventilator | 0.562 (0.047-6.675) | - | 0 (0-infinity) | - |
| On Dialysis | 1.709 (0.633-4.615) | 1.131 (0.148-8.639) | 4.998 (1.520-16.428)* | - |
| Open Wound | 0.847 (0.411-1.746) | - | 1.161 (0.315-4.276) | 1.102 (0.693-1.750) |
| Previous PCI[a] | | - | - | 1.542 (1.028-2.312)* |
| Previous Cardiac Surgery | 0.975 (0.534-1.782) | 1.748 (0.833-3.667) | 0.736 (0.234-2.315) | - |
| Renal Failure | 0.488 (0.043-5.587) | - | - | 1.456 (0.427-4.966) |
| Steroids | 0.977 (0.483-1.979) | - | - | 1.079 (0.691-1.686) |
| Systemic Sepsis | 1.574 (0.977-2.534) | 1.123 (0.517-2.441) | 0.96 (0.347-2.656) | 0.961 (0.686-1.346) |
| Smoking | 0.651 (0.317-1.337) | 1.153 (0.449-2.960) | 1.224 (0.391-3.831) | 0.892 (0.610-1.304) |
| Transfusion | 1.158 (0.568-2.362) | - | 0.849 (0.170-4.243) | 4.501 (2.910-6.961)* |
| Weight Loss | 1.353 (0.491-3.731) | - | - | - |
| Metabolic Syndrome | - | - | 0.554 (0.106-2.910) | 0.899(0.452-1.788) |

[a] Percutaneous Coronary intervention/ [b] Odds ratio/ [c] Confidence interval
*Significance defined as p<0.05
- Not included due to no significance with chi square testing

**Table 4. Predictors of Complications**

| | **Prolonged LOS[b]** | **UTI** | **Not Home Discharge Destination** |
|---|---|---|---|
| **Female** | OR[c] (95% CI[d]) | OR[c] (95% CI[d]) | OR[c] (95% CI[d]) |
| | 0.829 (0.595-1.153) | 2.094 (1.211-3.621)* | 1.318 (0.884-1.966) |
| | | **Age** | |
| 18-40 | Reference | Reference | Reference |
| 41-60 | 0.545 (0.120-2.484) | 0.24 (0.019-2.991) | 0.627 (0.093-4.206) |
| 61-80 | 0.678 (0.162-2.842) | 0.641 (0.076-5.430) | 2.555 (0.402-16.254) |

**Table 4. Continued**

| | | | |
|---|---|---|---|
| >80 | 0.749 (0.178-3.141) | 0.613 (0.073-5.173) | 4.142 (0.653-26.280) |
| **Race** | | | |
| Caucasian | Reference | Reference | Reference |
| African American | 1.518 (0.760-3.029) | 1.329 (0.458-3.857) | 1.482 (0.387-5.672) |
| Hispanic | 0.847 (0.314-2.288) | 0 (0-infinity) | 0.272 (0.076-0.968)* |
| Other | 1.218 (0.246-6.038) | 4.312 (1.171-15.875)* | 0.264 (0.052-1.334) |
| Alcohol | - | 0 (0-infinity) | - |
| Ascites | 3.595 (0.552-23.397) | - | - |
| Angina | - | - | - |
| Bleeding Disorder | 0.959 (0.656-1.401) | 1.774 (1.001-2.934)* | 1.326 (0.776-2.264) |
| COPD | 1.259 (0.822-1.927) | 1.165 (0.640-2.122) | 0.63 (0.365-1.088) |
| Current PNA | 6.667 (2.259-19.676)* | - | - |
| Dyspnea | 1.379 (0.893-2.128) | - | 1.226 (0.639-2.353) |
| Disseminated Cancer | 1.545 (0.788-3.026) | - | 0.729 (0.323-1.648) |
| Diabetes | 1.056 (0.715-1.559) | 0.864 (0.446-1.673) | 1 (0.555-1.801) |
| Impaired Functional Status | 1.131 (0.829-1.543) | 0.928 (0.612-1.408) | 0.721 (0.475-1.095) |
| History of CHF | 1.48 (0.774-2.833) | 0.958 (0.326-2.815) | 0.762 (0.244-2.383) |
| History of MI | - | - | - |
| Hypertension | 1.011 (0.704-1.451) | 2.138 (1.211-3.776)* | 1.305 (0.885-1.925) |
| Hypoalbuminemia | 1.843 (1.336-2.542)* | 0.939 (0.617-1.428) | 0.691 (0.477-1.001) |
| Hyponatremia | 1.494 (1.036-2.155)* | 1.185 (0.713-1.970) | - |
| Impaired Sensorium | 3.421 (1.738-6.731)* | - | - |
| Obese | 1.713 (1.154-2.544)* | - | - |
| On Ventilator | 5.084 (0.755-34.250) | - | - |
| On Dialysis | 2.94 (1.486-5.818)* | 0.303 (0.040-2.301) | 4.992 (1.521-16.382)* |
| Open Wound | 2.119 (1.303-3.445)* | 1.041 (0.465-2.329) | |
| Previous PCI[a] | - | - | 1.776 (0.822-3.840) |
| Previous Cardiac Surgery | - | - | 2.135 (0.896-5.083) |
| Renal Failure | 2.224 (0.600-8.250) | - | 0.051 (0.006-0.456)* |
| Steroids | 0.832 (0.468-1.480) | - | - |
| Systemic Sepsis | 1.589 (1.070-2.361)* | - | 1.6 (0.891-2.875) |
| Smoking | - | 0.823 (0.373-1.816) | 1.744 (0.989-3.076) |
| Transfusion | 1.251 (0.701-2.232) | 0.933 (0.390-2.229) | 1.647 (0.851-3.190) |
| Weight Loss | 2.02 (0.892-4.575) | - | - |
| Metabolic Syndrome | - | 0.992 (0.297-3.309) | 0.931 (0.291-2.976) |

[a] Percutaneous Coronary intervention/ [b] Length of Stay >95th percentile/ [c] Odds ratio/ [d] Confidence interval
*Significance defined as p<0.05
- not included due to no significance with chi square testing

## Discussion

Minimizing complications in the treatment of intertrochanteric fractures is a major focus in determining which treatment method is ideal for management. Our data, contrary to many previous studies, shows that a SHS has lower mortality, reintubation, bleeding, prolonged length of stay, urinary tract infections, and non-home discharge destination rates than a CMN fixation. Several studies have found no difference between the two, and there are limited studies that have found that SHS has lower complication rates than CMN.[14,15] Our data show that there was an increase in mortality, reintubation, bleeding, prolonged length of stay, UTI, and a non-home discharge destination when a CMN was utilized for fixation compared to SHS.

Ascites, disseminated cancer, history of congestive heart failure, and hypoalbuminemia all increased the risk for mortality in patients who underwent CMN fixation. This correlates with the results of other studies, which have shown that liver disease increases mortality after hip and knee arthroplasty, and hypoalbuminemia has been associated with increased mortality after hand and hip fracture surgery.[17-19] We found that CMN fixation increases mortality rates when compared to SHS fixation while previous studies have found no difference in mortality between CMN and SHS.[9,20,21]

The rates of reintubation were increased by COPD, diabetes, and dialysis. There is a paucity of research investigating the relationship between reintubation rates and intertrochanteric fracture fixation, but one study identified hypoalbuminemia as a risk factor for reintubation after hip fracture surgery, which was not shown in our study.[22] A preoperative bleeding disorder and hypertension medications increased the risk of a urinary tract infection. No previous studies have specifically observed urinary tract infections after intertrochanteric facture fixation, but researchers have studied infection rates and have found that there was no significant difference in superficial or deep wound infection rates between SHS and CMN.[15,23] Compared to SHS, our study showed that CMN had an increased risk of bleeding. Previous studies have found the opposite, determining that SHS increased bleeding, while other studies have found no difference in bleeding.[24-27] We specifically found that previous percutaneous coronary intervention (PCI) and transfusions increased the rate of bleeding, while impaired functional status resulted in lower rates of bleeding when fractures were fixed with CMN. It is possible that PCI would have increased bleeding since these patients are more likely to be on anticoagulants, leading to increased risk of bleeding. An additional factor to consider is with SHS, you have a larger incision with more visualization which may aid in appropriate estimation of blood loss and thus quicker resuscitation. In addition, due to the larger exposure allows for increased hemostasis, visual identification of all vessels in the surgical wound. Based on these results, patients can be better educated regarding their specific risk profile in a more accurate manner.

Previous research have shown no difference in LOS between patients undergoing CMN and SHS.[21,28,29] However, we found an increase in LOS after CMN fixation. In our study, preoperative pneumonia, hypoalbuminemia, hyponatremia, impaired senses, dialysis, open wound, systemic sepsis, and obesity were associated with an increased risk of prolonged LOS in patients who underwent CMN fixation. Increased LOS predisposes patients to higher risks of nosocomial complications such as infections, thrombotic events, and decreased mobility. Additionally, the financial cost of prolonged admissions is considerable. The average cost per inpatient day is $2,424, yet hospitals only saw a marginal increase in reimbursement for each increased length of stay for all hospitalizatons.[30] Factors such as hyponatremia, pneumonia, open wound, and hypoalbuminemia should therefore be highly considered in the preoperatively planning of fracture fixation.

Myocardial infarctions were associated with female sex and CMN fixation but were not associated with any other comorbidities or preoperative factors. Avakian et. al also found that there was no significance in rates of MI between CMN and SHS.[31] Dialysis patients had an increased rates of non-home discharge destinations while patients with renal failure had a lower risk after CMN fixation. Medical comorbidities incur significant risk to patients undergoing intertrochanteric fracture fixation and need to be emphasized in preoperative planning. By discussing the potential increased risks of complications with patients, informed decisions can be made, and proper planning can be executed to prevent these complications.

There are several important limitations to this study. Our study only observed the complication rates and associated preoperative factors and did not observe the biomechanics, failure rates of the two fixation options, fracture pattern, or compare the different types of nails. In addition, it is important to note that more comminuted fractures may have had a greater tendency to use IMN, which may be a confounding variable as higher injury severity may have used more IMN. However, a study by Niu et al. surveyed nearly 4,000 orthopaedic surgeons on their preferences for treating standard obliquity intertrochanteric femur fractures.[32] Sixty-eight primarily used CMN, 19% primarily used SHS, and only 13% used both equally. Those using only CMN did so primarily due to ease of surgical technique, whereas those using only SHS did so primarily due to familiarity. In both of these groups, only 1% cited comorbidities as a factor influencing decision making. Thus, while the implant selection decision making process is multifactorial, this suggests it may be more driven by surgeon-related factors than patient-related factors. The NSQIP database is limited by the accuracy of reporting and completeness of data, as not all procedures performed at all institutions are added to the database. This may result in an inherent selection bias, resulting in a potential disproportionate contribution of surgeries.[33] In addition, NSQIP only tracks 30-day morbidity and mortality and thus does not provide long term results or severity of complications. In addition, some complications, such as myocardial infarction and reintubation, were low in frequency and thus may be underpowered to show any

meaningful conclusions.

## Conclusion

Despite the limitations, our study highlights an increase in mortality, bleeding, reintubation, UTI, prolonged length of stay, and non-home discharge destination rates for IMN compared to DHS in the fixation of closed intertrochanteric fractures. We have also identified patient risk factors associated with several postoperative complications following these procedures. While many previous studies have found varying results, these studies had small sample sizes, and definite conclusions could not always be made. A randomized prospective study is needed to demonstrate the relationship between associated preoperative factors and complication rates and to determine to which degree each factor plays a role in complication rates.

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***Authors Contribution:***

Kamil Amer, Dominick Congiusta, Kunj Jain, and Robert DalCortivo contributed to research design, the acquisition, analysis, and interpretation of data, and drafting the paper. Irfan Ahmed, Michael Vosbikian, and Joseph Benevenia were responsible for the critical analysis and writing of the manuscript and approval of the submitted and final versions.

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