Incidence and Risk Factors for Health-Care Associated Infections after Hip Operation

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Abstract

Background: Hip operation reduces pain and improves mobility and quality of life for more than 300,000 people annually, most of whom are more than 65 years old. Substantial increases in surgical volume are projected between 2005 and 2030 in primary total (174%) and revision (137%) procedures. This projection demands that the impact of increasing age on the relative risk of health-care associated infections (HAI) after hip surgical procedures be assessed. Our aim was to examine the incidence and risk factors of HAI among patients who underwent hip operations between 2006 and 2012.

Patients and Methods: This secondary analysis included data from patients 18 years old or older and having a hip prosthesis procedure in three New York City hospitals between 2006 and 2012. Procedures were categorized as total or partial hip replacements or revision and re-surfacing procedures. Outcomes of interest were blood stream infections (BSI), urinary tract infections (UTI), or surgical site infections (SSI). Patients in whom an infection developed during the hospital visit in which the hip procedure occurred were counted as cases.

Result: Of 2021 patients, approximately 11% (n=218) had an HAI. There was no difference in infection rates by admission year despite an increase in surgical volume. SSI was associated with younger age, previous hospitalization, and hip revision surgical procedure whereas UTI and BSI were associated with older age, greater co-morbidity, longer pre-operative length of stay and intensive care unit stay, (p<0.05).

Conclusion: HAI after hip operation affected approximately one in 10 patients over a 7-year period in three high-volume hospitals. SSI occurred least frequently, predominantly among patients who underwent revision surgery (without previous SSI), were younger, and had a history of previous hospitalization. Infections such as BSI and UTI, although rare, occurred more frequently and in patients with more co-morbidities, longer pre-operative length of stay, and who required higher level care. Further research to understand these unexpected findings and target interventions is warranted.

HIP REPLACEMENT is a cost-effective intervention to reduce pain and improve mobility and quality of life for adults who have arthritis, hip degeneration and disability, or fractures [1,2]. Recent data indicate that of 51.4 million procedures performed in 2010, 332,000 procedures were total hip replacements, the majority of which (168,000, 50.6%) were performed in patients 65 years of age or older [3]. Currently, orthopedic procedures, including hip replacement and revision, are the most commonly performed elective surgical procedures and are the greatest procedural Medicare expenditure [4,5].

This high resource utilization trend is likely to continue, because in recent years, the volume of hip replacement surgical procedures has increased as a result of a number of factors such as evolving demographics with more procedures being performed in younger patients as well as a growing

elderly population [6–9]. In fact, population health estimates had projected that primary total hip surgeries would reach 600,000 by 2015, and that there will be a substantial increase in total hip surgeries (174%) and hip revision surgeries (137%) between 2005 and 2030 [8–10].

Consequently, not only is the age distribution of patients receiving hip replacements changing, but also hip replacement surgical volume is growing. Thus, as the benefits of hip replacement surgery become more widespread, so may the risks, complications, and costs. Post-operative complications of hip operations can include dislocation or loosening of the joint, bleeding, and infections such as surgical site infections (SSI), pneumonia, or sepsis [2,10,11].

Examining the current distribution and frequency of post-operative complications is of paramount importance to guide

risk reduction interventions. Studies to date have focused primarily on SSI risk factors and have not examined patient risk factors in relation to other health-care associated infection (HAI) outcomes in patients who have undergone hip surgery. Therefore, the objectives of this study were to determine incidence and associated factors associated with HAIs in patients who underwent hip surgery in three academic medical centers.

Patients and Methods

After Institutional Review Board approval, electronically stored data were extracted from a clinical data warehouse for all hospitalized in-patients undergoing hip procedures from three hospitals in the New York City metropolitan area between 2006 and 2012. The development of this database has been described elsewhere [12]. The database was compiled using information from (1) laboratory reports, including microbiologic results from blood, urine, respiratory, and wound cultures; (2) International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes, including conditions present on admission, procedures performed, and discharge diagnoses; (3) clinical records documenting medication administration and catheter use; and (4) administrative records including age, gender, admission and discharge dates, and previous hospitalizations within the system.

Patients were included if they were at least 18 years old and had an ICD-9-CM billing code associated with a hip prosthesis procedure (00.70–00.73, 00.85–00.87, or 81.51–81.53). We examined only the hospital visit in which the hip procedure occurred. Hip procedures were categorized as total or partial hip replacements and revision and resurfacing procedures. Patients who had an identified infection after the hip surgery were included as cases; patients who had a SSI identified before surgery were excluded, thus excluding patients who required a revision secondary to infection.

The HAI outcomes of interest included urinary tract infection (UTI), blood stream infection (BSI), and SSI after a hip prosthesis procedure. In the data repository, UTI, BSI, and SSI were defined based on the modified criteria from the Centers for Disease Control and Prevention National Healthcare Safety Network (CDCNHSN) [13].

For this study, patients' demographic characteristics (age, gender) and admission and discharge characteristics (admission date, discharge date, hip procedure date, length of stay before hip operation, admission source, discharge location, mortality, and unit of stay) were extracted. Age was examined as a continuous variable and as a categorical variable with younger age being 18–70 years and older age as 71 years and older. Length of stay before hip operation was categorized into two groups: 0–2 days and ≥ 2 days. Previous hospitalization was defined as hospitalization within the same hospital system before the hip operation.

Detailed clinical characteristics were also collected (type of hip procedure, weighted Charlson Comorbidity Index (CCI), previous hospital stay, diagnoses of diabetes mellitus, trauma, renal failure, and malignant diseases, and high risk medication use). High risk medications refer to chemotherapeutic drugs. The CCI was used to predict death in patients based on their co-morbidities; higher scores signify greater and/or severe co-morbidities and lower scores indicate fewer co-morbidities [14]. The CCI was categorized into two groups: 0 or no co-morbidities and greater than 0 or any co-morbidities.

Statistical analysis

The incidence and types of HAI were determined for all adult patients who underwent a hip procedure. Multivariable analyses were conducted for UTI because the sample was sufficiently large; independent variables significantly associated ($p < 0.05$) with infection were included in a multiple logistic regression model to assess the risk of infection compared with no infection. Logistic regression models were run individually for each of the main predictors, including age, gender, length of stay before the hip procedure in the same hospital visit, CCI, and hip replacement or revision as potential risk factors.

Secondary to smaller sample sizes, bivariable associations were examined between potential risk factors and the infected versus uninfected patients for BSI and SSI using chi-square tests. All analyses were completed using SAS version 9.3 (SAS Institute Inc., Cary, NC).

Results

As shown in Table 1, there were 2021 patients who had a hip procedure between 2006 and 2012. The majority (60.9%) were female and of older age (mean 71.2 years, range 21–102 years). Nearly half of the patients had total hip replacements (47.1%), 38.5% had partial hip replacement, 11% had a revision for hip replacement, and 3.4% had a total or partial hip re-surfacing. The average length of stay before hip operation was 1 day (range 0–63 days), and average total length of stay for all patients was 8 days (range 2–102 days). The average CCI was 1.24 (range 0–12).

Approximately 11% of patients ($n = 218$) had a HAI. Of those patients with infections, 84.8% ($n = 181$) had a UTI, 9.4% ($n = 21$) had a BSI, and 7.2% ($n = 17$) had a SSI. Patients with a UTI were older and predominantly female compared with other hip operation patients ($p < 0.05$) (Table 2). These patients had

TABLE 1. DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF 2021 PATIENTS WHO UNDERWENT A HIP PROCEDURE BETWEEN 2006 AND 2012

Variable	All patients
Age mean, SD (range)	71.2, SD = 15.1, (21–102)
Female gender (n, %)	1,231 (60.9)
Hip procedure	
Total/partial replacement	1,798 (88.9)
Revision	223 (11.0)
Total length of stay mean, SD (range)	8.0, SD = 7.7, (2–102)
Length of stay before hip procedure (mean, SD, range)	0.9, SD = 3.1, (0– 63)
Previous hospitalization (n, %)	845 (41.8)
Stay in ICU (n, %)	166 (8.2)
Charlson Comorbidity Index mean, SD (range)	1.2, SD = 1.9, (0– 12)
Diabetes (n, %)	293 (14.5)
Renal failure (n, %)	228 (11.3)
Malignant diseases (n, %)	189 (9.4)
High risk medications (n, %)	255 (12.6)
Intubation (n, %)	38 (1.9)

SD = standard deviation; ICU = intensive care unit.

TABLE 2. LOGISTIC REGRESSION ANALYSIS OF RISK FACTORS ASSOCIATED WITH URINARY TRACT INFECTION AFTER HIP OPERATION (n = 181)

	Crude OR [95% CI]		OR [95% CI]*	
Age (older vs. younger)	1.04	[1.03, 1.06]	1.04	[1.03, 1.06]
Gender (F vs M)	2.19	[1.54, 3.13]	2.52	[1.74, 3.64]
Length of stay before hip operation	1.02	[0.98, 1.06]	0.99	[0.94, 1.03]
Charlson Comorbidity Index	1.17	[1.10, 1.24]	1.14	[1.03, 1.27]
Hip operation type (replacement vs. revision)	1.82	[1.00, 3.33]	1.72	[0.94, 3.17]

OR = odds ratio; CI = confidence interval.

Bold indicates significant finding at $p < 0.05$. *Adjusted for intensive care unit stay, renal failure, malignant diseases, high risk medication use, and intubation.

more renal failure, malignant diseases, intubation, high risk medications, intensive care unit (ICU) stay, longer length of stay before operation, and higher CCI scores compared with patients without a UTI (all $p < 0.05$). In the multiple logistic regression model adjusted for ICU stay, renal failure, malignant diseases, high risk medications, and intubation, however, only older age (odds ratio [OR] = 1.04, 95% confidence interval [CI] = 1.03–1.06), female gender (OR = 2.51, 95% CI = 1.74–3.64), and higher CCI score (OR = 1.14, 95% CI = 1.03–1.27) were associated with a UTI. Length of stay before operation and hip operation type were not predictive of a UTI in hip operation patients.

In bivariable analyses, patients with a BSI had a higher CCI score, an ICU stay, intubation, trauma, renal failure, or taking high risk medications compared with patients without a BSI

($p < 0.05$). In addition, patients with an SSI were, on average, younger (mean age 61.6 years, range 27–96) and primarily female (70.6%) compared with all hip operation patients and those with other infections. Compared with patients who did not acquire an SSI, SSI was associated with younger age, previous hospitalization, and hip revision surgical procedure ($p < 0.05$) (Table 3). Finally, as shown in Table 4, a higher proportion of SSI were identified in patients who had hip revision (82.4%) whereas a higher proportion of BSI and UTI were identified in patients who had a hip replacement procedure.

Discussion

This study examined the incidence and risk factors of HAI in patients undergoing hip operations between 2006 and 2012

TABLE 3. DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF 38 PATIENTS WHO UNDERWENT A HIP PROCEDURE BETWEEN 2006 AND 2012 AND EXPERIENCED A BLOOD STREAM INFECTION OR SURGICAL SITE INFECTION

Variable	Patients with BSI (n = 21)		Patients with SSI (n = 17)	
	n (%)	p	n (%)	p
Age categories		0.05		<0.01*
18–70	5 (23.8%)		13 (76.4%)	
71 and older	16 (76.2%)		4 (23.5%)	
Gender		0.09*		0.41
Female	9 (42.9)		12 (70.6)	
Male	12 (57.1)		5 (29.4)	
Hip procedure		0.82		<0.01*
Total replacement	11 (52.4)		3 (17.6)	
Partial replacement	8 (38.1)		0	
Revision	2 (9.5)		14 (82.4)	
Length of stay before hip procedure		0.05		0.19
0–2 days	14 (66.7%)		12 (70.6)	
≥2 days	7 (33.3%)		5 (29.4)	
Previous hospitalization	11 (52.4)	0.32	14 (82.4)	<0.01*
Stay in ICU	9 (42.9)	<0.01*	3 (17.6)	0.15
Charlson Comorbidity Index		0.00*		0.19
0	3 (14.3)		11 (64.7)	
>0	18 (85.7)		6 (35.3)	
Diabetes	3 (14.3)	0.98	2 (11.8)	0.75
Renal failure	7 (33.3)	0.00*	2 (11.8)	0.95
Malignant diseases	3 (14.3)	0.44	1 (5.9)	0.62
High risk medications	8 (38.1)	<0.01*	3 (17.7)	0.53
Intubation	2 (9.5)	0.01*	1 (5.9)	0.22

BSI = blood stream infection; SSI = surgical site infection; ICU = intensive care unit.

Bold * indicates significant finding at $p < 0.05$.

TABLE 4. INFECTIONS BY HIP PROCEDURE TYPE
IN PATIENTS WHO HAD A HIP OPERATION
BETWEEN 2006 AND 2012

	<i>All types</i>	<i>Total/partial replacements</i>	<i>Hip revisions</i>
n	2,021	1,798 (88.9%)	223 (11.0)
Infection			
BSI	21	19 (90.5)	2 (9.5)
UTI	181	169 (93.4)	12 (6.6)
SSI	17	3 (17.7)	14 (82.4)

BSI = blood stream infection; UTI = urinary tract infection; SSI = surgical site infection.

in three large academic institutions using a unique dataset. The incidence and distribution of the HAI was consistent with the literature in that we found UTI occurred most frequently, followed by BSI and SSI [15]. We expected older age and sicker patients to be at greater risk of HAI, although this was only confirmed for the outcome of UTI. Although advanced patient age is not a contraindication to hip surgery [1], it has been identified as a risk factor for post-operative complications of increased length of stay, death, and re-admissions [5,16,17], as well as HAI, including SSI [5,18,19].

With regard to SSI, evidence suggests that an SSI develops in 2%–5% of all patients who have in-patient surgical procedures (approximately 160,000–300,000/year) [20]. The most recent data reported to the CDC NHSN in 2009–2010 indicated that the largest percentage of all SSI were attributed to orthopedic operations (40.5%), and the rate of SSI after hip operations with a prosthetic implant ranged from 0.67–2.40 per 100 operations [21]. We found the incidence of SSI among all hip surgical procedures, while comparatively low at 0.8%, was greater for those who underwent a hip revision procedure compared with a hip replacement procedure.

Our findings of younger age and previous hospitalizations, not greater co-morbidity, as independent risk factors for SSI stand in contrast to the long-standing belief that advanced age and greater co-morbidities are a risk factor for SSI. These findings are congruent with a recent risk adjustment modeling study that found younger age a risk factor for patients categorized as having hip prosthesis operation, and younger patients typically have less experience with co-morbid conditions [22]. Indeed, a recent systematic review found the evidence of age as a risk factor for the development of SSI after hip operation to be mixed [23]. This finding of greater risk of SSI in younger patients may be explained by anatomic differences in younger patients compared with older patients (such as joint space width), or underlying etiology for operation (e.g., osteoarthritis, congenital malformation, hip fracture) [24].

Although it would be reasonable to expect more patients who have hip revision procedures also to have an SSI as the impetus for the revision procedure, our analyses excluded those patients. Differences in the surgical procedure (replacement or revision) and surgical technique exist, and accordingly there may be a differential provider learning curve to develop the necessary proficiency for each type of procedure [25,26]. Our finding that surgical procedure type was an independent risk factor suggests interventions that enhance provider performance, such as surgical technique in revision operation, may prove beneficial in reducing SSI.

We also expected a longer pre-surgical length of stay may be associated with worse outcomes, and this was confirmed for BSI and UTI, but not SSI. A systematic review that examined the effects of early operation (shorter pre-surgical length of stay) on patient complications after hip operation found lower rates of post-operative pneumonia in addition to lower mortality rates [27]. This study adds to the literature by detailing other important outcomes related to pre-operative length of stay and suggests an important window of opportunity to prevent HAI outcomes exists pre-operatively.

Although patient age, extant co-morbidities, and patient requirements for assistive devices and medications are not modifiable, interventions to shorten the pre-operative length of stay and optimize medical and nursing care (including management of invasive devices) may be beneficial. Specifically, interventions can target patients who are deemed at higher risk for BSI or UTI because of the level of care requirements (ICU) and other factors identified in this study [28].

Our study has several limitations. Administrative data could not distinguish between deep and superficial SSIs, provide operative detail such as use of antibiotic cement, and capture those who were re-admitted for SSI at a later date, or identify UTI with a urinary catheter in situ. Thus the true burden may be underestimated, and unmeasured risk factors may exist. In addition, the sample size for SSI and BSI was too small for multivariable regression analyses.

Conclusion

HAI after hip operation affected approximately one in 10 patients over a 7-year period in three high-volume hospitals. BSI and UTI occurred more frequently than SSI, and in patients with more co-morbidities, longer pre-operative length of stay, and who required higher level care such as an ICU stay and intubation. The SSIs were identified predominantly among patients who underwent revision operation (without previous SSI), who were younger, and had a history of previous hospitalization. Further research to understand these unexpected findings and target interventions is warranted.

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Author Disclosure Statement

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