

# Nationwide survey of pediatric septic arthritis in the United States



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## ABSTRACT

**Background:** The epidemiology of pediatric septic arthritis, such as annual hospitalization rates and disparities by age, gender, race/ethnicity, and socioeconomic status, remains unclear.

**Methods:** We obtained hospital discharge records of patients under the age of 20 years with septic arthritis from the kids inpatient database for 2006, 2009 and 2012. We weighted the records to estimate the number of hospitalizations in the US and calculated the annual rates of hospitalization due to septic arthritis. We used multivariable logistic regression to assess risk factors associated with comorbidities of osteomyelitis and bacteremia/septicemia.

**Results:** Overall annual hospitalization rates showed a decreasing trend (4.23, 3.64, and 3.28 per 100,000 children in 2006, 2009, and 2012, respectively). Children who were male, white or black, and between the ages of 0–4 years were more likely to have higher hospitalization rates than others. The proportions of hospitalizations were high among children living in lower-income areas. Large joints at the lower limbs were the most frequently affected sites of infection. Infections of large joints and age category of 10–14 years were the factors that were significantly associated with comorbidities of osteomyelitis and bacteremia/septicemia.

**Conclusions:** We demonstrated a change in the epidemiological patterns of pediatric septic arthritis and identified risk factors associated with comorbidities of osteomyelitis and bacteremia/septicemia.

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## 1. Introduction

Septic arthritis (SpA) of bacterial origin accounts for 6.5% of all childhood arthritis cases.<sup>1</sup> The epidemiology of pediatric SpA has continued to change and be influenced by many factors, such as the advent of antibiotics and vaccines, pattern of causative organisms, and sophisticated diagnostic tools, including bone scans and magnetic resonance imaging.<sup>2–13</sup>

Several studies with varying numbers of pediatric patients with SpA have revealed that SpA is more common among boys<sup>8,9,11</sup> and younger children.<sup>12,13</sup> The joints of the lower extremities, such as the knee, hip, and ankle, were the most commonly affected sites of infection.<sup>5,9,13</sup>

However, these previous studies were limited because they were conducted within a few hospital catchment areas and, thus, the sample sizes were relatively small.<sup>1–13</sup> Some of these studies were published between the 1980s and 1990s, furthermore, no large multicenter study or national survey on SpA-associated hospitalizations in children has been conducted. In addition, the potential effects of race/ethnicity and socioeconomic status on SpA remain unclear.

The present study aimed to investigate SpA-associated hospitalizations among children based on patient and hospital characteristics, using a national representative database in the US. In addition, we ascertained factors that were associated with SpA and the comorbidities of osteomyelitis and bacteremia/septicemia.

## 2. Materials and methods

### 2.1. Study population

We conducted a serial, cross-sectional analysis among hospitalized patients with SpA under the age of 20 years using the national representative Kids Inpatient Database (KID) for the years

**Abbreviations:** SpA, Septic arthritis; KID, Kids Inpatient Database; AHRQ, the Agency for Healthcare Research and Quality; HCUP, the Healthcare Cost and Utilization Projects; ICD, 9CM, *International Classification of Disease, Ninth Revision, Clinical Modification*.

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2006, 2009 and 2012. The data are compiled by the Agency for Healthcare Research and Quality (AHRQ).<sup>14,15</sup> KID is a large national all-payer hospital pediatric discharge database. KID is designed to generate robust national estimates of annual pediatric hospitalizations, and to present hospital use, outcome and cost for children aged 20 years or younger.<sup>14,15</sup> The sampling frame of KID was constructed using all US short-term, non-federal, general and specialty hospitals that participated in the Healthcare Cost and Utilization Projects (HCUP). KID had more than 3 million pediatric discharge records per year from 38 states in 2006, and 44 states in 2009 and 2012. Discharge-level weights variables (DISCWT) were provided with KID, and we used them to obtain the national estimates of annual hospitalization rates in the US.

Hospitalization discharge records were obtained from KID in 2006, 2009 and 2012. Hospitalizations with SpA of bacterial origin were identified using *International Classification of Disease, Ninth Revision, Clinical Modification* (ICD-9CM) code (pyogenic arthritis: 711.0×) in the primary diagnosis field. Hospitalizations due to SpA were subdivided into the affected sites of infection using ICD9-CM codes: shoulder (711.01), elbow (711.02), wrist (711.03), hand (711.04), pelvic region and hip (711.05), knee (711.06), ankle and foot (711.07), and others (711.00 and 711.08). Multiple sites infections were defined if the patients had two or more sites of infections or had ICD-9CM code of multiple sites (711.09). Comorbidities of osteomyelitis (730.1×, 730.2×, 730.8×) and bacteremia/septicemia (790.xx)/(038.xx) were also identified.

## 2.2. Measurements of variables

Patient characteristics consisted of age categories (0–4 years, 5–9 years, 10–14 years, or 15–19 years), gender (male or female), race/ethnicity (black, Hispanic, white, Asian and Pacific Islanders, or others), primary payer information (private, Medicare/Medicaid, self-pay or no insurance/information), and income quartiles for counties of residence for patient's zip code (very low, low, high or very high: see detail in supplement 1).

Hospital characteristics included hospital location (Northeast, Midwest, South, or West), type of hospital (urban teaching, urban nonteaching, or rural), and bed size (small, medium or large).<sup>16–18</sup> The definitions of bed size are different across the hospital locations. For instance, in Northeast region, hospital bed size was classified small if rural hospital had 1 to 49 beds, urban nonteaching hospital had 1 to 124 beds, or urban teaching hospital had fewer than 250 beds. The bed size was considered medium if rural hospital had 50 to 99 beds, urban nonteaching hospital had 125 to 199 beds, and urban teaching hospital had 250 to 424 beds. A large-size hospital could be defined by  $\geq 100$  beds for rural hospital,  $\geq 200$  beds for urban nonteaching hospital, and  $\geq 425$  beds for urban teaching hospital (see supplement 2).<sup>16–18</sup>

## 2.3. Outcomes

The outcomes of interest were annual hospitalization rates due to SpA of bacterial origin with respect to age, gender, and race/ethnicity. The annual hospitalization rates were calculated: the number of hospitalizations as the numerator and the population of each subgroup as the denominator derived from the US census in 2006, 2009 and 2012.<sup>19–22</sup> We also identified risk factors that were associated with comorbidities of osteomyelitis and bacteremia/septicemia.

## 2.4. Statistical analysis

The number of SpA-associated hospitalizations and the annual hospitalization rates were calculated using DSCWT. We calculated 95% confidence intervals for the hospitalization rates, assuming a

normal approximation to a Poisson distribution. Multivariable logistic regression was used to identify risk factors that were associated with osteomyelitis or bacteremia/septicemia. Data were analyzed using STATA software version 14.1 (StataCorp LP, Texas, USA).

## 3. Results

Fig. 1 showed a decreasing trend of annual hospitalization rates due to pediatric SpA with respect to the age categories. The highest hospitalization rates were children aged between 0 and 4 years. Fig. 2 showed the differences of annual hospitalization rates by race/ethnicity. White children had the highest hospitalization rates, whereas Asian children did the lowest rates. The rates among Hispanic children decreased from 2006 to 2012. Male children had higher hospitalization rates than female children (Table 1).

Patient socioeconomic status and hospital characteristics were summarized in Table 2. Children living in areas of low or very low median household income by patient ZIP Code were more likely to be hospitalized. Approximately ninety percent of patients had primary payer information of private or Medicare/Medicaid. The highest proportions of hospital characteristics were urban teaching hospital with large bed size in West.

Table 3 describes the proportions of the affected sites of infection and comorbidities of osteomyelitis or bacteremia/septicemia. The knee and hip/pelvic joints were the most frequently affected sites of infection. Approximately 10%–13% of hospitalized children with SpA had osteomyelitis, and 9%–11% of children with SpA had bacteremia/septicemia.

We used multivariable logistic regression to analyze the association between age categories, the affected sites of infection and the presence of osteomyelitis (Table 4). Crude analysis showed that age categories of 10–14 years and 15–19 years, and septic arthritis at hip/pelvic, ankle/foot, elbow and shoulder were significantly associated with osteomyelitis. After adjusting for gender, race/ethnicity, socioeconomic status, and hospital characteristics, the odds ratio of osteomyelitis among children who aged between 10 and 14 years, and who had septic arthritis at hip/pelvic, ankle/foot, elbow, and shoulder, remained statistically significant.

Multivariable logistic regression was conducted to ascertain the association between age categories, the affected sites of infection and the presence of bacteremia/septicemia (Table 5). In crude analysis, age category of 10–14 years and septic arthritis at hip/pelvic, ankle/foot, hand or shoulder were significantly related to the presence of bacteremia/septicemia. After adjusting for covariates, the same factors (10–14 years of age, and hip/pelvic,

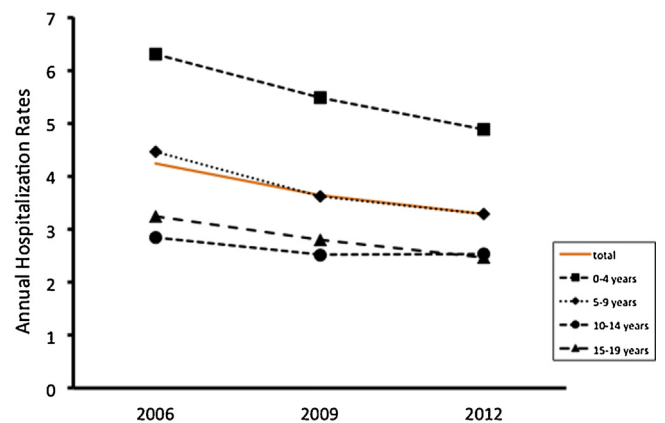


Fig. 1. Annual hospitalization rates due to pediatric SpA with respect to the age categories.

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