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Inpatient orthopaedic hardware removal in children: A cross-Sectional study

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ABSTRACT

Introduction: Few data describe the specific reasons for inpatient hardware removal in the pediatric population. This study was designed to understand the conditions necessitating inpatient removal following fracture surgery. Cost data was analyzed to understand the financial implications of these procedures.

Methods: The Kids' Inpatient Database (KID) was evaluated for the year 2012. Patients undergoing open reduction internal fixation following upper and lower extremity fractures as well as those undergoing hardware removal due to hardware complications were identified using ICD-9 CM diagnosis and procedure codes. Univariable and multivariable logistic regression were used to determine predictors of surgical removal due to complications, controlling for patient demographics and comorbidities.

Results: The most common indication for removal was infection (1141 patients; 32%), followed by mechanical dysfunction (923; 25.4%), and pain (472; 13%). Logistic regression analysis showed that femur fractures (OR = 8.27, 95% CI: 7.63–8.96) and tibia/fibula fractures (OR = 1.24, 95% CI: 1.17–1.35) were independent predictors of infection-related hardware removal ($P < 0.001$). Patients who underwent removal due to infection were more likely to have asthma (OR = 1.87, 95% CI: 1.62–2.07), smoke tobacco (OR = 1.12, 95% CI: 1.05–1.23), and suffer from developmental delays (OR = 1.32, 95% CI: 1.19-1.54) ($P < 0.001$). Average hospital charges and costs were $36,349 and $11,792 respectively.

Conclusion: While most commonly performed as an outpatient procedure, inpatient hardware removal occurs with relative frequency and is most often performed for infection, mechanical failure, or pain. Risk factors for infection-related removal were identified and provide a basis for further investigation.

1. Introduction

Operatively treated fractures in pediatric patients most commonly occur in the extremities. Following initial fixation, hardware removal is one of the most common procedures performed by pediatric orthopedic surgeons. However, there exists a paucity of literature examining the indications for hardware removal after open reduction internal fixation (ORIF). In addition, few explicit guidelines address the specific indications for hardware removal following ORIF. Pediatric orthopedic surgeons nonetheless remove hardware for a variety of reasons in children including pain, infection, and surgeon and patient preference.[1]

Fracture fixation in the pediatric population often involves implantation of hardware either with closed reduction and percutaneous pinning (CRPP) or ORIF. While percutaneous pins can be routinely removed in the outpatient setting, no official guidelines or recommendations have been published regarding removal of internal hardware after successful fracture healing.[2] The decision to remove hardware in the pediatric patient is varied and may be related to fear of affecting future growth, surgeon preference to not leave hardware in young patients, or patient/family preference. Despite the lack of evidence-based guidelines, common pediatric orthopedic practice is to remove hardware in children after fracture healing or upon patient/family request.[3–5] Reported indications for hardware removal include pain, soft tissue irritation, and infection.[6,7] While a majority of these procedures are done in the outpatient setting, little is known about the factors associated with inpatient hardware removal. Furthermore, given the high prevalence of infection in ORIF patients, risk factors and

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conditions associated with infection-related removal should be further investigated.

We sought to query the 2012 Healthcare Cost and Utilization Project (HCUP) Kid's Inpatient Database (KID) in order to describe the type and frequency of diagnoses associated with hardware removal, risk factors for hardware removal, and hospital charges and costs associated with these procedures. We hypothesized that inpatient hardware removal would be a relatively common procedure most frequently performed due to symptomatic hardware and infection. Additionally, we hypothesized that certain patient characteristics and fracture types and locations would be associated with higher rates of removal.

2. Methods

2.1. Data collection

The Healthcare Cost and Utilization Project (HCUP) Kids' Inpatient Database (KID) was utilized to examine the incidence of fracture management and hardware removal in the United States in the year 2012. The HCUP-KID is the largest publically available all-payer pediatric inpatient database that is compiled based on 2 to 3 million hospital stays. The database is a result of the data collected in the 46 states that have partnered with the Agency for Healthcare Research and Quality (AHRQ) and maintain statewide data collection efforts. The database approximates a 20-percent stratified sample of all pediatric discharges at all of the hospitals in participating states. The large sample size generates data that is generalizable to the national pediatric population. Data collected from KID include demographic information, including patient age, gender, median income and ZIP code, primary and secondary diagnoses, procedures, payment information, and patient length of stay. KID also collects information on factors including hospital size, teaching status, type of hospital and hospital location.

2.2. Data management

Orthopaedic hardware removal and co-morbidities were identified and classified by International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9 CM) diagnosis codes and Current Procedural Terminology (CPT) codes. All discharges in patients aged 0–17 years old were included. National estimates of incidence and standard errors were calculated using HCUP national discharge weights. To calculate rates and estimates, we used a method described by Rasouli et. al.[8] Population data was downloaded from the census.gov website. Variables queried included: demographics, diagnostic code associated with removal, causative organism in cases involving infection, average length of stay and average hospital charges and costs. Data was stratified by both age and limb affected. Demographic variables collected were patient age and sex, census division and insurance status (Table 1). Procedural data queried included diagnostic code associated with removal specific to orthopedic procedures, site of removal, and

Table 1
Demographic and Descriptive Variables of Study Population.

		Total number of orthopedic hardware removal from the upper and lower extremities	
All discharges		3621	100.00%
Age group	<1	7	0.19%
	1–4	259	7.16%
	5–9	750	20.71%
	10–14	1506	41.57%
	15–17	1100	30.36%
Sex	Male	2114	58.38%
	Female	1506	41.59%
	Missing	1	0%
Payer	Medicare	20	0.54%
	Medicaid	1382	38.17%
	Private insurance	1868	51.57%
	Uninsured	99	2.74%
	Other	238	6.57%
	Missing	15	0%
Owner (Hospital)	Government	356	9.83%
	Private, not-for-profit	2980	82.28%
	Private, for-profit	286	7.90%
Location/teaching status	Rural	70	1.95%
	Urban nonteaching	398	10.98%
	Urban teaching	3153	87.08%
Bedsize	Small	784	21.65%
	Medium	607	16.75%
	Large	2231	61.60%
Region	Northeast	539	14.89%
	Midwest	942	26.01%
	South	1168	32.25%
	West	972	26.85%
Children's hospital	Not a children's hospital	820	22.65%
	Children's hospital	2801	77.35%
Free-standing children's hospital	Not a free-standing children's hospital	2078	57.39%
	Free-standing children's hospital	1543	42.61%