



## Septic arthritis of the hip and knee treated surgically in pediatric patients: Analysis of the Kids' Inpatient Database

Mikhail Tretiakov<sup>a</sup>, Frank S. Cautela<sup>a</sup>, Sarah E. Walker<sup>a</sup>, Joanne C. Dekis<sup>a</sup>, George A. Beyer<sup>a</sup>, Jared M. Newman<sup>a,\*</sup>, Neil V. Shah<sup>a</sup>, Jenna Borrelli<sup>a</sup>, Sharan T. Shah<sup>a</sup>, Anter S. Gonzales III<sup>a</sup>, Jennifer M. Cushman<sup>b</sup>, John P. Reilly<sup>c</sup>, Jeffrey M. Schwartz<sup>d</sup>, Claude B. Scott<sup>d</sup>, Khalid Hesham<sup>a</sup>

<sup>a</sup> Department of Orthopaedic Surgery and Rehabilitation Medicine, SUNY Downstate Medical Center, Brooklyn, NY, USA

<sup>b</sup> New Jersey Society of Physical Medicine & Rehabilitation, South Orange, NJ, USA

<sup>c</sup> Department of Orthopaedic Surgery, Staten Island University Hospital, Northwell Health, Staten Island, NY, USA

<sup>d</sup> Department of Orthopaedic Surgery, Kings County Hospital Center, Brooklyn, NY, USA

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### ABSTRACT

**Objective:** This study evaluated incidence over time, any association between race and demographics, and hospital-related parameters in pediatric patients with septic hip or knee arthritis.

**Methods:** The Kids' Inpatient Database was used to identify all children with a diagnosis of septic hip or knee arthritis who underwent incision and drainage (1997–2012).

**Results:** Between 1997 and 2012, overall incidence of septic arthritis of the knee (0.20–0.33 per 100,000) and hip (0.12–0.18 per 100,000) increased.

**Conclusion:** Incidence of pediatric septic joint arthritis, an emergent orthopaedic condition, has increased over time. Patient demographics may vary with respect to both age and race.

### 1. Introduction

Septic arthritis in children is a common cause of emergency room visits and is considered an orthopaedic emergency.<sup>1</sup> While septic arthritis may also be caused by viral and fungal organisms, bacteria, such as *Staphylococcus aureus* and *Kingella kingae* are by far the most common causative organisms.<sup>2</sup> In developed countries, the incidence of acute bacterial septic arthritis is estimated to be 4 to 10 per 100,000 children.<sup>3</sup> Intra-articular infection can be the result of hematogenous spread, extension from a local infection, or direct inoculation of the joint. These infections can potentially lead to complications such as arthritis, osteomyelitis, systemic complications, and malalignment; one study showed that up to 29% of septic arthritis and osteomyelitis pediatric patients may have long-term sequelae such as osteonecrosis, limb-length discrepancy, and pathologic fractures, which can lead to lifelong disability and impairment.<sup>2,4–6</sup>

Although any joint may be affected, the hip and knee are the most commonly involved joints in the pediatric population,<sup>7</sup> and account for as many as 70% of septic arthritis cases in children.<sup>8</sup> While criteria has been developed and validated for pediatric septic arthritis of the hip,<sup>9,10</sup> diagnosis can be challenging due to factors such as absence of fever,

normal leukocyte count, or negative gram staining, which cannot reliably be used to rule out septic arthritis.<sup>11</sup> Consequently, clinical suspicion must remain high in a child with hip or knee pain and refusal or inability to ambulate. Time between onset of symptoms and treatment is the most important factor in preventing potentially devastating outcomes.<sup>5,12</sup> Various risk factors for septic arthritis in children have been proposed, such as young age, male gender, osteomyelitis, joint surgery, and immunodeficiencies.<sup>13,14</sup> Well documented is the decrease in incidence of *Haemophilus influenzae* as the purported causative organism in pediatric septic arthritis; which has been attributed to effective vaccination.<sup>15</sup> Nonetheless, there is a paucity of literature describing the demographic risks and trends of septic arthritis of the hip and knee over time in the pediatric population.

Due to the importance of this topic, this study utilized a large national database to analyze children with a diagnosis of septic hip or knee arthritis. The purpose of this study was to determine: 1) if the incidence of septic hip and knee arthritis has changed in the pediatric population since 1997; 2) if there was an association between race and other demographic factors for the incidence of septic hip and knee arthritis in the pediatric population from 1997 to 2012; and 3) the lengths of stay (LOS) and total charges in pediatric patients who had septic

\* Corresponding author. Department of Orthopaedic Surgery, SUNY Downstate Medical Center, 450 Clarkson Ave. Box 30, Brooklyn, NY, 11203, USA.

E-mail address: [jared.newman@downstate.edu](mailto:jared.newman@downstate.edu) (J.M. Newman).

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arthritis of the hip and knee.

## 2. Materials and methods

### 2.1. Database

The Kids' Inpatient Database (KID) is the largest publicly available all-payer pediatric inpatient care database in the United States. Developed for the Healthcare Cost and Utilization Project (HCUP), the KID is produced triennially and started in 1997. It yields hospital stay information for patients 21 years of age or younger. Weighted, it compiles records of roughly three million hospital stays across more than 4100 community hospitals every year. This creates a fairly representative sample of annual U.S. pediatric hospital admissions.<sup>16</sup> Each patient's discharge record contains demographic and clinical data, including ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) diagnosis and procedure codes. The KID database is publicly available to researchers and contains de-identified data, and was deemed exempt from our institutional review board.

### 2.2. Study population

Patients who had an ICD-9 diagnosis code for septic arthritis of the hip (711.05) or knee (711.06) and underwent irrigation and drainage (I & D) between the years 1997 and 2012 were included. Pediatric patients that had septic arthritis of other joints, unspecified septic arthritis, or did not undergo I&D were excluded.

### 2.3. Outcomes

After pediatric cases of septic arthritis of the hip and knee were identified, multiple patient variables were collected. These include age, sex, race, lengths of stay (LOS), and total charges. Race was characterized as white, black, Hispanic, Asian or Pacific Islander, Native American or other. Mean LOS was the number of days from admission to discharge.

### 2.4. Data analysis

All statistical analyses were performed using SPSS version 24 (IBM Corporation, Armonk, New York). The threshold for statistical significance was set a p-value of less than 0.05. Univariate analysis was used to compare the differences in mean age and sex distribution between varying races. Linear regression was used to analyze the trends of race and septic hip and knee arthritis.

## 3. Results

In the 6 available datasets from the year 1997, 2000, 2003, 2006, 2009, 2012, the KID sample contained 5555 septic knee arthritis patients and 3061 septic hip arthritis patients. Overall, whites comprised the majority of septic knee arthritis patients (57.0%) and septic hip arthritis patients (56.4%). The next two most common races were Hispanic (19.9% hip; 17.0% knee) and black (14.4% hip; 17.4% knee).

The incidence of septic arthritis of the hip increased from 0.12 per 100,000 in 1997 to 0.18 in 2012 (Fig. 1). Similar increases were seen across varying races, with the incidence in black patients increased from 0.014 per 100,000 to 0.024 per 100,000 ( $R^2 = 0.79$ ,  $p = 0.018$ ) and the rate of septic arthritis of the hip in Hispanics increased from 0.018 per 100,000 to 0.034 ( $R^2 = 0.95$ ,  $p = 0.001$ ). In white patients, the incidence increased from 0.06 per 100,000 to 0.09 ( $R^2 = 0.84$ ,  $p = 0.01$ ). The mean age in whites was 7 years, which varied significantly from Hispanic patients who had a mean age 6 years ( $p < 0.001$ ). The distribution of sex did not vary between races.

The incidence of septic arthritis of the knee increased from 0.20 per

100,000 in 1997 to 0.33 in 2012 (Fig. 2). Similar increases were seen across varying races, with the incidence in black patients increasing from 0.028 per 100,000 to 0.048 per 100,000 ( $R^2 = 0.70$ ,  $p = 0.037$ ) and the rate of septic arthritis of the knee in whites increased from 0.09 per 100,000 to 0.17 per 100,000 ( $R^2 = 0.91$ ,  $p = 0.003$ ). However, in Hispanics the rate of septic knee arthritis increased insignificantly from 0.02 per 100,000 to 0.049 ( $R^2 = 0.64$ ,  $p = 0.055$ ). The mean age in whites was 10 years, which was significantly higher than black and Hispanic patients who both had a mean age of 8 years ( $p < 0.001$ ). Sex did not vary between different races.

Mean total charges in the septic hip group were \$45,761 (SD = \$88,814). Mean total charges in the septic knee group were \$35,996 (SD = \$77,774). Total charges did not vary between races in either sample. The mean length of stay (LOS) in the septic hip group was 8.69 (SD = 12.8) and was 7.10 (SD = 12.1) in the septic knee group. As with total charges, mean LOS did not vary between races in either group.

## 4. Discussion

Septic arthritis of the hip and knee are emergent conditions in the pediatric population. These conditions can have potentially catastrophic sequelae, such as limb-length discrepancy, destruction of surrounding bone, osteomyelitis, pathologic fractures, or sepsis.<sup>5,17</sup> While still relatively rare, this study showed that the incidence of septic arthritis of the hip and knee has increased since 1997. Our analysis determined the rate of septic arthritis was highest among white children at (56.4% hip; 57.0% knee), followed by Hispanic children (19.9% hip; 17.0% knee), and black children (14.4% hip; 17.4% knee). The mean age in white children was higher than in Hispanic children for septic hip arthritis patients, and in both black and Hispanic septic knee arthritis pediatric patients. There was no differences regards to mean total charges or mean LOS.

This study does have some limitations that may affect interpretation of its results. First, the sample size was limited to confirmed cases of septic knee and hip arthritis in pediatric patients that also underwent incision and drainage of the affected joint, thereby excluding patients who were misdiagnosed, or did not undergo an operation. The KID does contain detailed information on patient demographics, but it does not contain detailed information on other patient characteristics of interest, such as laboratory markers at presentation or medical history, including previous episodes of septic joint arthritis. Despite these limitations, this study, to our knowledge, contains one of the largest sample sizes analyzing recent incidence and demographic trends of septic hip and knee arthritis in the literature today.

While there is a lack of literature analyzing how demographics relate to septic arthritis of the hip and knee in children, this study does have similar results to others in the literature. Riise et al.<sup>18</sup> found that, while arthritis occurred more frequently in males than females in children under the age of 8, this was not the case after the age of 8. Our analyses found that the distribution of sex did not vary across races in either hip or knee septic arthritis. Okubo et al.<sup>19</sup> found that the rate of hospitalization for septic arthritis between the years 2006 and 2012 was highest in white children. This is similar to our finding in both hip and knee septic arthritis.

We found that the distribution of septic arthritis of the hip and knee did not vary between males and females in any race. This is in contrast to Yagupsky et al.,<sup>20</sup> who found that septic arthritis of the hip was more common in males than in females in children under 24 months of age. The mean age of our sample size was much higher than this, however. Joshy et al.<sup>21</sup> also found that patients with septic arthritis of the knee were much younger than patients with septic arthritis of the hip. This is the opposite of the trend that we found, where patients in our sample treated for septic arthritis of the hip were younger than those treated for septic arthritis of the knee. Okubo et al.<sup>19</sup> found that the rates of hospitalization among Hispanic children suffering from septic arthritis

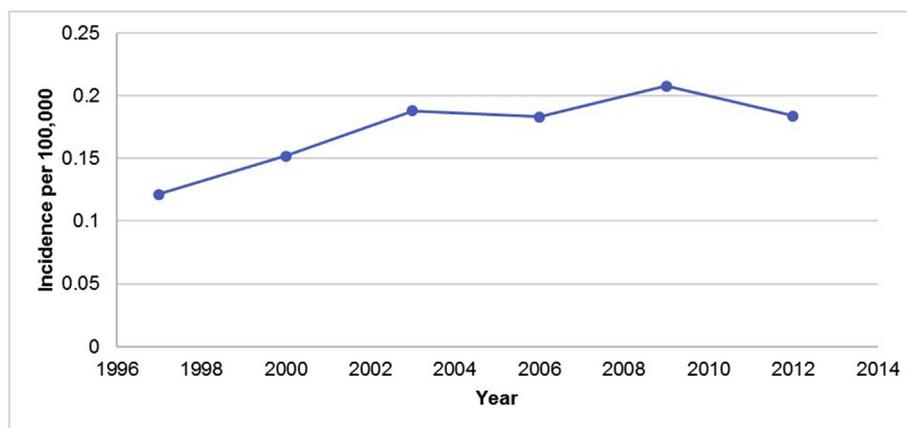


Fig. 1. Incidence of septic arthritis of the hip from 1997 to 2012, with data sampled triennially.

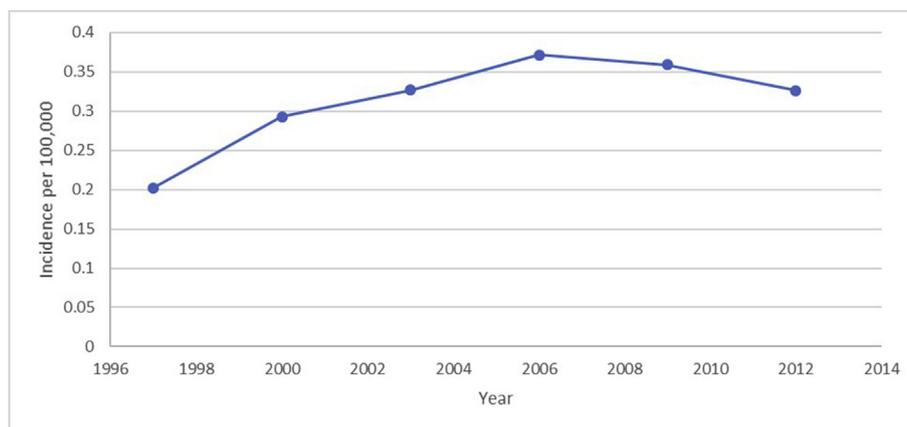


Fig. 2. Incidence of septic arthritis of the knee from 1997 to 2012, with data sampled triennially.

decreased from 2006 to 2012. This contrasts our finding in septic arthritis of the hip, where the incidence increased in Hispanic children, and the trend we found where the incidence of septic arthritis of the knee insignificantly trended upward during our study time period.

Septic arthritis of the pediatric joint may arise from hematogenous spread via transphyseal vessels, adjacent osteomyelitis especially at the metaphysis, or direct inoculation via an open wound.<sup>22</sup> Blood supply of the pediatric hip and knee are different in children than adults.<sup>23</sup> The developing proximal femur is well vascularized by the medial and lateral femoral circumflex vessels as well as the artery of the ligamentum teres until the child reaches about four years of age. The artery of the ligamentum teres begins to play a smaller role in intra-articular blood supply, and the lateral femoral circumflex artery regresses and primarily provides vascularity to the extra-articular metaphysis. By the age of 10, the hip is primarily vascularized by end-arterial flow from posterior branches of the medial femoral circumflex. As the child nears skeletal maturity, an anastomotic network develops between the artery of the ligamentum teres, circumflex and perforating arteries; this improved blood supply has been implicated in a decreased rate of osteonecrosis after adult hip fractures as compared to pediatric hip fractures.<sup>24–26</sup>

The blood supply of the adult knee, similar to the adult hip, is an anastomotic network formed by the medial and lateral branches of both the superior and inferior genicular arteries, as well as the middle genicular artery. On microangiographic studies of children and adults, Shim and Leung<sup>27</sup> noted that pediatric vascularity was poor in the areas of the epiphyseal plates, which they observed until the physes were closed.

## 5. Conclusions

While still relatively rare, this study shows that the incidence of septic arthritis of the hip and knee have both increased in white, black, and Hispanic pediatric patients since 1997. The rate of septic arthritis was highest among white children, followed by Hispanic children and then black children. Future studies can further analyze this demographic trend, and focus on the long-term sequelae of these patients.

## Conflicts of interest

There are no relationships or conflicts of interest directly related to this paper or that could influence or bias this work. The following authors have no disclosures to report: Tretiakov, Cautela, Walker, Dekis, Beyer, Newman, NV Shah, Borrelli, ST Shah, Gonzales, Cushman, Reilly, Scott, and Hesham. The author Schwartz reports stock or stock options for the following: Amgen, Gilead Sciences, GlaxoSmithKline, and Johnson & Johnson.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jor.2018.12.017>.

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