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ORIGINAL RESEARCH & CONTRIBUTIONS

A Community-Based Hip Fracture Registry: Population, Methods, and Outcomes

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ABSTRACT

Introduction: Hip fracture is associated with substantial morbidity and mortality. A large integrated health care system developed a registry to characterize its current patient population with hip fractures. This report describes the population, methods used, and outcomes of patients registered during the initial three years (2009-2011).

Methods: Cases of hip fracture recorded from January 2009 through December 2011 were ascertained using the Kaiser Permanente Hip Fracture Registry. The registry collects information on patient, procedure, surgeon, facility, and surgical outcomes. Outcomes monitored included length of stay, readmissions, mortality, revisions, surgical site infections, deep vein thrombosis, pulmonary embolism, pneumonia, pressure ulcers, dislocations, and myocardial infarction.

Results: The population (N = 12,562) was predominantly white (77.8%), women (68.6%), and older (71.6% aged ≥ 75 years), and 32% had at least 5 comorbidities. The average length of follow-up was 1.1 years (standard deviation = 0.9). The most prevalent comorbidities were hypertension (70.8%) and anemia (29.4%). Femoral neck fractures (54.6%) were the most common fracture type. Hemiarthroplasty was the most common procedure (33.1%). Most fractures were treated by medium-volume (10 to 29 cases per year) surgeons (68.4%) at high-volume (≥ 130 cases per year) facilities (63.0%). The 90-day readmission rate was 22.1%, and the mortality rate was 12.3%. The most common postoperative complications were pneumonia (11.4%) and pressure ulcers (2.9%). There were 2.2 revisions per 100 observation years.

Conclusion: A hip fracture registry provides important information regarding patient characteristics, intraoperative practices, and postoperative outcomes, which can be analyzed, interpreted, and used to reduce morbidity and mortality.

INTRODUCTION

In the US, 306,000 hip fractures occurred in 2010.[1] By 2040, it is estimated there will be 500,000 hip fractures per year.[2] Most hip fractures occur among the elderly for whom complications are common and often life threatening. The morbidity and mortality associated with hip fractures is substantial, with reported mortality rates of 16% to 23% within 1 year after injury.[3-5] Although the incidence of hip fractures may be on the decline, the cost associated with the treatment of hip fractures, which is among the most costly orthopedic procedures,[6] continues to grow.[7,8]

The high morbidity, mortality, and cost associated[2-6] with hip fractures emphasizes the need to monitor the outcomes of these patients, identify risk factors associated with adverse events, and evaluate the comparative effectiveness of techniques and implants for this high-risk population. These opportunities for care improvement can significantly reduce morbidity and mortality associated with these events and can reduce cost. Patient registries are one potential tool for monitoring outcomes in a real-world setting. In orthopedic surgery, arthroplasty registries introduced in the 1970s have led to a reduction in revision rates by providing feedback to surgeons on specific implants and techniques.[9,10] National arthroplasty registries have also been critical in early identification of defective implants,[11-13] including one of the most costly orthopedic recalls to date, the DePuy ASR hip system recall.[14] Although the US does not yet have a fully functional national arthroplasty registry, institutional and regional registries have contributed to increased patient safety, quality improvement, identification of clinical best practices, and cost reduction.[15,16]

Hip fractures are captured by arthroplasty registries in some European countries,[17-19] Australia,[12] New Zealand,[20] and Canada.[21] In countries such as Norway,[22] Sweden,[23] and the United Kingdom (UK),[24] dedicated hip fracture registries exist. These hip fracture registries monitor all procedures used to treat these events.[22-24] In the US, single-institution studies and large-scale administrative databases have provided data for evaluation of hip fracture outcomes.[25] Although these databases and claims data provide important information, some gaps in knowledge remain because these data sources contain limited detail, inaccurate codes, and unvalidated outcomes. To help fill this gap, Kaiser Permanente (KP), the largest US integrated health care system, developed the Hip Fracture Registry. The registry is intended to serve as a quality surveillance tool, and to monitor patients who undergo a surgical procedure because of a hip fracture.

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It includes information on patient characteristics, surgical procedures, morbidity and mortality, and characteristics of both the surgeon and the hospital. The purpose of this report is to provide an overview of the methods used by the KP Hip Fracture Registry and to describe the population and outcomes of patients registered during the first three years (2009-2011).

METHODS

Setting and Population

KP is an integrated health care system that covers more than 9.5 million individuals throughout 7 US geographic Regions. This integrated health care system provides medical services, owns hospitals, employs its clinicians, and provides patients with health insurance, ensuring a captured and stable population. Additionally, a comprehensive integrated electronic medical record (EMR) is used by the system (with full implementation in 2008), allowing monitoring of patients' activities using unique identifiers. The KP membership has been shown to be mostly demographically and socioeconomically representative of the largest geographic areas it covers.[26,27]

The registry's target population is patients with fractures of the femoral neck, intertrochanteric region, or subtrochanteric region, which comprise nearly all operative, low-energy, fragility-type fractures in the elderly population. Pelvic, acetabular, distal femur, and shaft fractures are not included in the Hip Fracture Registry. This report describes patient information ascertained between January 2009 and December 2011.

Data Collection Procedures

The Hip Fracture Registry identifies relevant hip fracture cases using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), diagnostic and procedure codes recorded into KP's EMR and administrative claims. All data are extracted electronically on a quarterly schedule and sent to a data repository for data management, validation, and reporting. The Hip Fracture Registry captures data collected from the 7 geographic Regions of the integrated health care system. The patients included in this report are from the 2 largest Regions covered by the Hip Fracture Registry—Northern and Southern California—with 33 Medical Centers and 474 participating surgeons.

Variables Characterizing Patients, Surgeries, Surgeons, and Hospitals

The Hip Fracture Registry has information related to the patient, procedure, surgeon, and hospital where the hip fracture was treated. Patient variables include age, sex, race, American Society of Anesthesiologists (ASA) score,[28] comorbidities,[29] and body mass index. Procedure variables include laterality and stipulate whether an open or closed reduction with internal fixation, internal fixation of bone without fracture reduction, hemiarthroplasty (partial hip replacement), or total hip arthroplasty was used to treat the hip fracture. Surgeon variables include information about total joint arthroplasty fellowship training as well as average annual volume of hip fracture surgical cases. Surgeons were classified as low volume if they performed fewer than 10 cases per year, medium volume if they performed 10 to 29 cases per year, and high volume if they performed 30 or more cases per year. The average annual hospital volume was also captured by the Hip Fracture Registry. Hospitals were considered low volume if they treated fewer than 60 cases per year, medium volume if 60 to 129 cases per year, and high volume if 130 or more cases per year.

Outcomes

The Hip Fracture Registry monitors 10 outcomes associated with hip fractures. These outcomes are length of stay (LOS), any readmissions within 30 and 90 days, pneumonia, pressure ulcers, dislocations, myocardial infarction, surgical site infections (deep and superficial), thromboembolic events (deep vein thrombosis [DVT] and pulmonary embolism [PE]), revisions, and mortality. Except for LOS and mortality, the outcomes were captured using ICD-9-CM diagnosis and procedure codes recorded into the EMR and administrative claims.[30,31] The outcomes of revisions, surgical site infections, DVTs, and PEs were adjudicated by clinical content experts who reviewed the patient charts. The other outcomes were ascertained using only administrative and EMR data.

Table 1. Characteristics of primary hip fracture cohort (N = 12,562)

Characteristic	No. (%)
Age, years[a]	
< 65	1645 (13.1)
65-74	1922 (15.3)
75-84	4354 (34.7)
≥ 85	4639 (36.9)
Sex	
Female	8611 (68.6)
Male	3947 (31.4)
Unknown	4 (< 0.1)
ASA category	
1 and 2	3143 (25.0)
≥ 3	828 (65.9)
Unknown	113 (9.1)
Diabetes	3392 (27.0)
Race/ethnicity[b]	
White	9772 (77.8)
Hispanic	1241 (9.9)
Asian	719 (5.7)
Black	624 (5.0)
Unknown	70 (0.6)
Multiracial	63 (0.5)
Other	49 (0.4)
Native American	24 (0.2)
Continous variables	
Median age, years	82 (73-87)
Median BMI,[c] kg/m^2	23.7 (20.8-27.2)

[a] Missing data in < 0.1% (n = 1).
[b] Percentages total to more than 100% because of rounding.
[c] Missing data in 0.7% (n = 92).
ASA = American Society of Anesthesiologists; BMI = body mass index.

Revisions are defined as an operation that required any implant exchange after the primary hip fracture procedure. Revisions are tracked for the lifetime of the patient. Surgical site infections are adjudicated using the guidelines of the Centers for Disease Control and Prevention's National Healthcare Safety Network; they include superficial infections that occur within 30 days and deep infections that occur within 1 year after an implant procedure.[32] Death information was available for all patients (with possible delayed reporting) using data from the Social Security Administration updated with information recorded into the EMR.

Statistical Analysis

Descriptive statistics, including frequencies, proportions, means, standard deviations (SDs), medians, and interquartile ranges (IQRs), were computed using the software program SAS 9.2 (SAS Institute Inc, Cary, NC). Crude complication rates for all outcomes captured by the registry were provided as proportions of events, with the entire hip fracture population being included in the denominator. Revision density, which is the rate of revision per 100 years of observation, was also provided. Patients were considered lost to follow-up if they disenrolled from the integrated health care system or died during the study period.

RESULTS

Characteristics of Patients

Between 2009 and 2011, a total of 12,562 primary hip fractures were registered in the Hip Fracture Registry. The median age of the population was 82 (IQR = 73-87) years old, 68.6% were women, and 77.8% were white. See Table 1 for detailed population characteristics. Only 5.7% of the population had no comorbidities at the time of hip fracture, and most had multiple comorbidities (Table 2). The most common comorbidities were hypertension (70.8%), deficiency anemia (29.4%), renal failure (25.2%), fluid and electrolyte disorders (22.0%), chronic pulmonary disease (21.4%), and peripheral vascular disease (20.0%).

Table 3 presents the detailed fracture type and procedures for the population. The most prevalent fracture types were femoral neck fractures (43%) followed by closed intertrochanteric femoral neck fractures (36.0%). The most common procedures for hip fracture treatment were hemiarthroplasty (33.1%), open reduction of fracture with internal fixation (29.7%), and closed reduction of fracture with internal fixation (23.8%).

Outcomes after Hip Fractures

The median LOS at hospitals for patients with a hip fracture was 4 days (IQR = 3-6 days). Within 90 days of the primary hip fracture, 22.1% of patients were readmitted to the hospital and 12.3% died. The most common complication in this population was pneumonia (11.4%), followed by pressure ulcers (2.9%), and DVT (1.4%). Revisions occurred in 2.4% of patients (or 2.2 revisions/100 years of observation). The average follow-up duration for patients was 1.1 years (SD = 0.9), and 2.6% were lost to follow-up (Table 4).

Participating Hospitals and Surgeons

Of the 12,562 hip fractures, 13.7% were treated by surgeons with joint arthroplasty fellowship training. The median number of hip fracture cases a surgeon treated yearly was 18 (IQR = 13-24), and most surgeons were considered medium volume (10 to 29 cases per year; 68.4%; Table 5). The median number of cases per hospital treated yearly was 167 (IQR = 114-219), and most of the cases were treated in high-volume hospitals (63.0%; Table 5).

Table 2. Comorbidity profile of primary hip fracture cohort

Comorbidity parameter	No. (%)
Total number in cohort	12,562 (100.0)
Comorbidities (at least 1)	11,648 (92.7)
Number of comorbidities[a]	
0	716 (5.7)
1	1395 (11.1)
2	1976 (15.7)
3	2242 (17.9)
4	2068 (16.5)
≥ 5	3967 (31.6)
Specific conditions[b]	
AIDS	25 (0.2)
Alcohol abuse	498 (4.0)
Chronic blood loss anemia	485 (3.9)
Chronic pulmonary disease	2685 (21.4)
Coagulopathy	961 (7.7)
Congestive heart failure	1943 (15.5)
Deficiency anemias	3696 (29.4)
Depression	1063 (8.5)
Drug abuse	114 (0.9)
Fluid and electrolyte disorders	2769 (22.0)
Hypertension	8887 (70.8)
Hypothyroidism	2462 (19.6)
Liver disease	331 (2.6)
Lymphoma	165 (1.3)
Metastatic cancer	461 (3.7)
Other neurologic disorders	2201 (17.5)
Paralysis	629 (5.0)
Peptic ulcer disease, bleeding	7 (0.1)
Peripheral vascular disease	2515 (20.0)
Psychoses	1513 (12.0)
Pulmonary circulation disease	593 (4.7)
Renal failure	3162 (25.2)
Rheumatoid arthritis/collagen vascular disease	529 (4.2)
Solid tumor without metastasis	381 (3.0)
Valvular disease	1381 (11.0)
Weight loss	1598 (12.7)

[a] Missing data in 1.6% (n = 198).

[b] Elixhauser comorbidity measures. Diabetes and obesity are omitted from this list because they are obtained from different sources. Diabetes data are obtained from regional diabetic registries, and obesity data are obtained from body mass index measurements. Both comorbidities are included in Table 1.

AIDS = acquired immunodeficiency syndrome.

DISCUSSION

A Hip Fracture Registry was established to capture detailed information on hip fractures treated surgically in the KP integrated health care system. The current registered cohort was treated by 474 surgeons across 33 hospitals. The population identified by this registry is similar to the populations captured in other hip fracture registries, but some important differences were identified. Operative practices and outcomes associated with procedures differ in certain instances from those previously reported in the literature.

Patients included in the registry were mostly women, elderly, white, and had multiple comorbid conditions. Women constituted 68.6% of the population, which is similar to the 70% figure reported by other registries[12,18,22-24] and agrees

Table 3. Patient-specific diagnosis and procedure type in primary hip fracture cohort[a]

Diagnostic codes	Total, No. (%)	Hemiarthroplasty (code 81.52), No. (%)	Internal fixation, with open reduction of fracture (code 79.35), No. (%)	Internal fixation, with closed reduction of fracture (code 79.15), No. (%)	Internal fixation, without fracture reduction (code 78.55), No. (%)	Total hip arthroplasty (code 81.51), No. (%)	Other, No. (%)
Total	12,562 (100.0)	4163 (33.1)	3731 (29.7)	2989 (23.8)	1127 (9.0)	270 (2.1)	282 (2.2)
Fracture type							
Intracapsular (733.14, 820.00, 820.01, 820.02, 820.03, 820.09)	2603 (20.7)	1317 (31.6)	347 (9.3)	510 (17.1)	285 (25.3)	82 (30.4)	62 (22.0)
Extracapsular (820.20, 820.21, 820.22, 821.00)	5671 (45.2)	147 (3.5)	2995 (80.3)	1880 (62.9)	543 (48.2)	21 (7.8)	85 (30.1)
Other/cannot be determined (820.8, other)	4288 (34.1)	2699 (64.8)	389 (10.4)	599 (20.0)	299 (26.5)	167 (61.9)	135 (47.9)
ICD-9 code specific							
733.14: Pathologic fracture neck of femur	665 (5.3)	248 (6.0)	151 (4.1)	114 (3.8)	117 (10.4)	15 (5.6)	20 (7.1)
820.00: Fracture, femur neck; closed; intracapsular section, unspecified	78 (0.6)	50 (1.2)	3 (0.1)	16 (0.5)	4 (0.4)	2 (0.7)	3 (1.1)
820.01: Fracture, femur neck; closed; epiphysis (separation) (upper), transepiphyseal	50 (0.4)	0 (0.0)	4 (0.1)	1 (0.0)	21 (1.9)	0 (0.0)	24 (8.5)
820.02: Fracture, femur neck; closed; midcervical section, transcervical NOS	118 (0.9)	81 (2.0)	5 (0.1)	26 (0.9)	3 (0.3)	3 (1.1)	0 (0.0)
820.03: Fracture, femur neck; closed; base of neck, cervicotrochanteric section	260 (2.1)	112 (2.7)	73 (2.0)	38 (1.3)	24 (2.1)	11 (4.1)	2 (0.7)
820.09: Fracture, femur neck; closed; other, head of femur, subcapital	1432 (11.4)	826 (19.8)	111 (3.0)	315 (10.5)	116 (10.3)	51 (18.9)	13 (4.6)
820.20: Fracture, femur neck; pertrochanteric, closed; trochanteric section, unspecified, trochanter: NOS, greater, lesser	286 (2.3)	17 (0.4)	164 (4.4)	66 (2.2)	26 (2.3)	2 (0.7)	11 (3.9)
820.21: Fracture, femur neck; pertrochanteric, closed; intertrochanteric section	4517 (36.0)	123 (3.0)	2338 (62.7)	1602 (53.6)	411 (36.5)	16 (5.9)	27 (9.6)
820.22: Fracture, femur neck; pertrochanteric, closed; subtrochanteric section	706 (5.6)	6 (0.1)	414 (11.1)	205 (6.9)	68 (6.0)	2 (0.7)	11 (3.9)
820.8: Fracture; unspecified part of neck of femur, closed, hip NOS, neck of femur NOS	3964 (31.6)	2550 (61.3)	343 (9.2)	568 (19.0)	264 (23.4)	162 (60.0)	77 (27.3)
821.00: Fracture; closed; unspecified part of femur, thigh, upper leg	162 (1.3)	1 (0.0)	79 (2.1)	7 (0.2)	38 (3.4)	1 (0.4)	36 (12.8)
Other diagnosis	324 (2.6)	149 (3.6)	46 (1.2)	31 (1.0)	35 (3.1)	5 (1.9)	58 (20.6)

[a] Some percentages may not total to 100 because of rounding.
ICD-9 = International Classification of Diseases, Ninth Revision; NOS = not otherwise specified.

with the higher incidence of hip fractures in women around the world.[25] Of the registered patients, nearly 72% were age 75 years or older. This higher age is consistent with that of the population of hip fracture registries in Norway and the UK,[22,24] but it is slightly younger than reported by arthroplasty registries. The Australian arthroplasty registry reported that in its bipolar hemiarthroplasty cohort at least 76% were age 75 years or older and 92% of its monoblock cohort was older than 75 years. This elderly population is consistent with the higher risk of hip fractures in older patients.[25] Racial and ethnicity data, which are available in our patient population (21.7% of the population is nonwhite), were not available in other hip fracture registries and are most likely not captured data elements because of their countries' homogenous populations. This adds value to future findings from the presented registry, which can contribute information regarding minority groups.

Finally, 65.9% of the patients had an ASA score greater than 3, indicating substantial systemic disease, which is similar to the rate reported by the UK registry between 2011 and 2013 (approximately 60%).[24] The proportion of patients with higher ASA score, however, was higher than reported by the Norwegian Hip Fracture Register (47%),[22] which could be because of their inclusion of younger patients in their registry. We also found a high number of comorbid conditions in our patient population; 92.7% had at least 1 comorbid condition, and conditions such as hypertension, deficiency anemias, renal failure, and fluid and electrolyte disorders were common at the time of the hip fracture hospitalization. Other registries did not report on specific comorbid conditions, but a high prevalence of comorbid conditions has been reported by studies using administrative data in the US.[2,33]

Racial and ethnicity data, … available in our patient population (21.7% are nonwhite), were not available in other hip fracture registries and … adds value … regarding minority groups.

The most common type of fractures in our population was intertrochanteric femoral neck fracture (36%, ICD-9-CM 820.21) and unspecified femoral neck fractures (31.6%, ICD-9-CM 820.8). Because the registry relies on ICD-9-CM codes for identifying type of fracture, it cannot determine with certainty whether cases with unspecified location fracture codes are intracapsular vs extracapsular, or displaced vs undisplaced fractures. It can, however, determine the main treatment groups from the combination of ICD-9-CM procedure codes and diagnoses.

Table 4. Postoperative outcomes of primary hip fracture cohort by procedure type[a]

Postoperative outcome	Total, No. (%)	Hemiarthroplasty (code 81.52), No. (%)	Internal fixation, with open reduction of fracture (code 79.35), No. (%)	Internal fixation, with closed reduction of fracture (code 79.15), No. (%)	Internal fixation, without fracture reduction (code 78.55), No. (%)	Total hip arthroplasty (code 81.51), No. (%)	Other, No. (%)
Total	12,562 (100.0)	4163 (33.1)	3731 (29.7)	2989 (23.8)	1127 (9.0)	270 (2.1)	282 (2.2)
Mortality, utilization, and outcomes identified with administrative/EMR data							
Death within 30 days	783 (6.2)	291 (7.0)	240 (6.4)	171 (5.7)	61 (5.4)	5 (1.9)	15 (5.3)
Death within 90 days	1546 (12.3)	563 (13.5)	481 (12.9)	340 (11.4)	127 (11.3)	13 (4.8)	22 (7.8)
Death (ever)	3278 (26.1)	1160 (27.9)	1002 (26.9)	744 (24.9)	293 (26.0)	35 (13.0)	44 (15.6)
Readmission within 30 days	1532 (12.2)	568 (13.6)	459 (12.3)	328 (11.0)	145 (12.9)	18 (6.7)	14 (5.0)
Readmission within 90 days	2775 (22.1)	978 (23.5)	840 (22.5)	630 (21.1)	261 (23.2)	43 (15.9)	23 (8.2)
Pneumonia	1427 (11.4)	496 (11.9)	441 (11.8)	333 (11.1)	117 (10.4)	24 (8.9)	16 (5.7)
Pressure ulcers	365 (2.9)	141 (3.4)	117 (3.1)	67 (2.2)	25 (2.2)	9 (3.3)	6 (2.1)
Dislocation	114 (0.9)	89 (2.1)	3 (0.1)	1 (0.0)	5 (0.4)	9 (3.3)	7 (2.5)
Myocardial infarction	110 (0.9)	27 (0.7)	29 (0.8)	35 (1.2)	16 (1.4)	3 (1.1)	0 (0.0)
Median length of stay, days (IQR)[b]	4 (3-6)	4 (4-6)	4 (3-6)	4 (3-5)	4 (3-5)	4 (3-6)	3 (1-5)
Validated outcomes[c]							
Revision (all cause)	305 (2.4)	102 (2.5)	81 (2.2)	78 (2.6)	29 (2.6)	7 (2.6)	8 (2.8)
Septic revision	32 (0.3)	23 (0.6)	3 (0.1)	1 (0.0)	1 (0.1)	1 (0.4)	3 (1.1)
Revision rate per 100 years of observation	1342 (2.2)	4506 (2.3)	4173 (1.9)	3216 (2.4)	1208 (2.4)	288 (2.4)	360 (2.2)
Deep vein thrombosis	173 (1.4)	65 (1.6)	57 (1.5)	25 (0.8)	12 (1.1)	8 (3.0)	6 (2.1)
Pulmonary embolism	156 (1.2)	59 (1.4)	43 (1.2)	33 (1.1)	13 (1.2)	5 (1.9)	3 (1.1)
Surgical site infection (any)	136 (1.1)	77 (1.9)	27 (0.7)	15 (0.5)	6 (0.5)	5 (1.9)	6 (2.1)
Surgical site infection (deep)	75 (0.6)	47 (1.1)	12 (0.3)	7 (0.2)	1 (0.1)	3 (1.1)	5 (1.8)
Surgical site infection (superficial)	61 (0.5)	30 (0.7)	15 (0.4)	8 (0.3)	5 (0.4)	2 (0.7)	1 (0.4)

[a] Some percentages do not total to 100 because of rounding. Codes are from the International Classification of Diseases, Ninth Revision, Clinical Modification.

[b] Missing data in 1.3% (n = 164).

[c] Only crude estimates of incidence are presented. No adjustments for confounders, loss to follow-up, or follow-up time are included (with the exception of the revision rate per 100 years of observation).

EMR = electronic medical record; IQR = interquartile range.

Table 5. Surgeon and hospital characteristics in primary hip fracture cohort (N = 12,562)

Characteristic	No. of surgeries (%)
Joint arthroplasty fellowship training	
Yes	1728 (13.7)
No	5284 (42.1)
Unknown	5550 (44.2)
Surgeon volume category, average per year[a]	
Low (< 10)	1520 (12.1)
Medium (10-29)	8590 (68.4)
High (≥ 30)	2450 (19.5)
Surgeon yearly volume, median (IQR)[a]	18 (13-24)
Hospital volume category, average per year	
Low (< 60)	207 (1.7)
Medium (60-129)	4439 (35.3)
High (≥ 30)	7916 (63.0)
Hospital yearly volume, median (IQR)	167 (114-219)

[a] Missing data in < 0.1% (n = 2).
IQR = Interquartile range.

By our estimates, at least 43% (n = 5315) of our registered fractures are intracapsular fractures (2603 from diagnostic codes only and 2712 from the procedures and diagnoses combined), making this the most common type of fracture in our registry, which is in agreement with other registries where a traditional fracture classification is used. In Sweden, the UK, and Norway the reported prevalence of intracapsular fractures is 54%, 58%, and 63%, respectively.

The most common procedures used to treat fractures were internal fixation and hemiarthroplasty, in agreement with other registries' populations. Overall, 33.1% of the cases in our population were treated with hemiarthroplasty, which is slightly higher than the overall numbers of 25% reported by Sweden and 21% by Norway (no overall numbers available for the UK).[22-24] Hemiarthroplasty is the most common procedure used for treatment of intracapsular fractures in our population (93% had a hemiarthroplasty), and it is also the most commonly used procedure to address intracapsular fractures in other registries, although only for displaced intracapsular fractures (53% Norway, 63% Sweden, and 77.5% UK).[22-24] For the second most common fracture in our population, intertrochanteric femur neck fractures (36%), 96% were treated with internal fixation: 9% without fracture reduction, 35% with closed reduction, and 52% with open reduction. This again agrees with the reported internal fixation rate for these types of fracture in the UK, Sweden, and Norway (all > 95%).[22-24] Finally, the use of total hip arthroplasty for addressing hip fractures is infrequent (2.1%), and this rate agrees with the small proportions seen by other registries (range = 1.1%-5%).

Medium- and high-volume surgeons (89.7%) and hospitals (98.3%) treat the majority of the hip fractures in our population. This information is not available in the reports of other dedicated hip fracture registries. The proportion of patients treated in high volume (63%) hospitals is, however, similar to those reported by studies using Medicare data (approximately 60% consistently from 1991 to 2008).[5] Previous studies evaluating the outcomes of hip fracture treatment by hospital and surgeon volume suggest surgeon volume is an important factor when evaluating hip fracture outcomes, but hospital volume may not be as important.[5]

Ten postoperative outcomes were available in the KP Hip Fracture Registry. Mortality, LOS, pressure ulcers, and repeated operations ("reoperations") are the common outcomes monitored by the dedicated fracture registries. The incidence of mortality in our population within 30 days was 6.2%; this is comparable to mortality in the Norwegian registry (only a 4-month estimate is available and is 14%)[22] and is slightly lower than in the UK registry (8%).[24] This is also consistent with contemporary estimates from the US Medicare population of 5% to 6%.[2,34] The LOS in our cohort was much shorter (median = 4 days) than that reported by other registries (range = 11-16 days)[23,24] but was similar to the LOS in the US Medicare hip fracture cohort.[2,34] Differences in LOS are probably because of the overall health care system structure and hip fracture care practices in the various countries. Pressure ulcers occurred in 2.9% of our population, which is comparable to the 3.7% reported by the UK hip fracture registry.[24] Finally, the only reoperations monitored by our registry are subsequent revision procedures (defined as a surgery where one component is either removed and/or replaced for any reason) of the original hip fracture components, which we found occur at a rate of 2.2/100 years of observation (2.4% crude overall revision incidence). This rate is significantly lower than the 18% reoperation rate reported by the Norwegian Hip Fracture Register, probably because they track all subsequent reoperations and not just revisions.[22] Complications related to the hip fractures such as pneumonia, myocardial infarction, DVT, PE, dislocations, and surgical site infections also are monitored by this registry but not by others. These complications, except for pneumonia, were infrequent (< 1.4%), an incidence that is mostly consistent with reports from other large hip fracture cohorts.[33,35-39] Pneumonia was the most common complication in our population (11.4%) and was higher than the 5% reported by a meta-analysis of clinical trials by Lawrence et al.[35] This higher incidence in our cohort could be caused by our use of administrative data to ascertain the cases without validating them with other records, which was probably done by the clinical trials included in the meta-analysis study.

This report's main limitation is the reliance of its data source, the KP Hip Fracture Registry, on ICD-9-CM diagnostic and procedure codes to determine fracture location and procedures performed to address these fractures. Information on whether the fractures were displaced or nondisplaced was not available. Additionally, confirmation of whether they were located in the intracapsular or extracapsular area was not possible in all cases. The Hip Fracture Registry leverages the existing system's EMR and administrative data sources to capture all hip fractures in the system. This is done instead of relying on the surgeon to report, which would not achieve full capture of this population. The tradeoff for full case capture means the Hip Fracture Registry has limited fracture location

information. In addition, procedure codes do not offer information on specific types of hemiarthroplasty procedures (bipolar or unipolar) or internal fixation (whether screws only, screws and plates, or intramedullary rods were used). However, this limitation is currently being addressed by the Hip Fracture Registry by implementing procedure classification on the basis of the collected implant information from the procedure. This work is under development, but we hope to include it in future reports on the registry's cohort.

Other limitations were a lack of certain comorbidity information, such as osteoporosis and intestinal disorders, which were not captured by the validated comorbidity algorithm used by the registry. Additionally, this report was descriptive and did not evaluate relationships between specific variables and outcomes associated with hip fracture procedures. No inferences can be made regarding the outcomes and specific treatments presented in this report.

Our report strengths include the description of a fully captured hip fracture population in a large and diverse integrated health care system in the US. Using unique identifiers and the EMR, the Hip Fracture Registry captured the full spectrum of care delivered to these patients after surgery and prospectively monitored several outcomes associated with these events in addition to the traditional outcomes tracked by other studies and registries. Some of the outcomes monitored (ie, surgical site infection, DVT, PE, reoperation, and revision surgery) are also adjudicated using additional sources, which guarantees a high internal validity for these data elements. Additionally, because data for the Hip Fracture Registry are captured electronically, possible response bias introduced by relying on clinicians to report events and complete the required registry information was nonexistent. Finally, the population captured included cases from a large number of hospitals and surgeons with a wide variety of surgical experience, which is representative of the larger orthopedic community.

CONCLUSION

A community-based registry of hip fractures was used to identify a contemporaneous cohort of patients with hip fractures who were mostly women, elderly, and white, with substantial multimorbidity. The KP Hip Fracture Registry population was treated predominantly with internal fixations or hemiarthroplasty procedures, which were performed primarily in high-volume hospitals by medium-volume surgeons. The incidence of 30-day mortality, readmission, and pneumonia was high in this patient population, and the incidence of other monitored complications was relatively low.

Using a hip fracture registry to understand patients and procedures performed to treat hip fractures, as well as the possible complications and outcomes associated with these events, can give orthopedic clinicians a major advantage in planning for the care of these patients. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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References

1. National hospital discharge survey [Internet]. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Health Statistics; 2013 [updated 2015 Feb 12; cited 2014 Jan 23]. Available from: www.cdc.gov/nchs/data/nhds/2average/2010ave2_firstlist.pdf.
2. Brauer CA, Coca-Perraillon M, Cutler DM, Rosen AB. Incidence and mortality of hip fractures in the United States. JAMA 2009 Oct 14;302(14):1573-9. DOI: http://dx.doi.org/10.1001/jama.2009.1462.
3. Blomfeldt R, Törnkvist H, Ponzer S, Söderqvist A, Tidermark J. Comparison of internal fixation with total hip replacement for displaced femoral neck fractures. Randomized, controlled trial performed at four years. J Bone Joint Surg Am 2005 Aug;87(8):1680-8. DOI: http://dx.doi.org/10.2106/JBJS.D.02655.
4. Blomfeldt R, Törnkvist H, Ponzer S, Söderqvist A, Tidermark J. Displaced femoral neck fracture: comparison of primary total hip replacement with secondary replacement after failed internal fixation: a 2-year follow-up of 84 patients. Acta Orthop 2006 Aug;77(4):638-43. DOI: http://dx.doi.org/10.1080/17453670610012728.
5. Miller BJ, Lu X, Cram P. The trends in treatment of femoral neck fractures in the Medicare population from 1991 to 2008. J Bone Joint Surg Am 2013 Sep 18;95(18):e132. DOI: http://dx.doi.org/10.2106/JBJS.L.01163.
6. Elixhauser A, Andrews RM. Profile of inpatient operating room procedures in US hospitals in 2007. Arch Surg 2010 Dec;145(12):1201-8. DOI: http://dx.doi.org/10.1001/archsurg.2010.269.
7. Adams AL, Shi J, Takayanagi M, Dell RM, Funahashi TT, Jacobsen SJ. Ten-year hip fracture incidence rate trends in a large California population, 1997-2006. Osteoporos Int 2013 Jan;24(1):373-6. DOI: http://dx.doi.org/10.1007/s00198-012-1938-5.
8. Crisp A, Dixon T, Jones G, et al. Declining incidence of osteoporotic hip fracture in Australia. Arch Osteoporos 2012;7(1-2):179-85. DOI: http://dx.doi.org/10.1007/s11657-012-0095-y.
9. Herberts P, Malchau H. Long-term registration has improved the quality of hip replacement: a review of the Swedish THR Register comparing 160,000 cases. Acta Orthop Scand 2000 Apr;71(2):111-21. DOI: http://dx.doi.org/10.1080/000164700317413067.
10. Labek G, Janda W, Agreiter M, Schuh R, Böhler N. Organisation, data evaluation, interpretation and effect of arthroplasty register data on the outcome in terms of revision rate in total hip arthroplasty. Int Orthop 2011 Feb;35(2):157-63. DOI: http://dx.doi.org/10.1007/s00264-010-1131-4.
11. Konan S, Haddad FS. Joint registries: a Ptolemaic model of data interpretation? Bone Joint J 2013 Dec;95-B(12):1585-6. DOI: http://dx.doi.org/10.1302/0301-620X.95B12.33353.
12. Australian Orthopedic Association national joint replacement registry. Hip and knee arthroplasty: 2014 annual report [Internet]. Adelaide, South Australia, Australia: Australian Orthopaedic Association; 2014 [cited 2014 Nov 3]. Available from: https://aoanjrr.dmac.adelaide.edu.au/documents/10180/172286/Annual%20Report%202014.
13. Smith AJ, Dieppe P, Vernon K, et al. Failure rates of stemmed metal-on-metal hip replacements: analysis of data from the National Joint Registry of England and Wales. Lancet 2012 Mar 31;379(9822):1199-204. DOI: http://dx.doi.org/10.1016/S0140-6736(12)60353-5.
14. Cohen D. Out of joint: the story of the ASR. BMJ 2011 May 13;342:d2905. DOI: http://dx.doi.org/10.1136/bmj.d2905.
15. Gioe TJ, Killeen KK, Mehle S, Grimm K. Implementation and application of a community total joint registry: a twelve-year history. J Bone Joint Surg Am 2006 Jun;88(6):1399-404. DOI: http://dx.doi.org/10.2106/JBJS.E.01198.
16. Paxton EW, Inacio MC, Kiley ML. The Kaiser Permanente implant registries: effect on patient safety, quality improvement, cost effectiveness, and research opportunities. Perm J 2012 Spring;16(2):36-44. DOI: http://dx.doi.org/10.7812/TPP/12-008.
17. Garellick G, Rogmark C, Kärrholm J, Rolfson O. Swedish hip arthroplasty register: annual report 2012 [Internet]. Gothenburg, Sweden: Swedish Hip Arthroplasty Register; 2012 [cited 2014 Oct 31]. Available from: www.shpr.se/Libraries/Documents/AnnualReport_2012_Eng_WEB.sflb.ashx.
18. Stea S, Bordini B, De Clerico M, Petropulacos K, Toni A. First hip arthroplasty register in Italy: 55,000 cases and 7 year follow-up. Int Orthop 2009 Apr;33(2):339-46. DOI: http://dx.doi.org/10.1007/s00264-007-0465-z.

19. National joint registry for England and Wales: 7th annual report 2010 [Internet]. Hemel Hempstead, England: National Joint Registry; 2010 [cited 2011 Jul 6]. Available from: www.njrcentre.org.uk/NjrCentre/LinkClick.aspx?fileticket=QkPI7kk6B2E%3d&tabid=86&mid=523.
20. The New Zealand joint registry. Fourteen year report: January 1999 to December 2012 [Internet]. Wellington, New Zealand: New Zealand Orthopaedic Association; 2013 Nov [cited 2014 Oct 31. Available from: www.nzoa.org.nz/system/files/NJR%2014%20Year%20Report.pdf.
21. Sayana MK, Lakshmanan P, Peehal JP, Wynn-Jones C, Maffulli N. Total hip replacement for acute femoral neck fracture: a survey of National Joint Registries. Acta Orthop Belg 2008 Feb;74(1):54-8. Erratum in: Acta Orthop Belg 2008 Dec;74(6):890.
22. Gjertsen JE, Engesaeter LB, Furnes O, et al. The Norwegian Hip Fracture Register: experiences after the first 2 years and 15,576 reported operations. Acta Orthop 2008 Oct;79(5):583-93. DOI: http://dx.doi.org/10.1080/17453670810016588.
23. Thorngren KG. National registration of hip fractures in Sweden. In: Bentley G, editor. European instructional lectures: volume 9, 2009; 10th EFORT Congress, Vienna, Austria. New York, NY: Springer Science & Business Media, LLC; 2009. DOI: http://dx.doi.org/10.1007/978-3-642-00966-2_2.
24. Falls and Fragility Fracture Audit Programme (FFFAP). National Hip Fracture Database (NHFD) annual report 2014 [Internet]. London, England: Royal College of Physicians; 2014 Sep [cited 2014 Oct 31]. Available from: www.nhfd.co.uk/20/hipfractureR.nsf/vwcontent/2014reportPDFs/$file/NHFD2014SummaryReport.pdf?OpenElement.
25. Cooper C, Cole ZA, Holroyd CR, et al; IOF CSA Working Group on Fracture Epidemiology. Secular trends in the incidence of hip and other osteoporotic fractures. Osteoporos Int 2011 May;22(5):1277-88. DOI: http://dx.doi.org/10.1007/s00198-011-1601-6.
26. Karter AJ, Ferrara A, Liu JY, Moffet HH, Ackerson LM, Selby JV. Ethnic disparities in diabetic complications in an insured population. JAMA 2002 May 15;287(19):2519-27. DOI: http://dx.doi.org/10.1001/jama.287.19.2519.
27. Koebnick C, Langer-Gould AM, Gould MK, et al. Sociodemographic characteristics of members of a large, integrated health care system: comparison with US Census Bureau data. Perm J 2012 Summer;16(3):37-41. DOI: http://dx.doi.org/10.7812/TPP/12-031.
28. Owens WD, Felts JA, Spitznagel EL Jr. ASA physical status classifications: a study of consistency of ratings. Anesthesiology 1978 Oct;49(4):239-43. DOI: http://dx.doi.org/10.1097/00000542-197810000-00003 [password protected].
29. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. Med Care 1998 Jan;36(1):8-27. DOI: http://dx.doi.org/10.1097/00005650-199801000-00004.
30. Postoperative pulmonary embolism or deep vein thrombosis rate. Patient safety indicators #12: technical specifications [Internet]. Rockville, MD: Agency for Healthcare Research and Quality; 2012 Mar [cited 2012 Aug 31]. Available from: www.qualityindicators.ahrq.gov/Downloads/Modules/PSI/V44/TechSpecs/PSI%2012%20Postoperative%20PE%20or%20DVT%20Rate.pdf.
31. Inacio MC, Paxton EW, Chen Y, et al. Leveraging electronic medical records for surveillance of surgical site infection in a total joint replacement population. Infect Control Hosp Epidemiol 2011 Apr;32(4):351-9. DOI: http://dx.doi.org/10.1086/658942.
32. Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control 2008 Jun;36(5):309-32. DOI: http://dx.doi.org/10.1016/j.ajic.2008.03.002. Erratum in: Am J Infect Control 2008 Nov;36(9):655. DOI: http://dx.doi.org/10.1016/j.ajic.2008.10.001.
33. Lawrence VA, Hilsenbeck SG, Noveck H, Poses RM, Carson JL. Medical complications and outcomes after hip fracture repair. Arch Intern Med 2002 Oct 14;162(18):2053-7. DOI: http://dx.doi.org/10.1001/archinte.162.18.2053.
34. Neuman MD, Rosenbaum PR, Ludwig JM, Zubizarreta JR, Silber JH. Anesthesia technique, mortality, and length of stay after hip fracture surgery. JAMA 2014 Jun 25;311(24):2508-17. DOI: http://dx.doi.org/10.1001/jama.2014.6499.
35. Lawrence VA, Cornell JE, Smetana GW; American College of Physicians. Strategies to reduce postoperative pulmonary complications after noncardiothoracic surgery: systematic review for the American College of Physicians. Ann Intern Med 2006 Apr 18;144(8):596-608. DOI: http://dx.doi.org/10.7326/0003-4819-144-8-200604180-00011.
36. Roche JJ, Wenn RT, Sahota O, Moran CG. Effect of comorbidities and postoperative complications on mortality after hip fracture in elderly people: prospective observational cohort study. BMJ 2005 Dec 10;331(7529):1374. DOI: http://dx.doi.org/10.1136/bmj.38643.663843.55.
37. Rosencher N, Vielpeau C, Emmerich J, Fagnani F, Samama CM; ESCORTE group. Venous thromboembolism and mortality after hip fracture surgery: the ESCORTE study. J Thromb Haemost 2005 Sep;3(9):2006-14. DOI: http://dx.doi.org/10.1111/j.1538-7836.2005.01545.x.
38. 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 Jun;90(6):770-7. DOI: http://dx.doi.org/10.1302/0301-620X.90B6.20194.
39. Duckworth AD, Phillips SA, Stone O, Moran M, Breusch SJ, Biant LC. Deep infection after hip fracture surgery: predictors of early mortality. Injury 2012 Jul;43(7):1182-6. DOI: http://dx.doi.org/10.1016/j.injury.2012.03.029.

Fixation

I assert that a fractured thigh, if treated by extension only, would be accompanied with vastly more muscular irritability than if the same case was placed in a modern appliance, in which the limb was immoveable in the strict meaning of the term fixation.

— *Disease of the Hip, Knee and Ankle Joints,* Hugh Owens Thomas, MD, 1834-1891, Welsh surgeon who is considered to be the father of orthopaedic surgery in Britain