Urinary tract infection (UTI) at time of geriatric hip fracture surgery increases the risk of experiencing adverse 30-day outcomes

Nisha Crouser, Azeem Tariq Malik, Laura S. Phieffer, Thuan V. Ly, Safdar N. Khan, Carmen E. Quatman*

Department of Orthopaedics, The Ohio State University Wexner Medical Center, United States

ARTICLE INFO

Article history:

Received 18 June 2018

Received in revised form

12 July 2018

Accepted 18 July 2018

Available online 19 July 2018

Keywords:

Urinary tract infection

UTI

Geriatric hip fracture

Re-admissions

Complications

Reoperations

ABSTRACT

Introduction: Pre-operative urinary tract infection (UTI) may be associated with a high rate of complications following surgeries. Few studies have investigated the clinical impact of a pre-operative UTI on post-operative outcomes following surgeries for hip-fracture in geriatric patients.

Methods: The 2015–2016 ACS-NSQIP database was queried for patients undergoing hip fracture surgery using CPT-Codes for Total Hip Arthroplasty (27130), Hemiarthroplasty (27125) and Open Reduction/Internal Fixation (ORIF) (27236, 27244, 27245). Only patients ≥ 65 years of age undergoing surgery due to a traumatic hip fracture were included in the study.

Results: Out of 31,621 patients undergoing surgical treatment for a hip fracture, 410 (1.3%) had UTI at the time of the surgery. Following adjusted logistic regression analysis, UTI present at the time of surgery was associated with a longer length of stay > 5 days (OR 5.46 [95% CI 2.27–13.1]; $p = 0.008$), any complication (OR 1.33 [95% CI 1.49–1.63]; $p = 0.007$), infectious complications (OR 1.71 [95% CI 1.19–2.47]; $p = 0.004$), non-infectious complications (OR 1.28 [95% CI 1.04–1.58]; $p = 0.021$), 30-day unplanned re-operations (OR 1.96 [95% CI 1.25–3.06]; $p = 0.003$) and 30-day readmissions (OR 2.04 [95% CI 1.57–2.66]; $p < 0.001$). With regards to infectious complications, presence of a UTI at time of surgery was a significant independent predictor of sepsis (OR 2.44 [95% CI 1.24–4.80]; $p = 0.010$) and septic shock (OR 4.05 [95% CI 2.03–8.08]; $p < 0.001$).

Conclusions: Patients undergoing hip-fracture surgery with a concurrent UTI at the time of surgery have more adverse 30-day outcomes as compared to hip fracture patients who do not present with a UTI. Despite adjustment for a delay in the time to surgery, the impact of UTI on post-operative outcomes remained significant. While it is difficult to eradicate a UTI in a non-elective population, the findings stress the need for clinical optimization and potential need for early recognition/management of UTI in patients who sustain a hip fracture to minimize the risk of adverse outcomes.

© 2018

1. Introduction

Urinary tract infections are a common source of resistant pathogens that have the potential to increase patient morbidity in the hospital. Pre-operative urinary tract infections (UTI) may be associated with a high rate of complications following surgeries. Few studies have investigated the clinical impact of a pre-operative UTI on adverse outcomes following geriatric hip fracture surgery. Notably, urinary tract infections are the second most commonly diagnosed infections in the elderly population and patients often

do not present with genitourinary symptoms, making the diagnosis difficult. As the population ages, the burden of UTIs in older adults continues to grow along with the incidence of traumatic hip fractures.¹ Gaining a better understanding of the effects of pre-operative UTI on the outcomes of traumatic hip fracture surgery is important to potentially improve outcomes in this population.

Currently, there is limited research looking at the demographics of patients with pre-operative UTIs and the post-operative outcomes of hip fracture patients. Pokrzywa et al. investigated the outcomes of patients with pre-operative UTIs undergoing elective general surgery procedures and found that patients with UTIs pre-operatively had a higher risk of post-operative infectious and non-infectious complications.² Pokrzywa et al. concluded that treatment of UTIs prior to elective surgery may reduce complications

* Corresponding author. 376 W 10th Avenue, Columbus, OH, 43210, United States.
E-mail address: Carmen.Quatman@osumc.edu (C.E. Quatman).

and surgical intervention should be delayed to allow clearance of the infection.² Looking more specifically at the orthopaedic literature, investigators have found that pre-operative UTIs in patients undergoing hip surgery are associated with increased wound complications and surgical site infections. Ollivier et al. found that in elective joint arthroplasty cases, 36% of patients with pre-operative UTI demonstrated delayed post-operative wound healing or infection versus 16% of patients in the control group.³ Yassa et al. demonstrated a strong relationship between pre-operative UTI and the development of post-operative surgical site infections, specifically in the hip fracture population.⁴ Another study at St. Joseph's Mercy Health Center retrospectively reviewed elderly patients with urinary tract infections at the time of hip fracture surgery and found that those patients with a diagnosis of UTI had a prolonged hospital stay and a greater incidence of delirium compared with subjects without a UTI.⁵

While some small studies exist in the literature for hip fracture surgery evaluating the complications associated with patients who present with UTIs, few large prospective, multi-center studies have been conducted. The paucity of information on the effects of pre-operative UTI in the geriatric hip fracture population may be related to the non-elective nature of hip fracture surgery in the traumatic setting limiting the optimization of UTI status prior to operation. In this study, we hope to gain a better understanding of the patient demographics associated with pre-operative UTIs and evaluate the effects of UTIs on the post-operative recovery period. We hypothesize that preoperative UTIs are an independent risk factor for morbidity and adverse events following hip fracture surgery.

2. Methods

Our study is a retrospective cohort study, utilizing the 2015–2016 American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database files. The ACS-NSQIP is a prospective, multi-institutional outcomes program that collects data on preoperative co-morbidities, intra-operative variables, and 30-day post-operative outcomes for patients undergoing surgical procedures in inpatient and outpatient settings.^{6,7} Specifically in orthopaedic literature the database has gained respect as a powerful and valid source of data.⁸ The data are collected by trained surgical and clinical reviewers using a strict protocol. Details of how the review and audit process is carried out can be found as described by the NSQIP website.⁹ The database was queried for patients undergoing hip fracture repair using Current Procedural Terminology (CPT)-Codes for Total Hip Arthroplasty (27130), Hemiarthroplasty (27125) and Open Reduction/Internal Fixation (ORIF) (27236, 27244, 27245). Patients ≥ 65 years of age undergoing surgery due to a traumatic hip fracture were included in the study.

UTI at the time of surgery was identified using the pre-defined NSQIP variable termed as 'urinary tract infection present at time of surgery (UTIPATOS)'. Under this variable, UTI is defined if a patient meets one of two pre-set criteria (A or B) - A) One of the following: Fever ($>38^{\circ}\text{C}$ or 100.4°F), urgency, frequency, dysuria, suprapubic tenderness, costovertebral angle pain/tenderness AND urinary culture with $>100,000$ colonies/ml urine with < 2 species of organisms, B) Two of the following: Fever ($>38^{\circ}\text{C}$ or 100.4°F), urgency, frequency, dysuria, suprapubic tenderness, costovertebral angle pain/tenderness AND one of the following: Dipstick test positive for leukocyte esterase and/or nitrate, pyuria, organisms seen on Gram stain of unspun urine, two urine cultures with repeated isolation of the same pathogen with $>100,000$ colonies/ml urine in non-voided specimen, urinary culture with $<100,000$ colonies/mL urine of single pathogen in patient being treated with appropriate antimicrobial therapy, physician's

diagnosis or physician instituted appropriate antimicrobial therapy. Our entire patient cohort was divided into two groups – those who had UTI present at time of surgery and those who did not.

Pre-operative demographics that were assessed as part of the study included age, sex, race, and body mass index (BMI). A large number of co-morbid conditions, as defined by NSQIP, including diabetes, congestive heart failure, COPD, ascites, acute renal failure, cancer, among others, were also included as part of the analysis. The occurrence of post-operative complications and length of stay were the primary outcome variables assessed in this study. Post-operative complications were defined into categories, which were as follows: 1) infectious complications and 2) non-infectious complications. Infectious complications were defined as the occurrence of any one of the following – superficial/deep/organ space surgical site infection (SSI), pneumonia, sepsis and septic shock. Non-infectious complications included the occurrence of any one of the following – wound dehiscence, myocardial infarction, cardiac arrest, deep venous thrombosis (DVT), pulmonary embolism, post-operative ventilator use >48 h, unplanned reintubation, bleeding requiring transfusion, acute renal failure, progressive renal insufficiency and cerebrovascular stroke. In addition, 30-day mortality rates, discharge destination, 30-day readmissions and 30-day re-operations were also compared between the two groups as part of analysis.

Unadjusted analyses, to compare differences between baseline demographic, pre-operative and operative data, were carried out using Pearson-Chi square tests. Multivariate analysis using logistic regression models was used to assess the odds of developing post-operative complications in patients with UTI at the time of surgery, while controlling for all baseline demographic, co-morbidities, pre-operative and operative data in via a backward elimination approach. Results from multivariate analysis have been reported as Odds Ratios along with 95% confidence intervals. For all statistical purposes, a p-value of less than 0.05 was considered significant. Statistical analysis was carried out using SPSSv22 (IBM, Armonk, NY).

3. Results

A total of 31,621 patients undergoing surgical treatment of a hip fracture were identified for inclusion in the study, with an overall pre-operative UTI rate of 1.3% ($n = 410$). Baseline clinical characteristics were compared between those patients with pre-operative UTI and the control group. Age, BMI, smoking, history of COPD, ventilator dependency, dyspnea at rest, ascites, transfusion of packed red blood cells within 72 h of surgery and chronic steroid use were similar between groups. Additionally, there was no difference in anesthesia type or operative time between the two groups. Patients with pre-operative UTI differed significantly with respect to sex, race, diabetes, functional status prior to surgery, congestive heart failure, hypertension, pre-operative dialysis, disseminated cancer, open wound/infection, history of sepsis, transfer from facility, ASA class and time to operation (Table 1).

Unadjusted analysis (Table 2) showed that UTI at the time of surgery was significantly associated with an increased length of stay (>5 days), increased infectious and non-infectious complications, along with increased 30-day reoperations and increased 30-day readmissions. There was a significant difference with regards to discharge destination, with patients in the UTI group having a lower rate of discharge home (9.3%) compared to the non-UTI group (12.8%, $p = 0.033$). There was no significant difference in unadjusted 30-day mortality between patients with preoperative UTI and those without ($p = 0.67$). Following adjusted logistic regression analysis, UTI present at time of surgery was associated with a longer length of stay (>5 days), any complication, infectious

Table 1
Baseline clinical characteristics between UTI and control (non-UTI) groups.

Variable	UTI at time of surgery	No UTI at time of surgery	P-Value
Age (years)			0.362
65–79	123 (30.0%)	10,265 (32.9%)	
80–89	183 (44.6%)	13,765 (44.1%)	
≥90	104 (25.4%)	7181 (23.0%)	
Gender			<0.001
Male	59 (14.4%)	9112 (29.2%)	
Female	351 (85.6%)	22,099 (70.8%)	
Race			0.020
White	326 (79.5%)	24,931 (79.8%)	
Black or African American	17 (4.1%)	967 (3.1%)	
American Indian or Alaska Native	0 (0%)	781 (2.5%)	
Native Hawaiian/Pacific Islander	0 (0%)	25 (0.1%)	
Unknown/Not Reported	1 (0.2%)	124 (0.4%)	
Body Mass index (BMI; kg/m²)			0.097
<25.00	239 (58.3%)	17,838 (57.1%)	
25.0–29.99	98 (23.9%)	8873 (28.4%)	
30.0–34.99	53 (12.9%)	3196 (10.2%)	
≥35.0	20 (4.9%)	1304 (4.2%)	
Co-Morbidities			
Diabetes			0.019
IDDM	40 (9.8%)	2296 (7.4%)	
NIDDM	55 (13.4%)	3267 (10.5%)	
Smoker within past year	44 (10.7%)	2886 (9.2%)	0.303
Dyspnea			0.385
At rest	3 (0.7%)	343 (1.1%)	
At moderate exertion	20 (4.9%)	1961 (6.3%)	
Functional Status prior to surgery			<0.001
Totally Dependent	28 (6.8%)	1002 (3.2%)	
Partially Dependent	106 (25.9%)	5602 (17.9%)	
Unknown	7 (1.7%)	269 (0.9%)	
Independent	269 (65.6%)	24,338 (78.0%)	
Ventilator dependent	1 (0.2%)	54 (0.2%)	0.732
History of severe COPD	52 (12.7%)	3541 (11.3%)	0.397
Ascites	0 (0%)	57 (0.2%)	0.386
Congestive Heart Failure (CHF) in 30 days before surgery	24 (5.9%)	1208 (3.9%)	0.039
Hypertension (HTN) requiring medication	305 (74.4%)	21,752 (69.7%)	0.040
Acute Renal Failure	2 (0.5%)	198 (0.6%)	0.712
Pre-operative dialysis	1 (0.2%)	555 (1.8%)	0.019
Disseminated Cancer	1 (0.2%)	475 (1.5%)	0.034
Open wound/wound infection	24 (5.9%)	1159 (3.7%)	0.023
Chronic Steroid Use	26 (6.3%)	1562 (5.0%)	0.218
Bleeding disorders	55 (13.4%)	5326 (17.1%)	0.051
Transfusion of at least one unit of packed RBCs within 72 h before surgery	25 (6.1%)	1365 (4.4%)	0.091
History of Systemic Sepsis			<0.001
Prior Sepsis	13 (3.2%)	188 (0.6%)	
Prior Septic Shock	0 (0%)	17 (0.1%)	
Prior SIRS	45 (11.0%)	3324 (10.7%)	
>10% weight loss in last 6 months	3 (0.7%)	486 (1.6%)	0.178
Transferred from			<0.001
Home	265 (64.6%)	23394 (75.0%)	
Nursing Home/Chronic Care	28 (6.8%)	1546 (5.0%)	
Acute Care Hospital – Inpatient	82 (20.0%)	3217 (10.3%)	
Outside ED	27 (6.6%)	2659 (8.5%)	
Other/Unknown	8 (2.0%)	312 (1.0%)	
ASA Class			0.007
I	0 (0%)	131 (0.4%)	
II	48 (11.7%)	5050 (16.2%)	
III	261 (63.7%)	20,089 (64.4%)	
IV	100 (24.4%)	5913 (18.9%)	
V	1 (0.2%)	28 (0.1%)	
Time to Operation			0.002
0–2 days	366 (89.3%)	29,059 (93.1%)	
>2 days	44 (10.7%)	2152 (6.9%)	

Table 1 (continued)

Variable	UTI at time of surgery	No UTI at time of surgery	P-Value
Operative Data			
Anesthesia Type			
General	302 (73.7%)	22,854 (73.2%)	0.960
Other	108 (26.3%)	8355 (26.8%)	
Unknown	0 (0%)	2 (~0%)	
Procedure			
THA	12 (2.9%)	1543 (4.9%)	0.028
HA	74 (18.0%)	4500 (14.4%)	
ORIF	324 (79.0%)	25,168 (80.6%)	
Total Operative time (mins)			
0–60	215 (52.4%)	16,290 (52.2%)	0.921
>60	195 (47.6%)	14,921 (47.8%)	

Table 2

Unadjusted analysis for significant complications developing between the two groups.

Variable	UTI at time of surgery	NO UTI at time of surgery	P-value
Length of Stay (LOS/days)			<0.001
0–5	211 (51.5%)	19,234 (61.6%)	
>5	199 (48.5%)	11,977 (38.4%)	
Any Complication	167 (40.7%)	10,253 (32.9%)	0.001
Infectious Complications	33 (8.0%)	1576 (5.0%)	0.006
Non-Infectious Complications	152 (37.1%)	9447 (30.3%)	0.003
30-day Mortality	25 (6.1%)	1756 (5.6%)	0.673
30-day Readmission	70 (17.1%)	2819 (9.0%)	<0.001
30-day unplanned reoperations	21 (5.1%)	845 (2.7%)	0.003
Discharge Destination			0.033
Home	38 (9.3%)	3999 (12.8%)	
Non-Home	372 (90.7%)	27212 (87.2%)	

complications, non-infectious complications, increased 30-day unplanned re-operations and increased 30-day readmissions (Table 3). With regard to infectious complications, UTI at time of surgery was a significant independent predictor of sepsis (OR 2.44 [95% CI 1.24–4.80]; $p = 0.010$) and septic shock (OR 4.05 [95% CI 2.03–8.08]; $p < 0.001$). While UTI at time of surgery was significantly associated with non-home discharge in unadjusted analysis, the significance was lost in multivariate regression.

4. Discussion

In the United States, urinary tract infections are the second most common cause of infectious disease hospitalization in patients over the age of 65, accounting for more than 25% of all infections.¹⁰ We identified a pre-operative UTI prevalence of 1.3% in elderly patients undergoing hip fracture surgical treatment. However, unfortunately UTI prevalence in the general elderly population is challenging to measure since criteria for diagnosis are not consistent

across epidemiologic studies and therefore it is difficult to know if the prevalence identified in this study is representative given the many estimates in the literature. This study represents one of the largest series of patients with pre-operative UTI at the time of hip fracture surgery and one of the first to look at 30-day readmission and re-operation rates. The results of this study identify specific demographics associated with higher rates of pre-operative UTIs in the setting of traumatic hip fractures. These groups include most notably females, patients with diabetes, patients with low functional status and those transferred from assisted care facilities. Based on these results, clinical providers should have a higher suspicion for urinary tract infections in these populations.

Additionally, the findings of this study show that patients undergoing hip fracture surgery with a concurrent UTI at the time of surgery are associated with adverse 30-day outcomes. Despite an adjustment for a delay in the time to surgery, the impact of UTIs on post-operative outcomes remained significant. Multivariate regression analysis for baseline demographics and co-morbidities demonstrate that multiple adverse events in the postoperative period were associated with preoperative UTI. Notably the presence of UTI was associated with an increased length of stay, contributing to increased healthcare costs and further increased risk for post-operative complications. Overall, UTIs were associated with an increase in all types of complications along with increased 30-day readmission and 30-day unplanned re-operation. These results suggest the need for improved management of patients with pre-operative urinary tract infections, to reduce healthcare costs and improve patient outcomes.

The results also indicate that pre-operative UTI was an independent predictor of sepsis and septic shock post-operatively. Septicemia is a leading cause of death, with over 20% of patients over the age of 65 diagnosed with sepsis or septicemia dying in the hospital. For those patients who survive septicemia or sepsis, they often have significant negative long-term cognitive or physical

Table 3

Multivariate logistic regression assessing the odds of post-operative complication in patients with UTI at time of surgery. Adjusted for age, gender, race, BMI, co-morbidities, transfer status, ASA Grade, time to operation, anesthesia type, procedure type and total operative time in a backward-elimination logistic regression model.

Dependent Variables	Odds Ratio [95% CI]	P-Value
Length of stay (LOS/days)		
0–5	Ref	-
>5	1.43 [1.16–1.78]	0.001
Any Complication		
	1.33 [1.49–1.63]	0.007
Infectious Complication		
	1.71 [1.19–2.47]	0.004
Non-Infectious Complication		
	1.28 [1.04–1.58]	0.021
30-day readmission		
	2.04 [1.57–2.66]	<0.001
30-day unplanned reoperations		
	1.96 [1.25–3.06]	0.003

issues.¹¹ In addition, treating sepsis is extremely expensive, placing a large burden on the healthcare system. The annual costs of treating sepsis have been increasing annually, with an estimated cost of \$20.3 billion in 2011, which almost quadrupled since 1997.¹² Even with treatment the death rate remains high and hospital stays are significantly increased compared to other diagnoses.¹¹ The association of pre-operative UTI with sepsis in the post-operative period following hip fracture repair highlights the importance of identifying these patients at risk pre-operatively and hopefully reducing the probability of this costly complication for the patient and the healthcare system.

Comparing our results to the existing literature, this study is consistent with the findings of Olliviere et al. and Yassa et al. who identified increased rates of surgical site infections post-operatively for hip operations in the setting of pre-operative UTI.^{3,4} Edwards et al. looked at the outcomes of patients with deep or superficial wound infections following hip fracture surgery and found that length of stay, cost of treatment and pre-discharge mortality all significantly increased with deep wound infection. They found that the overall one-year mortality increased from 30% to 50% in those who developed an infection.¹³ Although this study does not differentiate the type of infection, overall infectious complications increased significantly in the setting of pre-operative UTI. Mortality was only assessed 30 days post-operatively, and the one-year mortality may have been higher as suggested by Edwards given the overall higher infection rate; further studies are needed to analyze the one-year mortality in this population. Additionally, this study supports the findings of Kamel, who illustrated an increase in hospital stay duration for hip fracture patients over the age of 65 with a UTI present on admission.⁵

Limitations of this study include the use of the ACS-NSCQIP morbidity and mortality data, which only includes data on the first 30 post-operative days, excluding adverse events that may have occurred after this time period. Additionally, coding for urinary tract infection in ACS-NSCQIP does not include information about severity of the infection or additional details about organism, treatment, antibiotic dosing or duration. More information is needed to better understand the treatment modalities needed to reduce the pre-operative risk. Despite the inclusion of numerous variables to allow adjustment during analysis, there is always a chance of unseen factors confounding the analysis. In addition, the current database does not allow us determine causality from the association of UTI with infectious complications. Prospective studies with granular microbiological data, such as culture results and bacterial colony counts, may hold a more affirmative answer. Of note, this study did not look at the association of asymptomatic bacteriuria (ASB), defined as $>10^5$ colony forming units/mL in a single voided urine specimen for men and two consecutive urine specimens for women, with post-operative complications in the setting of hip fracture surgery. ASB is more common in older adults than younger adults and current guidelines do not recommend antibiotic treatment for ASB unless the patient is undergoing a urologic procedure. The overtreatment of ASB has led to multi-drug resistant pathogens in the elderly population.¹ It is unclear if ASB at the time of hip fracture surgery is associated with adverse outcomes.

There is literature to support and refute delaying surgery based on a pre-operative finding of UTI. For example, Pokrzywa suggests that in elective general surgery cases UTIs should be resolved pre-operatively given the increased post-operative morbidity,² meanwhile Koulouvaris et al. found no significant difference in infection rate after arthroplasty for patients with UTI and suggests against postponing the procedure.¹⁴ To date, there are no studies

addressing the issue of delaying surgery in the setting of pre-operative UTI for hip fractures. The risks of delaying hip fracture surgery have been demonstrated and include an overall increase in mortality, increased rates of post-operative pneumonia and pressure sores among elderly patients.¹⁵ A systematic review of operative delay beyond 48 h from admission of hip fracture patients suggested an increase in the odds of 30-day all-cause mortality by 41%.¹⁶ Given the limited research on this topic there is insufficient evidence to analyze the risk-benefit ratio of delaying surgery in the setting of a pre-operative UTI, and further studies are needed to determine the effects of delays in surgery in this population.

5. Conclusions

The findings in this study suggest that preoperative UTI is an independent risk factor for postoperative complications in geriatric patients undergoing hip fracture surgery. While it is difficult to eradicate UTIs in a non-elective population, the results indicate the need for optimized clinical status prior to operation and possible early identification and antibiotic treatment of UTIs in elderly patients with hip fractures. Further investigation is warranted to determine the specific pre-operative and post-operative interventions for urinary tract infections to optimize patients' surgical outcomes following hip fracture repair.

Declarations of interest

None.

References

- Rowe TA, Juthani-Mehta M. Urinary tract infection in older adults. *Aging Health*. 2013;9(5).
- Pokrzywa CJ, Papageorge CM, Kennedy GD. Preoperative urinary tract infection increases postoperative morbidity. *J Surg Res*. 2016;205(1):213–220.
- Olliviere BJ, Ellahee N, Logan K, Miller-Jones JC, Allen PW. Asymptomatic urinary tract colonisation predisposes to superficial wound infection in elective orthopaedic surgery. *Int Orthop*. 2009;33(3):847–850.
- Yassa RR, Khalfaoi MY, Veravalli K, Evans DA. Pre-operative urinary tract infection: is it a risk factor for early surgical site infection with hip fracture surgery? A retrospective analysis. *JRSM Open*. 2017;8(3), 2054270416675083.
- Kamel HK. The frequency and factors linked to a urinary tract infection coding in patients undergoing hip fracture surgery. *J Am Med Dir Assoc*. 2005;6(5):316–320.
- Khuri SF. The NSCQIP: a new frontier in surgery. *Surgery*. 2005;138(5):837–843.
- Patterson JT, Bohl DD, Basques BA, Arzeno AH, Grauer JN. Does preoperative pneumonia affect complications of geriatric hip fracture surgery? *Am J Orthoped*. 2017;46(3):E177–E185.
- Schilling PL, Hallstrom BR, Birkmeyer JD, Carpenter JE. Prioritizing perioperative quality improvement in orthopaedic surgery. *J Bone Joint Surg Am*. 2010;92(9):1884–1889.
- ACS NSCQIP. Participant use file (PUF) user guide; 2016. https://www.facs.org/~media/files/quality%20programs/nsqip/nsqip_puf_userguide_2016.ashx. Accessed June 18, 2018.
- Foxman B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. *Am J Med*. 2002;113(Suppl 1A):S5–S13S.
- Hall MJ, Williams SN, DeFrances CJ, Golosinskiy A. Inpatient care for septicemia or sepsis: a challenge for patients and hospitals. *NCHS Data Brief*. 2011;62:1–8.
- Pfuntner A, Wier LM, Steiner C. Costs for Hospital Stays in the United States. *Statistical Brief #168. Healthcare Cost and Utilization Project (HCUP) Statistical Briefs*. Rockville (MD)2006. 2011.
- Edwards C, Counsell A, Boulton C, Moran CG. Early infection after hip fracture surgery: risk factors, costs and outcome. *J Bone Joint Surg Br*. 2008;90(6):770–777.
- Koulouvaris P, Sculco P, Finerty E, Sculco T, Sharrock NE. Relationship between perioperative urinary tract infection and deep infection after joint arthroplasty. *Clin Orthop Relat Res*. 2009;467(7):1859–1867.
- Simunovic N, Devereaux PJ, Sprague S, et al. Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis. *CMAJ (Can Med Assoc J)*. 2010;182(15):1609–1616.
- Shiga T, Wajima Z, Ohe Y. Is operative delay associated with increased mortality of hip fracture patients? Systematic review, meta-analysis, and meta-regression. *Can J Anaesth*. 2008;55(3):146–154.