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Factors Associated With High Resource Utilization in Pediatric Skin and Soft Tissue Infection Hospitalizations

Michelle A. Lopez, MD[1], **Andrea T. Cruz, MD, MPH**[2,3], **Marc A. Kowalkowski, PhD**[4], and **Jean L. Raphael, MD, MPH**[5]

[1]Sections of Hospital Medicine, Baylor College of Medicine, Houston, Texas

[2]Emergency Medicine, Baylor College of Medicine, Houston, Texas

[3]Infectious Diseases, Baylor College of Medicine, Houston, Texas

[5]Academic General Pediatrics, Department of Pediatrics, Baylor College of Medicine, Houston, Texas

[4]Department of Medicine, Baylor College of Medicine, Houston, Texas

Abstract

OBJECTIVE—To describe factors associated with prolonged lengths of stay (LOS) and increased charges for pediatric skin and soft tissue infection (SSTI) hospitalizations.

METHODS—This study was a cross-sectional analysis of pediatric SSTI hospital discharges in 2009 within the Healthcare Cost and Utilization Project Kids' Inpatient Database. Outcomes were prolonged LOS (>75th percentile) and increased hospital charges (>75th percentile). Multivariate logistic regression controlling for patient and hospital level factors was conducted for 2009 data to assess associations among variables.

RESULTS—The 75th percentile for LOS was 3 days. Infants had higher odds of prolonged LOS than other age groups (<1 year: 1; 1–4 years: 0.70 [95% confidence interval (CI): 0.64–0.76]; 5–12 years: 0.69 [95% CI: 0.63–0.76]; 13–18 years: 1.01 [95% CI: 0.91–1.10]), as did all minority groups compared with white subjects (black subjects: 1.23 [95% CI: 1.09–1.38]; Hispanic subjects: 1.33 [95% CI: 1.20–1.47]; and other races: 1.30 [95% CI: 1.12–1.50]). Public payers compared with private payers (odds ratio: 1.17 [95% CI: 1.10–1.26]) also had increased odds of prolonged LOS. The 75th percentile for charges was $14 317. The adolescent-aged category had higher odds of charges >75th percentile compared with the age category <1 year (odds ratio: 1.54 [95% CI: 1.36–1.74]). All racial/ethnic minorities had higher odds of charges >75th percentile compared with white subjects (black subjects: 1.38 [95% CI: 1.17–1.62]; Hispanic subjects: 1.90 [95% CI: 1.59–2.26]; and other races: 1.26 [95% CI: 1.06–1.50]).

CONCLUSIONS—Vulnerable populations, including infants, racial/ethnic minorities, and publicly insured children, had higher odds of increased resource utilization during hospitalizations for SSTIs. The findings of this study provide potential targets for future preventive and public health interventions.

Address correspondence to Michelle A. Lopez, MD, Texas Children's Hospital, 6621 Fannin St, Suite A2210, Houston, TX 77030. malopez@texaschildrens.org.

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Keywords

cellulitis and abscess; health service research; public health

Skin and soft tissue infections (SSTIs) often require inpatient management. Risk factors for admission include a history of atypical exposures, rapidly progressing infection, extensive or serious site of involvement, failure of oral antibiotics, need for surgical management, comorbidities, or signs of sepsis/systemic infection.[1] Previous studies have demonstrated a rise in SSTI hospitalizations,[2,3] and from 1997 to 2009, pediatric SSTIs rose from the 21st to the ninth most common pediatric inpatient hospital discharge diagnosis.[4] Recent literature reports rising costs per patient hospitalized with SSTIs over time, with an estimated total aggregate of $184 million attributable to SSTI hospitalizations in 2006.[5]

Although the current literature indicates a current and rising financial burden attributable to SSTI hospitalizations, the factors associated with increased resource utilization are not well described. The objective of the current study was to identify factors associated with prolonged lengths of stay (LOS) and increased charges in SSTI hospitalizations.

METHODS

Study Design and Data Source

This study was a cross-sectional analysis of pediatric hospitalizations in the United States. Data were from the 2009 Kids' Inpatient Database (KID) maintained by the Agency for Healthcare Research and Quality as part of the Healthcare Resource Utilization Project (HCUP).[6] State organization HCUP data partners are listed at www.hcupus.ahrq.gov/hcupdatapartners.jsp. This pediatric inpatient database includes multiple hospital types and contains information on patient demographic characteristics, hospital characteristics, diagnoses, procedures, LOS, and total charges.[6] The 2009 data set is the most currently released and includes data on hospitalizations from 4121 hospitals in 44 states.

Study Participants

This study included children 0 to 18 years of age with a primary diagnosis of SSTI based on International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), codes (Appendix 1). Children with invasive disease (defined as bacteria in normally sterile bodily fluids[7]) (Appendix 2) and those with chronic medical comorbidities (as defined in previous HCUP KID studies[8]) were excluded. The purpose of these exclusions was to study high resource utilization in a healthy population.

Dependent Variables

The primary outcomes examined were prolonged LOS and increased charges. LOS, as determined according to HCUP, was obtained by subtracting the admission date from the discharge date.[6] Hospital charge information was collected as the total amount charged by the hospital. Prolonged LOS and increased charges were defined as the highest quartile based on a previous study's examination of resource utilization according to quartiles[8] and previous HCUP KID studies, which set an arbitrary cutoff point for high resource utilization.[9,10] LOS and charges were examined as dichotomous variables.

Independent Variables

Patient characteristics consisted of age, gender, race/ethnicity, household income, and payer type. Age was divided into categories of <1 year (infant), 1 to 4 years (preschool age), 5 to 12 years (school-age), and 13 to 18 years (adolescence). Racial/ethnic information collected

by hospitals was categorized as white, black, Hispanic, or other.[6] For institutions that did not systematically collect race/ethnicity information, admissions were classified as unknown race, and this group was controlled for in the analysis. Payer types were classified as private, public (including Medicaid and other government programs), and other (including uninsured). Household income was based on the median household incomes for the patients' zip codes divided into quartiles, with the highest income in the first quartile. Hospital characteristics consisted of region, hospital size, teaching status, and hospital ownership. Region was categorized as defined in KID: northeast, Midwest, south, and west. Hospital size was defined as small, medium, and large based on number of hospital beds. Bed size categories as defined in the HCUP KID database are determined according to hospital beds and are specific to the hospitals' region, location, and teaching status. Approximately one-third of the hospitals in a given region, location, and teaching status combination fall within each bed size category. Hospitals were categorized as teaching/urban and nonteaching/urban. Hospital ownership included children's general hospital, children's unit in a general hospital, and hospitals not identified as children's hospital by the National Association of Children's Hospitals and Related Institutions.

Admission date was included to determine the association of weekday versus weekend presentation in resource utilization.

Analysis

Data were weighted to estimate national numbers by using the appropriately scaled discharge weights provided by HCUP.[6] Analyses were performed by using SAS version 9.2 (SAS Institute, Inc, Cary, NC). Multivariate logistic regression was conducted to examine the relationships between each independent variable and the primary outcomes while controlling for the other independent variables: age, gender, race, insurance, income quartile, region, hospital bed size, teaching status, hospital type, and admission day. In 2009, 44% of all SSTI hospitalizations had incision and drainage procedures (I&D).[11] We controlled for perforance of I&D in multivariate analysis of LOS and charges. In addition, while analyzing increased charges as a dependent variable, LOS was controlled in the multivariate model. We controlled for I&D and LOS to decrease confounding of the resource utilization factors. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). The institutional review board at Baylor College of Medicine approved the study.

RESULTS

In 2009, there were 49 834 hospitalizations and 74 443 weighted hospitalizations with ICD-9-CM codes consistent with SSTIs. The 75th percentile for LOS was 3 days and the 75th percentile for charges was $14 317. Patient and hospital demographic characteristics are shown in Table 1. Adolescents accounted for more than one-quarter of all weighted hospitalizations. Approximately 40% of hospitalizations were seen in minority races, and >50% of hospitalizations were attributable to the publicly insured. These are similar to the proportions of minority races (36%) and publicly insured (48%) accounting for “all hospitalizations” in HCUP KID.

Factors Associated With Increased Resource Utilization (2009)

LOS >75th Percentile (3 Days)—The odds of prolonged LOS were higher among infants than preschool-and school-aged children (<1 year: 1; 1–4 years: 0.70 [95% CI: 0.64–0.76]; 5–12 years: 0.69 [95% CI: 0.63–0.76]; 13–18 years: 1.01 [95% CI: 0.91–1.10]) (Table 2). All minority groups also had increased odds of prolonged LOS compared with white subjects (black subjects: 1.23 [95% CI: 1.09–1.38]; Hispanic subjects: 1.33 [95% CI: 1.20–

1.47]; and other races: 1.30 [95% CI: 1.12–1.50]). Hospitalizations with public payers had nearly 20% greater odds (OR: 1.17 [95% CI: 1.10–1.26]) of prolonged LOS compared with private payers. The relationships between increased LOS and income, hospital region, hospital bed size, hospital type, day of admission, and I&D performed are shown in Table 2.

Charges >75th Percentile ($14317)—Adolescents had >50% higher odds of charges >75th percentile compared with infants (OR: 1.54 [95% CI: 1.36–1.74]). All racial/ethnic minorities had elevated odds of charges in the highest quartile compared with white subjects (black subjects: 1.38 [95% CI: 1.17–1.62]; Hispanic subjects: 1.90 [95% CI: 1.59–2.26]; and other races: 1.26 [95% CI: 1.06–1.50]). Additional factors associated with increased charges are shown in Table 3.

DISCUSSION

SSTIs account for a growing proportion of hospitalizations, and knowledge of factors associated with increased resource utilization provides potential insight into the disease. Our study found that a significant percentage of SSTI hospitalizations were attributable to the oldest patients, minority races, and the publicly insured. Groups associated with high-resource utilization included infants, adolescents, minority races, and the publicly insured.

Examination of high-resource utilization revealed age was a factor associated with increased resource utilization. Hospitalizations for infants were associated with increased LOS compared with all other age categories. In 2009, children 0 to 1 year of age had higher odds of requiring I&D during SSTI hospitalization.[11] I&D of abscesses may contribute to increased LOS. It is also possible, however, that infants are monitored and treated longer in the hospital due to their age. At the other extreme of the pediatric age group, adolescents accounted for increased charges. Adolescents are less likely to have continuous public insurance.[12] This lack may result in delays in care and more severe presentations of SSTI, resulting in increased charges. Hospitalizations in racial minorities were also associated with prolonged LOS and increased charges. One possible explanation is a difference in the strains of methicillin-resistant *Staphylococcus aureus* (MRSA) seen in certain racial groups. The USA300 strain type of MRSA is capable of spreading rapidly[13] and has been associated with African-American race.[14] Another explanation is differential access to health care in minority races[15] and therefore delays in presentation. A previous study examining health care disparities documented longer LOS among minority children with appendicitis.[16] However, when access was equal across race/ethnicity and socioeconomic status, differences in LOS were attenuated.[17] Lack of access to care may also lead to increased severity of illness at presentation and, therefore, drive resource utilization.

We also found that publicly insured children hospitalized with SSTIs accounted for increased LOS compared with privately insured patients. Despite having coverage for medical services, publicly insured patients experience difficulties accessing primary care,[18] and the delay in presentation may lead to longer durations of hospitalization compared with privately insured children. Another possibility, as discussed in a previous pediatric pneumonia study, is a variation in practice, including processes and quality of care, based on insurance type.[19] To our knowledge, there is currently limited evidence to support this theory. However, based on the number of publicly insured children, variations in practice according to insurance type for common conditions such as pneumonia and SSTI would be of great significance.

At the hospital level, children's hospitals were more than twice as likely as non-children's hospitals to have increased charges for SSTI hospitalizations. This finding is consistent with a previous HCUP KID study of common pediatric conditions, including pneumonia,

gastroenteritis, respiratory syncytial virus, dehydration, and asthma.[20] The differences in charges according to hospital type is likely related to children's hospitals serving as referral centers for a majority of the severe cases.

There were methodologic limitations to our study. This study was cross-sectional, and, as such, we provided the most currently released database information rather than trends. HCUP KID does not contain unique patient identifiers or record linkages; 1 patient may contribute to multiple discharges. In addition, analysis of utilization according to detailed patient characteristics, severity of illness, microbiology, or medication administration was not possible. Therefore, we could not assess the specific impact of MRSA and medication choices on our primary and secondary outcomes. Both factors have been shown to affect LOS and charges in adult literature. Lastly, because HCUP KID is an administrative database, our study has the limitations inherent to using such data sources, including coding errors and misclassifications.

CONCLUSIONS

Pediatric SSTI hospitalizations are responsible for a significant proportion of resource utilization. Our study provides new data on factors associated with increased resource utilization during hospitalizations. Factors such as age, race/ethnicity, and socioeconomic status warrant further epidemiologic study. By identifying the needs of a community, a previous multilevel educational program in a targeted population with SSTIs successfully prevented MRSA infections through radio broadcasts, community presentations, treatment algorithms, pamphlets, and school educational programs.[21] The results of this study suggest potential target areas for future public health interventions that may help reduce the high resource burden attributable to pediatric SSTI hospitalizations.

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Appendix

APPENDIX 1

Patient Sample: Children Aged ≤18 Years With Any of the ICD-9-CM Codes as Diagnosis 1

Diagnosis	Code
Cellulitis and abscess of finger and toe	681.0–681.9
Other cellulitis and abscess	682.0–682.9
Carbuncle and furuncle	680.0–680.9
Impetigo	684.00

APPENDIX 2

Exclusion: Invasive Disease: ICD-9 Codes for Diagnoses 2 to 15

Diagnosis	Code
Acute lymphadenitis	683.00
Necrotizing fasciitis	728.86
Acute and subacute endocarditis	421.0–421.9

Diagnosis	Code
Arthropathy associated with infection	711.0–711.9
Disorders of muscle, ligament, and fascia (infective myositis)	728.0–728.9
Osteomyelitis, periostitis, and other infections involving bone	730.0–730.9
Meningitis of unspecified cause	322.0–322.9
Bacterial meningitis	320.0–320.9
Urinary tract infection	V13.02
Urinary tract infection, site not specified	599.0
Urinary tract infection of newborn	771.82
Bacteremia	790.7
Systemic inflammatory response syndrome, unspecified	995.90–995.94

ABBREVIATIONS

CI	confidence interval
HCUP	Healthcare Cost and Utilization Project
KID	Kids' Inpatient Database
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
I&D	incision and drainage procedures
LOS	lengths of stay
MRSA	methicillin-resistant *Staphylococcus aureus*
OR	odds ratio
SSTI	skin and soft tissue infection

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Table 1

Patient and Hospital Characteristics of 2009 SSTI-Related Hospitalizations

Characteristic	*N* = 49834[a] (Weighted *N* = 74443)	
	n **(Weighted *n*)**	**Weighted %**
Age, y		
<1	6581 (9915)	13.4
1–4	18 267 (27 490)	37.2
5–12	10 514 (15 726)	21.2
13–18	14 171 (20 884)	28.2
Gender		
Male	26 389 (39 442)	53.8
Female	22 666 (33 920)	46.2
Race		
White	22 222 (33 181)	44.6
Black	7862 (11 908)	16.0
Hispanic	8882 (13 043)	17.5
Other	3256 (4823)	6.5
Missing	7612 (11 489)	15.4
Insurance		
Private	18 284 (26 882)	36.1
Public	28 015 (42 280)	56.9
Other	3466 (5174)	7.0
Income quartile		
First	18 293 (28 003)	38.5
Second	12 668 (18 923)	26.0
Third	10 041 (14 795)	20.3
Fourth	7648 (10 998)	15.2
Region		
Northeast	9848 (14 471)	19.4
Midwest	9038 (12 326)	16.6
South	22 157 (35 288)	47.4
West	8791 (12 358)	16.6
Bed size		
Small	5120 (8210)	12.2
Medium	10 954 (16 428)	24.4
Large	29 136 (42 582)	63.4
Teaching status		
Nonteaching/urban	15 123 (21 813)	37.8
Teaching/urban	24 222 (35 846)	62.2
Hospital type		
Not children's hospital	28 585 (41 790)	64.4
Children's general hospital	5920 (9564)	14.7

Characteristic	*N* = 49834[a] (Weighted *N* = 74443)	
	n **(Weighted *n*)**	**Weighted %**
Children's unit in general hospital	9334 (13 576)	20.9

[a] Within-column values may not sum to 100% of the total due to missing data within HCUP KID.

Table 2

Survey-Weighted Multivariate Logistic Regression for Factors Associated With LOS

Characteristic	Adjusted OR (95% CI)	*P*
Age (vs <1 y)		
1–4 y	0.70 (0.64–0.76)	<.01
5–12 y	0.69 (0.63–0.76)	<.01
13–18 y	1.01 (0.91–1.10)	.57
Gender (vs male)		
Female	0.95 (0.90–1.00)	.06
Race (vs white)		
Black	1.23 (1-09–1.38)	<.01
Hispanic	1.33 (1.20–1.47)	<.01
Other	1.30 (1.12–1.50)	<.01
Missing	0.97 (0.83–1.14)	.23
Insurance (vs private)		
Public	1.17 (1.10–1.26)	<.01
Other	1.01 (0.90–1.14)	.24
Income quartile (vs first quartile)		
Second quartile	1.00 (0.92–1.09)	.14
Third quartile	0.98 (0.89–1.08)	.46
Fourth quartile	0.88 (0.79–0.97)	<.01
Region (vs Midwest)		
Northeast	0.84 (0.71–1.00)	.05
South	1.09 (0.93–1.29)	.38
West	1.31 (1.11–1.55)	<.01
Hospital bed size (vs large)		
Small	0.79 (0.66–0.95)	.02
Medium	0.94 (0.83–1.07)	.37
Teaching status (vs nonteaching/urban)		
Teaching/urban	1.14 (0.99–1.31)	.07
Hospital type (vs not children's hospital)		
Children's general hospital	0.91 (0.73–1.13)	.33
Children's unit in general hospital	0.79 (0.64–0.97)	.01
Admission day (vs weekday)		
Weekend	1.07 (1.01–1.14)	.03
I&D (vs no)		
Yes	1.66 (1.54–1.80)	<.01

Table 3

Survey-Weighted Multivariate Logistic Regression for Factors Associated With Charges

Characteristic	Adjusted OR (95% CI)	*P*
Age (vs <1 y)		
1–4 y	0.86 (0.78–0.95)	<.01
5–12 y	1.11 (0.99–1.25)	
13–18 y	1.54 (1.36–1.74)	<.01
Gender (vs male)		
Female	0.93 (0.88–0.99)	.01
Race (vs white)		
Black	1.38 (1.17–1.62)	<.01
Hispanic	1.90 (1.59–2.26)	<.01
Other	1.26 (1.06–1.50)	<.01
Missing	0.89 (0.72–1.11)	.80
Insurance (vs private)		
Public	0.89 (0.81–0.99)	.03
Other	1.00 (0.87–1.15)	.42
Income quartile (vs first quartile)		
Second quartile	1.06 (0.92–1.22)	.15
Third quartile	1.11 (0.95–1.30)	.99
Fourth quartile	1.31 (1.06–1.61)	.01
Region (vs Midwest)		
Northeast	0.40 (0.27–0.59)	<.01
South	0.58 (0.40–0.83)	<.01
West	1.51 (1.03–2.21)	<.01
Hospital bed size (vs large)		
Small	1.61 (1.14–2.27)	<.01
Medium	0.96 (0.73–1.25)	.49
Teaching status (vs nonteaching/urban)		
Teaching/urban	1.20 (0.89–1.61)	.23
Hospital type (vs not children's hospital)		
Children's general hospital	2.13 (1.47–3.10)	<.01
Children's unit in general hospital	1.23 (0.83–1.85)	.88
Admission day (vs weekday)		
Weekend	1.01 (0.95–1.07)	.85
Length of stay (vs <3 d)		
>3 d	10.86 (9.70–12.16)	<.01
I&D (vs no)		
Yes	2.23 (1.98–2.51)	<.01