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Socioeconomic Implications of Pediatric Cervical Methicillin-Resistant *Staphylococcus aureus* Infections

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Objective: To study cervical methicillin-resistant *Staphylococcus aureus* (MRSA) infections using a national database with the goal of providing normative data and identifying variations in resource utilization.

Design: Retrospective review using a pediatric national data set (Kids' Inpatient Database 2009).

Subjects: Inclusion criteria were admissions with *International Classification of Diseases, Ninth Revision, Clinical Modification*, codes for both MRSA and specific neck and pharyngeal infections.

Results: There were 26 829 admissions with MRSA; 3571 included a head and neck infection. The mean (SE) age at admission was 7.72 (0.20) years. Most patients (65.0%) were in the lower 2 socioeconomic quartiles; the most common payer was Medicaid (53.3%). The mean total charge per admission was \$20 442. The mean (SE) length of stay (LOS) was 4.39 (0.15) days; there were significant differences among age ($P < .001$) and racial ($P < .001$) groups. A total of 1671 children underwent at least 1 sur-

gical drainage procedure; there were statistically significant differences among racial ($P < .001$), age ($P < .001$), and socioeconomic ($P = .048$) groups. There were no regional variations in resource utilization when LOS, number of procedures, and total hospital charges were compared.

Conclusions: Cervical MRSA infections have a large socioeconomic impact across the nation. There are differences among the various races in resource utilization. Younger children have longer hospitalizations, are more likely to need surgery, and require more intubations. Children from the lowest socioeconomic group require surgery more frequently, but their LOS is not statistically different when compared with the other 3 groups. Knowledge of such characteristics for cervical MRSA infections in children can facilitate targeted clinical interventions to improve care of affected populations.

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METHICILLIN-RESISTANT *Staphylococcus aureus* (MRSA) infections have been increasing in incidence over the last decade.¹⁻³ The same trend has been similarly identified in a variety of MRSA head and neck infections in both adult and pediatric populations.⁴⁻⁸ Recent studies have demonstrated a MRSA incidence of 28% to 40% in pediatric head and neck infections.^{5,7} It is possible to attribute some of the increased overall incidence of MRSA infections to the parallel rise in community-acquired MRSA over the last several decades.^{2,6}

Cervical infections, both superficial and deep, represent a very common reason for physician visits in children. Standard treatment includes antibiotic therapy and surgical drainage when indicated, and the clinical course is often uneventful, with-

out significant morbidity. However, these infections can present a challenging clinical problem in the setting of resistant bacteria such as MRSA. Advanced antibiotic requirements, longer hospitalizations, and the need for multiple drainage procedures can make infections with MRSA and other resistant bacteria consume an increasing amount of health care resources.

This study looked at the clinical factors associated with pediatric MRSA neck infections using a large national database. Previous studies have demonstrated the influence of MRSA on skin and soft-tissue infections in an outpatient pediatric practice as well as the overall increase in resource utilization associated with MRSA.⁹⁻¹¹ The recent increase in pediatric MRSA head and neck infections has been analyzed using a limited national database,⁵ but, to our knowledge, no com-

ment has yet been made in the literature on the discrepancies in resource utilization associated with these infections. The aim of this study was to identify both normative data for this clinical condition and certain risk factors associated with a prolonged length of stay (LOS) and the need for surgical intervention. This knowledge can assist the otolaryngologist in the treatment of these at-risk patients and facilitate appropriate counseling of their families.

METHODS

Institutional review board approval was obtained for the study. The Kids' Inpatient Database (KID) 2009 was published by the Agency for Healthcare Research and Quality as part of the Healthcare Cost and Utilization Project. This database was developed to provide researchers with a tool to examine disease processes on a national level, thereby identifying trends and variations and establishing normative data. The KID 2009 contains data on more than 3.4 million discharges from 4121 community nonrehabilitation hospitals in 44 states.¹² Previous studies have used the KID to examine epidemiological features and regional variations of a variety of clinical conditions, including mastoiditis, subglottic stenosis, and orbital infections.¹³⁻¹⁵

The KID 2009 contains up to 15 coded diagnoses for each patient. The database was searched for the *International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM)*, code for MRSA (041.12), which was then cross-referenced for the ICD-9-CM codes for peritonsillar abscess (475.0), parapharyngeal abscess (478.22), retropharyngeal abscess (478.24), cellulitis and abscess of face or neck (682.0-1), and other abscess of pharynx or nasopharynx (478.29). The resulting group of patients was then examined for demographic information and admission details. Total hospital charges were used as an indicator for resource utilization, as has been previously described.¹⁵

Primary outcomes included LOS and the need for surgical drainage. Surgical drainage procedures included other incision with drainage of skin and subcutaneous tissue (86.04); drainage of face and floor of mouth (27.00); aspiration of skin and subcutaneous tissue (86.01); incision and drainage of tonsil and peritonsillar tissue (28.00); incision of nose (21.10); non-excisional debridement of wound, infection, or burn (86.28); other incision of soft tissue (83.09); and other incision of eyelid (08.09). A secondary outcome of mechanical ventilation requirements was also analyzed. Patients with the ICD-9-CM code of 96.71 (continuous invasive mechanical ventilation for less than 96 consecutive hours) and 96.72 (continuous invasive mechanical ventilation for 96 consecutive hours or more) were included in the mechanical ventilation analysis.

Regression analyses were used to estimate the effect of continuous variables. Categorical variables were evaluated using the χ^2 test. $P < .05$ indicated statistical significance.

RESULTS

There were 3571 weighted admissions in the KID 2009 that met inclusion criteria. The **Table** shows the demographic and hospitalization data for the cohort. There were no deaths in the patient population. The mean (SE) age of the patients was 7.72 (0.20) years, and there was a slight male predominance ($n = 1938$ [54.3%]). Because 44% of the children were younger than 3 years, the population

Table. Demographic and Hospitalization Data on 3471 Admissions

Variable	Value ^a
Age, mean (SE), y	7.72 (0.20)
Sex	
Male	1938
Female	1612
Race	
White	1550
Black	687
Hispanic	543
Asian or Pacific Islander	46
Native American	22
Other	115
Primary payer	
Medicaid	1904
Private, includes HMO	1305
Self-pay	207
Other	123
Median household income quartile by zip code (\$)	
1 (1-39 999)	1383
2 (40 000-49 999)	938
3 (50 000-64 999)	708
4 (≥ 65 000)	462
Hospital bed size	
Small	395
Medium	703
Large	2095
Hospital region	
Northeast	379
Midwest	794
South	1786
West	613
Hospital teaching status	
Teaching	1847
Nonteaching	1346
Deaths	0
Length of stay, mean (SE), d	4.39 (0.15)
No. of diagnoses, mean (SE)	4.16 (0.07)
No. of procedures	
0	1365
1	1530
≥ 2	676
Total charges, mean (SE), \$	20 442 (1049.60)

Abbreviation: HMO, health maintenance organization.

^aThe values are given as the number of admissions unless indicated otherwise.

was divided into 2 groups using 3 years of age as a cutoff. There was statistical regional variation in mean age ($P = .01$): the West region had the youngest patients (mean age, 7.18 years), while the Midwest had the oldest (mean age, 8.12 years).

The mean (SE) number of diagnoses per patient was 4.16 (0.07) (range, 2-25), and the most common diagnoses were cellulitis or abscess of the face (70.2%) and neck (29.0%). The mean (SE) total hospital charges were \$20 442 (\$1049.60) (range, \$901-\$642 409). Eighty-two percent of patients had total hospital charges of less than \$25 000. There was no significant regional variation in total hospital charges ($P = .14$) (**Figure 1**). The most common primary payer was Medicaid (53%). Almost all other patients had some form of private insurance (preferred provider organization or health maintenance organization). Mechanical ventilation was required

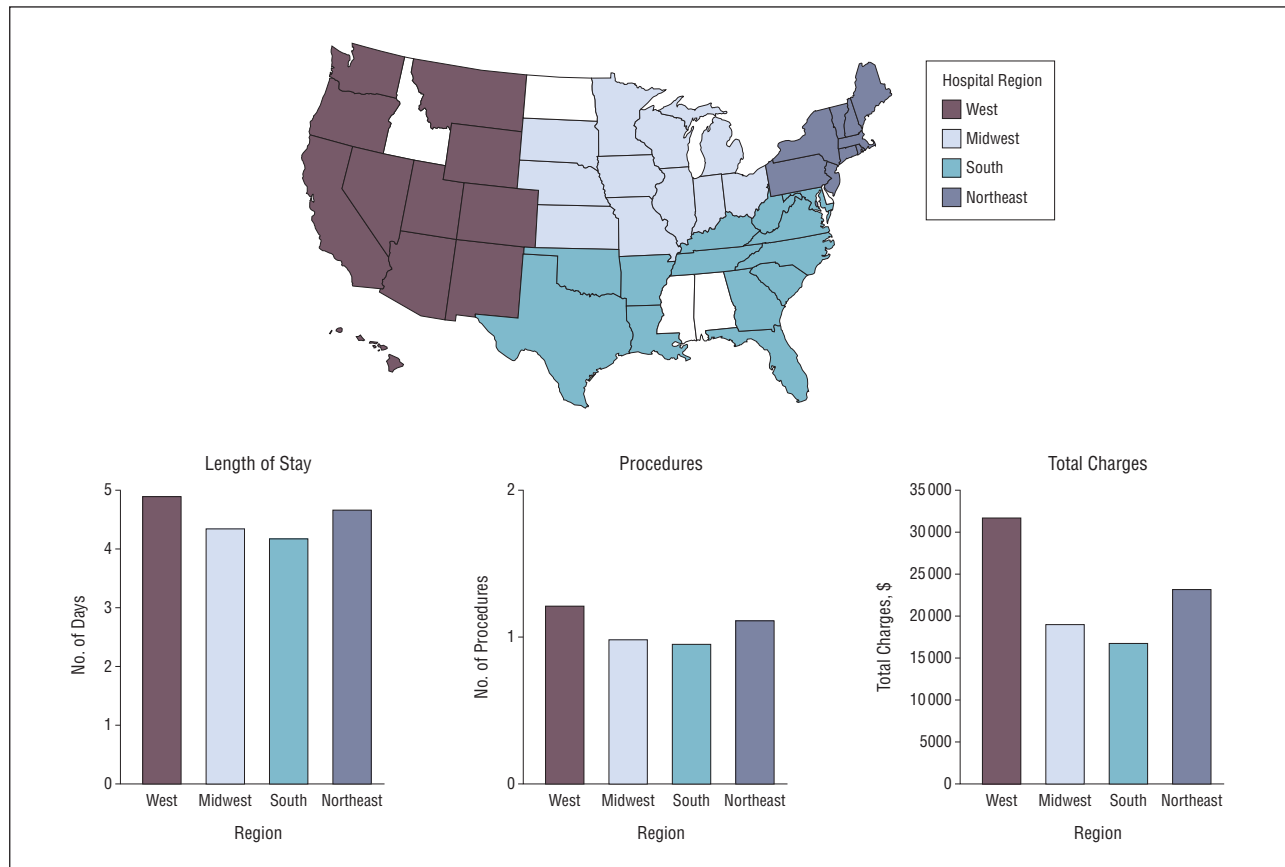


Figure 1. Regional variation in resource utilization. There were no regional variations in length of stay, number of surgical drainage procedures, and total hospital charges. While the values are not significant, patients in the West region had longer hospitalizations ($P = .81$), more surgery ($P = .54$), and higher total charges ($P = .14$). The following states are not included in the Kids' Inpatient Database 2009: Alabama, Alaska, Delaware, Idaho, Mississippi, and North Dakota.

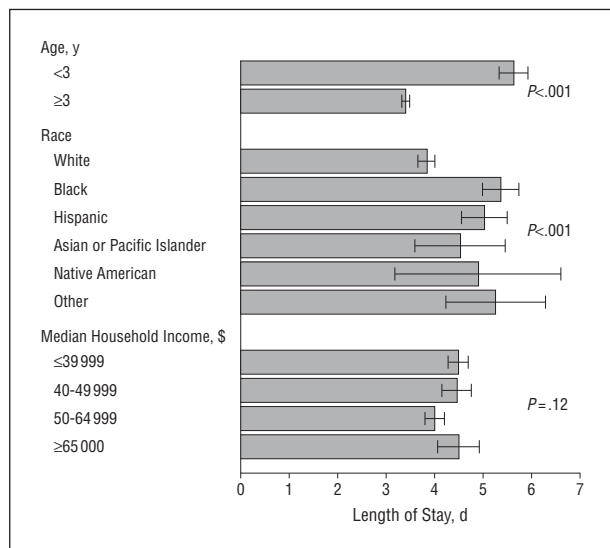


Figure 2. Length of stay vs age, race, and socioeconomic status. Longer hospitalizations were found in children younger than 3 years ($P < .001$) and nonwhite children ($P < .001$). The length of stay did not vary among socioeconomic groups ($P = .12$). The error bars represent the standard error.

in 2.0% of patients. Statistically, the sample size precluded analysis.

The mean (SE) LOS was 4.39 (0.15) days (range, 0-96 days). Seventy-five percent of the patients were discharged in 4 days or less. Longer hospitalizations were

associated with younger age ($P < .001$) and nonwhite races ($P < .001$) (**Figure 2**). There was no difference among socioeconomic groups with regard to LOS ($P = .12$). There was no regional variation in LOS ($P = .81$).

More than 60% of patients underwent at least 1 procedure, and the most common procedure was incision and drainage of skin and subcutaneous tissue (45.2%). The need for surgical drainage varied significantly by age, race, and socioeconomic status (**Figure 3**). Surgical drainage was needed more often in younger patients ($P < .001$), nonwhite patients ($P < .001$), and patients in the lowest socioeconomic quartile ($P = .048$). Surgical drainage did not vary among geographic regions ($P = .54$).

COMMENT

Over the last few decades, MRSA has received increasing attention in both the media and the medical literature, a trend that mirrors its clinical significance. One study showed a more than 10-fold increase in the incidence of methicillin-resistance in community-acquired *S aureus* infections, and a similar trend was found at the University of Chicago Children's Hospital, Chicago, Illinois, in the 1990s.^{6,16}

The role of MRSA in pediatric deep neck abscesses has been studied before.^{1,4,5,7,8,10} Brook⁴ reviewed a number of studies that examined the role of MRSA in neck in-

fections and identified both an increasing incidence of MRSA infections and an increasing resistance among MRSA isolates. A review of 245 pediatric patients with neck abscesses demonstrated an increase in MRSA incidence from 9% to 40% over a 5-year period.⁷ Children with medial neck abscesses and MRSA infections also experienced more complications than their non-*S aureus* counterparts. In a recent study at the Children's Hospital of Michigan, Detroit, children with MRSA retropharyngeal abscesses experienced longer hospitalizations and developed mediastinitis more frequently.¹⁰

Prior studies at Children's National Medical Center, Washington, DC, have used the KID to evaluate pediatric subglottic stenosis, mastoiditis, and retropharyngeal abscesses.^{13,15,17} Lander et al¹⁷ identified both seasonal and regional variations in the treatment of retropharyngeal abscesses. Regional variations and clinical predictors of surgical intervention were also identified in the treatment of orbital and periorbital infections using the KID.¹⁴

The current study used the KID data obtained from more than 4100 hospitals and examined demographic and regional variations in MRSA neck infections. To our knowledge, this is the largest such study to date and the first attempt to identify both normative data and variations in resource utilization with regard to this disease. One prior study used a different national database from more than 300 hospitals to demonstrate the increasing incidence of both MRSA and community-acquired MRSA in pediatric head and neck infections; however, no comment on the discrepancies in resource utilization was made.⁵

We identified younger age as a factor that is associated with both longer hospitalizations and an increased requirement for surgical drainage procedures. This association can potentially be explained by the smaller size of children's necks and airways, and a lower threshold for intervention may exist among otolaryngologists treating these patients. Also, surgical drainage procedures could naturally prolong a patient's hospitalization.

Interestingly, nonwhite race was significantly associated with both prolonged LOS and increased surgical drainage. The increased prevalence of MRSA in nonwhite populations has been identified in previous studies¹⁸⁻²⁰ but few studies have identified racial differences in the severity of MRSA infections. An increase in the overall incidence and mortality of MRSA infections in blacks has previously been found.³ It has been proposed that the increased severity of MRSA infections in nonwhite races is potentially confounded by socioeconomic status or the increased incidence of other comorbid conditions in those populations. Further studies are needed to better clarify this relationship.

Lower socioeconomic status was associated with an increased need for surgical drainage but not with a prolonged LOS. The discrepancies in access to care for lower socioeconomic groups have been previously described in the literature.²¹⁻²³ The present study's findings may be related to issues with access to care for these patients; however, these issues do not obviously explain why their LOS was not longer. We hypothesize that this block in access to care leads to a delay in presentation to either

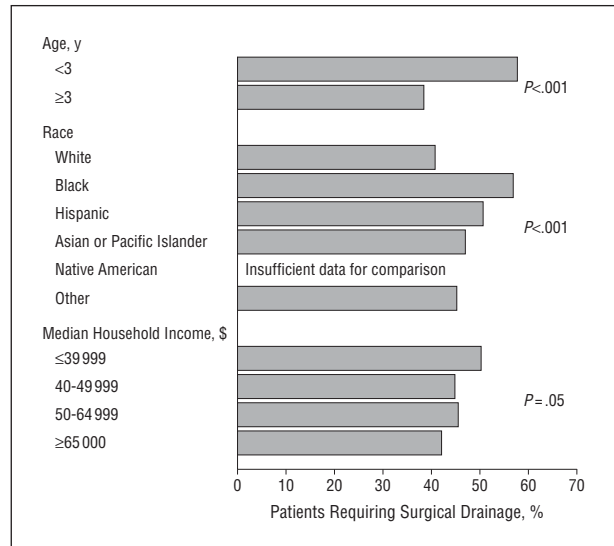


Figure 3. Surgical drainage vs age, race, and socioeconomic status. Surgical drainage was needed more frequently in younger children ($P < .001$), nonwhite children ($P < .001$), and children from areas with the lowest median household income ($P = .048$).

primary care or emergency departments for these patients. This delay could be associated with advanced disease at presentation (eg, larger abscesses), which would then require prompt surgical intervention rather than an initial trial of antibiotic therapy. Such a clinical course may explain the similar LOSs among socioeconomic groups despite the increased need for surgery. However, it must be noted that analyses of socioeconomic grouping based on KID data do have their limitations. Patients are assigned into 1 of 4 socioeconomic quartiles based on the median household income in their zip code in 2009 ($< \$39\,999$, $\$40\,000$ - $\$49\,999$, $\$50\,000$ - $\$65\,999$, and $\geq \$66\,000$). Therefore, this grouping does not reflect the true socioeconomic status of each individual patient.

Another limitation of our database analysis includes the fact that all data represent averages gathered across numerous institutions and physicians from 44 states. Individual practice patterns at each institution are themselves products of a number of factors, including location, institutional volume, physician training and experience, and microbiological profiles. With so many variables, it can be difficult to interpret and apply these normative data to a particular situation.

This study provides the first set of normative data on children with MRSA neck infections and identifies risk factors for longer hospitalizations and surgical intervention. Specifically, younger, nonwhite children from lower socioeconomic areas appear to be at higher risk for more complex disease courses. While there was no significant difference in resource utilization, the West region had higher total charges, longer LOSs, and a greater number of procedures than the other 3 regions. These findings could potentially be explained by the significantly younger population in this region.

Knowledge of these risk factors may facilitate clinical decision making to perhaps improve resource utilization of valuable health care resources. Otolaryngolo-

gists should be aware of these risk factors and possibly have a lower threshold for aggressive treatment of these at-risk patients if MRSA is suspected. We hope that the data presented herein can assist in such risk stratification; earlier surgical intervention may shorten the hospital course and thereby decrease overall health care costs.

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