Management of Urinary Tract Infections in Young Children: Balancing Admission With the Risk of Emergency Department Revisits

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ABSTRACT

OBJECTIVE: Oral antibiotics effectively treat most pediatric urinary tract infections (UTIs); however, children with UTIs are frequently admitted. We examined variation and trends in admission for children with UTIs plus investigated the relationship between admission and emergency department (ED) revisits for those initially managed on an outpatient basis. We hypothesized that hospitals would have similar 3-day revisit rates regardless of the admission rate at the index visit.

METHODS: This was a retrospective analysis of 36 hospitals in the Pediatric Health Information System. ED visits for children aged <2 years presenting with UTI between 2010 and 2016 were studied. Main outcomes were age-stratified and included admission and 3-day ED revisit rates. Regression analyses were used to test hospital-level associations between outcomes and linear temporal trends.

RESULTS: A total of 41,792 visits were studied. The overall admission rate was 27%. The admission rate was 89% for children aged <2 months and 15% for those aged 2 to 24 months. Interhospital admission rates varied from 6% to 64%.

Admission and revisit rates were inversely related (mean change, −0.07; 95% confidence interval [CI], −0.13 to −0.02 per 1% increase in admission rate); however, lower admission rates were not associated with increased revisits leading to admission (mean change, −0.02; 95% CI, −0.07 to 0.03). Over the study period, admission rates were stable (test for linear trend: adjusted odds ratio [aOR], 0.99; 95% CI, 0.95−1.02); however, among infants aged <2 months, admissions decreased (aOR, 0.92; 95% CI, 0.88−0.97).

CONCLUSIONS: A substantial variation in admission rates exists for children with UTI. Although hospitals with lower admission rates had higher revisit rates, those hospitals did not have an increase in revisits with subsequent admission, supporting the goal of outpatient management.

KEYWORDS: emergency department; hospitalization; UTI; variation

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WHAT'S NEW

Substantial variation in admission rates exists among children's hospitals for patients with urinary tract infections (UTIs). Lower hospital-level admission rates were not associated with increased revisits leading to admission, thereby supporting the goal of outpatient treatment for routine pediatric UTI.

URINARY TRACT INFECTIONS (UTIs) are one of the most commonly identified bacterial infections in young children,[1,2] and timely management with antibiotics is particularly important in infants and young children to prevent deterioration and minimize complications, such as renal scarring.[3,4] Oral antibiotics effectively treat most uncomplicated pediatric UTIs[5−9] and are recommended for the majority of UTIs in young children age 2 to 24 months, including presumed pyelonephritis.[2,10]

UTI remains one of the most common pediatric admission diagnoses.[11,12] Although admission rates for patients age <18 years with UTI are declining, admission rates remain >25% in younger patients, especially those aged <2 years.[12−16] For those hospitalized, in 2009 Conway et al[14] reported substantial hospital-level variability in the management of UTIs among pediatric medical centers. Determining the appropriateness of admission is a challenging and multifactorial decision for both emergency medicine and primary care physicians. Clinicians must weigh the risks and benefits of admission against outpatient management, realizing that a fraction of patients who initially receive outpatient management will have return visits and potentially require hospitalization. The

relationship between admission and emergency department (ED) revisit rates among patients with UTIs initially managed on an outpatient basis has not been explored.

Given the effectiveness of outpatient management of UTIs with oral antibiotics and the ongoing relatively high admission rates, especially in children aged <2 years, we explored the variation and trends in hospitalization and also investigated the relationship between admission and 3-day ED revisit rates among young children presenting to the ED with a UTI. We hypothesized that hospitals with lower admission rates at the initial visit for children with a UTI have similar 3-day revisit rates as hospitals with higher admission rates.

METHODS

DESIGN AND DATA SOURCE

Data for this study were obtained from the Pediatric Health Information System (PHIS), an administrative database that contains inpatient, ED, ambulatory surgery, and observation encounter-level data from more than 48 not-for-profit, tertiary care pediatric medical centers in the United States. These centers are all affiliated with the Children's Hospital Association. Data quality and reliability are ensured through a joint effort between the Children's Hospital Association and participating hospitals. Portions of the data submission and data quality processes for the PHIS database are managed by Truven Health Analytics (Ann Arbor, Michigan). For the purpose of external benchmarking, participating hospitals provide discharge or encounter data, including demographic information, diagnoses, and procedures. Nearly all of these hospitals also submit resource utilization data (e.g., pharmaceuticals, imaging, laboratory) into the PHIS. Data are deidentified at the time of data submission and are subjected to various reliability and validity checks before being included in the database. For this study, data from 39 hospitals with complete demographic and billing information during the study period were eligible for inclusion in the analysis.

All statistical analyses were performed using Stata/SE version 14.1 (StataCorp, College Station, Texas). The study was approved by the institutional review board and the administrators of the PHIS database. In accordance with PHIS policies, the identities of the institutions were not reported.

STUDY POPULATION, DEFINITIONS, AND ASSUMPTIONS

We included all children aged <2 years with an ED encounter between January 1, 2010, and December 31, 2016, with a primary diagnosis of UTI (including pyelonephritis). An encounter was classified as a case if any of the following International Classification of Diseases, Ninth or Tenth Revision (ICD-9 or ICD-10) codes were assigned as the primary diagnosis from the index ED visit: UTI or cystitis (ICD-9: 599, 595, 595.9, 771.82; ICD-10: N390, P393, N3000, N3001, N3090, N3091) or pyelonephritis (ICD-9: 590.1, 590.11, 590.2, 590.8, 590.81,

590.9; ICD-10: N151, N16) (Supplementary Table). ED revisits were defined for those patients discharged from the index visit and had a subsequent ED visit within 3 days for which the principal diagnosis was also one of the diagnostic codes listed above. ED revisit rates were calculated for all revisits meeting these criteria, restricted to those revisits with an associated admission. Admission was defined by inpatient or observation codes.

For patients with multiple ED encounters, we included only the first ED visit for UTI during the study period. To help identify a mostly healthy population and avoid those with urologic abnormalities, we excluded patients who had a visit with a primary diagnosis of UTI in the 12 months before the index visit. We reviewed data from 2009 for any cases of UTI in patients diagnosed with a UTI in 2010, the start of the study period. In addition, children with any chronic comorbidities were excluded based on ICD-9 and ICD-10 codes, as defined by Feudtner et al.[17]

DATA INTEGRITY

Data integrity was evaluated by analyzing the proportion of patients from each hospital with a urine culture and the proportion of admitted patients who received an antibiotic. Given the standard of sending cultures on children with a UTI,[2] hospitals were excluded if <85% of patients with a diagnosis of UTI had a urine culture sent (recognizing that some patients might have had a culture sent before the index ED visit). Patients who were admitted with a primary diagnosis of UTI but did not receive an antibiotic were excluded.

ANALYSIS

We calculated frequency and proportion for categorical variables and median with interquartile range (IQR) for continuous variables. To test the association between hospital-level admission rates and 3-day ED revisit rates among those managed initially on an outpatient basis, we estimated linear regression models with the hospital-level revisit rate as the dependent variable and hospital-level admission rate as the independent variable, weighted by the number of encounters composing each hospital-level observation.

We also estimated logistic regression models to test for linear temporal trends in admission and revisit rates, with the clinical outcome (i.e., admission or revisit) as the dependent variable and time (measured in calendar years) as the independent variable, adjusting for age, sex, and race. A robust variance estimator was used to accommodate the correlation resulting from the clustering of patients within hospitals. Analyses of admission and revisit rates were stratified by age <2 months and 2 to 24 months, age groups chosen because young infants are routinely admitted even with an isolated diagnosis of UTI.[15] Recognizing that return visits leading to admission may simply reflect a delay in admission (from the index visit), we attempted to characterize trends in admission and revisit rates by combining patients admitted either at the

index visit or at a revisit occurring within 3 days of ED discharge from the index visit, defining this as the effective admission rate. Hospital-level admission rates and ED revisit rates were examined to measure variations in care at the hospital level.

RESULTS

STUDY POPULATION

During the study period (January 1, 2010, through December 31, 2016), a total of 47,714 ED visits for UTI were identified. We excluded 3920 (8.2%) encounters because the patient had a visit for UTI in the 12 months before the index visit, and 103 (0.22%) encounters for an admission that did not include receipt of an antibiotic. Three hospitals were excluded secondary to <85% of patients with a UTI had a urine culture sent (composing 1899 encounters, or 4.0% of the sample). The remaining 36 hospitals and 41,792 children with UTI constituted the study sample.

Demographic and clinical characteristics are displayed in Table 1. The sample was predominantly female (69%), with a median age of 6.6 months (IQR, 3.0−11.6 months). Seventeen percent (n = 6968) were aged <2 months. Twenty-seven percent (11,266) of the study sample were admitted at the initial visit, including 89% of those aged <2 months and 15% of those aged 2 to 24 months. Discharged patients had a median age of 8.5 months (IQR, 5.1−13.7 months).

RELATIONSHIP BETWEEN ADMISSION RATE AT INDEX VISIT AND ED REVISITS

The hospital-level admission rate and 3-day ED revisit rate for patients initially managed on an outpatient basis were significantly associated. For every 1% increase in the admission rate, the revisit rate decreased by 0.07%, weighted for hospital case volume (mean change, −0.07; 95% CI, −0.13 to −0.02) (Fig. 1). At the 25th percentile of hospital-level admission rate (19.8 ± 1%), the mean hospital-level revisit rate was 3.2%, whereas at the 75th

percentile of hospital-level admission rate (39.4 ± 1%), the mean hospital-level revisit rate was 2.0%.

However, hospital-level admission rate and ED revisits leading to a subsequent admission were not significantly associated (aOR, −0.02; 95% CI, −0.07 to 0.03). For infants aged <2 months, the hospital-level admission rate was significantly associated with both revisit rate (aOR, −0.26; 95% CI, −0.35 to −0.17) and rate of revisits with subsequent admission (aOR, −0.33; 95% CI, −0.51 to −0.15); however, for children aged 2 to 24 months, no association existed between the hospital-level admission rate and either the revisit rate (aOR, −0.06; 95% CI, −0.12 to 0.01) or the rate of revisits with subsequent admission (aOR, 0.00; 95% CI, −0.05 to 0.05).

ADMISSION TRENDS AND INTERHOSPITAL VARIATION

Trends in hospital-level admission are shown in Table 2. Admission rates, adjusted for age, sex, and race, did not decline over the study period (test for linear trend: aOR, 0.99; 95% CI, 0.95−1.02). In the age-stratified analysis adjusted for sex and race, admission rates at the index visit for infants aged <2 months decreased (2010 vs 2016: −4.3%; 95% CI, −7.5% to −1.6%) over the study period (aOR, 0.92; 95% CI, 0.88−0.97), whereas for children aged 2 to 24 months, admission rates remained level (aOR, 0.99; 95% CI, 0.95−1.04). Admission rates by hospital ranged from 6% to 64% (Fig. 2).

TRENDS IN REVISITS

Among the patients discharged at the index visit, 4.1% had an ED revisit within 3 days, and 1.2% of patients discharged from the index visit had a revisit with subsequent admission (Table 2). In the age-stratified analysis adjusted for sex and race, both revisits and revisits leading to hospitalization for infants aged <2 months increased over time (aOR, 1.22; 95% CI, 1.12−1.32 and 1.21; 95% CI, 1.08−1.37, respectively). For children aged 2 to 24 months, revisit rates were stable over the study period

Table 1. Demographic Characteristics of Patients Aged <2 Years Treated for UTI in the EDs of Pediatric Medical Centers Across the United States, 2010 to 2016

Characteristic	All (n = 41,792)	Discharged Patients (n = 30,376)*
Age, mo, median (IQR)	6.6 (3.0−11.6)	8.5 (5.1−13.7)
Female sex, n (%)	28,728 (69)	22,865 (75)
Race, n (%)		
White	23,639 (57)	16,918 (56)
Black	5383 (13)	3872 (13)
Asian	1318 (3)	930 (3)
Other	8691 (21)	6589 (22)
Missing	2761 (7)	2067 (7)
Ethnicity, n (%)		
Latino	17,407 (42)	13,499 (44)
Non-Latino	21,724 (52)	14,873 (49)
Missing	2661 (6)	2004 (7)
Urban Residence	38,741 (94)	28,503 (95)
Annual household income in patient's ZIP code, 2010, USD, median (IQR)	38,297 (30,970−48,556)	38,306 (30,966−48,367)

Proportions might not sum to 100% due to rounding.
ED indicates emergency department; IQR, interquartile range; and UTI, urinary tract infection.
*Patients discharged from index ED visit with disposition data available on subsequent ED visits.
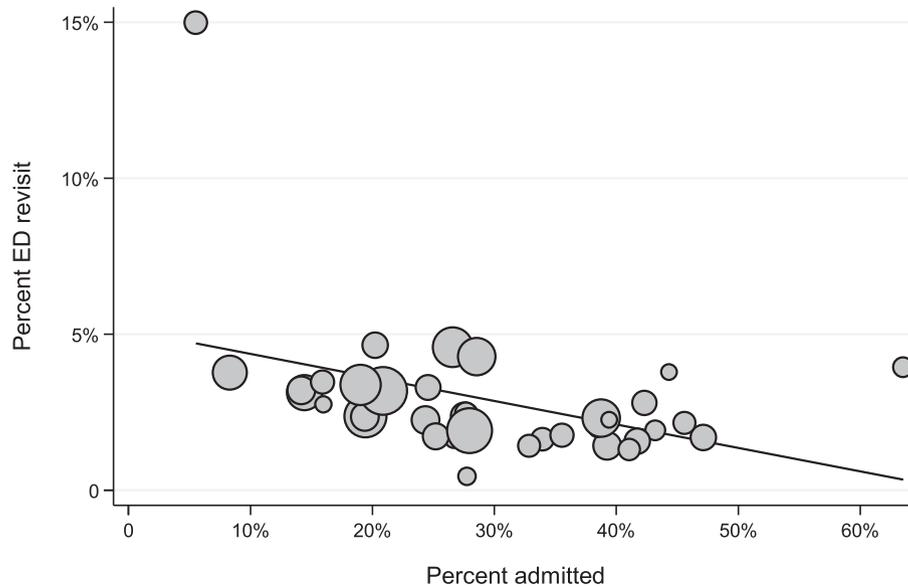
Note: size of marker corresponds to hospital-level patient volume

Figure 1. *Hospital-level admission rate and 3-day emergency department (ED) revisit rate.*

(aOR, 0.98; 95% CI, 0.94−1.03), whereas revisits resulting in hospitalization increased (aOR, 1.09; 95% CI, 1.02−1.16). Total effective admission rates for infants aged <2 months, adjusted for sex and race, also decreased over the study period (aOR, 0.94; 95% CI, 0.90−0.98). For older children aged 2 to 24 months, total effective admission rates were stable over the study period (aOR, 1.00; 95% CI, 0.96−1.04).

DISCUSSION

Using a large administrative database of US pediatric medical centers, we found that >25% of children aged <2 years with a UTI were admitted. Admission rates over the study period did not decrease over time, except for infants aged <2 months. In addition, substantial variation in admission rates exists among these pediatric centers. Counter to our hypothesis that ED revisit rates among children initially managed as outpatients would be comparable regardless of hospital-level admission rate at the index visit, admission and revisit rates were inversely related. Importantly, however, young children aged 2 to 24 months with a UTI evaluated in hospitals with lower admission rates did not have an increased rate of revisits leading to subsequent hospitalization.

Our analysis was age-stratified, because infants aged <2 months are routinely admitted with UTI[15] based on current febrile infant guidelines that recommend admission for all infants aged <2 months with presumptive UTI.[18,19] However, recent literature suggests that these infants are at low

Table 2. Trends in Hospital-Level Admission and 3-Day ED Revisits for Young Children With UTI, 2010 to 2016

Parameter	Number	Row Outcome, n (%)	Absolute Difference, 2010 vs 2016 (95% CI), %	Test for Linear Trend, aOR (95% CI)
Admission at index visit*	41,792	11,266 (27)	−0.8 (−2.3 to 0.8)	0.99 (0.95−1.02)
Age <2 mo†	6968	6173 (89)	−4.3 (−7.2 to −1.6)	0.92 (0.88−0.97)
Age 2−24 mo†	34,824	5093 (15)	−0.1 (−1.5 to 1.2)	0.99 (0.95−1.04)
3-d revisits*	30,376	1236 (4.1)	0.0 (−0.9 to 0.9)	1.00 (0.95−1.04)
Age <2 mo†	791	80 (10.1)	8.4 (0.3−16.5)	1.22 (1.12−1.32)
Age 2−24 mo†	29,585	1156 (3.9)	−0.3 (−1.2 to 0.6)	0.98 (0.94−1.03)
3-d revisits resulting in admission*	30,376	356 (1.2)	0.7 (0.1−1.2)	1.11 (1.04−1.18)
Age <2 mo†	791	53 (6.7)	4.0 (−3.6 to 11.7)	1.21 (1.08−1.37)
Age 2−24 mo†	29,585	303 (1.0)	0.5 (−0.1 to 1.0)	1.09 (1.02−1.16)
Effective‡ admission rate*	41,788	11,622 (28)	−0.3 (−1.9 to 1.3)	0.99 (0.96−1.03)
Age <2 mo†	6968	6226 (89)	−3.4 (−6.0 to −0.7)	0.94 (0.90−0.98)
Age 2−24 mo†	34,820	5396 (16)	0.2 (−1.2 to 1.7)	1.00 (0.96−1.04)

aOR indicates adjusted odds ratio; CI, confidence interval; ED, emergency department; and UTI, urinary tract infection.
*Adjusted for age, sex, and race.
†Adjusted for sex and race.
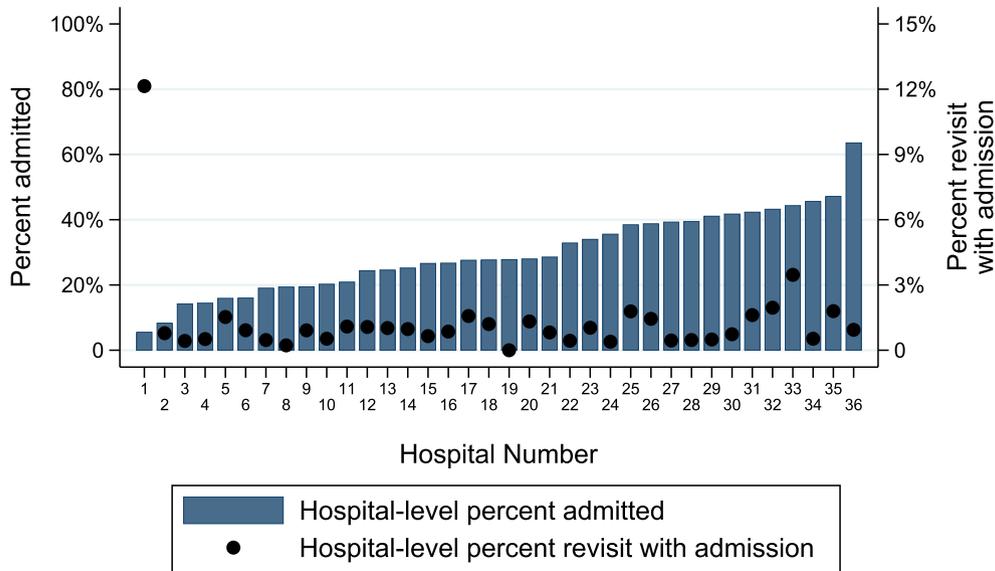‡Effective admission rate defined as hospitalization at index visit or within 3 days.

Figure 2. *Hospital-level admission rate at index visit and 3-day revisits leading to admission.*

risk for adverse events,[20] and the practice of admitting all young infants with a UTI appears to be shifting within pediatric medical centers, with admission rates among this age group decreasing by 4% over the study period. Notably, as admission rates in this age group decreased, rates of both revisits and revisits with subsequent admission increased, raising the possibility that admission is simply being delayed; however, total effective admission rates (hospitalization at index visit or within 3 days) also decreased over the study period. We also noted that although admission rates decreased among younger infants, the effective admission rates and overall revisit rates remained stable over the study period for children aged 2 to 24 months.

In the present study, we also found substantial variation in admission rates among pediatric medical centers, ranging from 6% to 64%. Although variation in admission rates among children aged <2 years has not been reported previously, Schnadower et al[15] noted admission rates ranging from 80% to 100% for infants aged 29 to 60 days, a patient population that is traditionally admitted. Although the study hospitals are major pediatric medical centers, variations in severity of illness among institutions likely contributed to the variation in admission rates. Such a marked degree of variation is unlikely to be simply explained by severity of illness, however. Among patients aged <19 years with UTI, Bourgeois et al[11] also noted substantial variation, ranging from 6% to 37%, even in severity adjusted admission rates among pediatric medical centers. Local practice patterns are a known independent factor contributing to admission rate among young infants with UTI,[15] and it is likely that these practice patterns influence admission rates among older children as well. Clinical guidelines can decrease the variation in care for common pediatric disesases,[21,22] and given that oral antibiotics are effective in the management of routine pediatric UTIs,[5−9] efforts to standardize management, including the indications for hospitalization, should be considered or more effectively implemented.

When deciding on disposition, clinicians weigh the risks of outpatient management against hospitalization, knowing some patients who are discharged may revisit and subsequently require admission. Intuitively, assuming the decision to admit a patient is based primarily on severity of illness, hospitals with higher admission rates will have lower revisit rates. We found that admission and revisit rates were inversely related, with hospitals with lower admission rates having higher revisit rates. However, we found no association between hospital-level admission rate and rate of revisits with subsequent admission. Importantly, when patients revisit after initial ED discharge, only a fraction are admitted, suggesting that revisit alone does not justify admission at the index visit. This investigation highlights the substantial variability in the management of young children with UTI. The next steps would include investigation of this variability at the patient and hospital levels, followed by interventions to standardize management.

Our investigation has several important limitations. First, we leveraged the value of a large administrative database to investigate the variation and trends in emergency care for young children with a UTI. Such methodology does not allow patient-level review for clinical characteristics, the appropriateness of admissions, or the reason for revisits. A more precise outcome would include the patient's condition at the return visit; however, clinical details were not available. Although most UTIs in patients aged <2 years are associated with fever, we are unable to assess the proportion of febrile UTIs versus simple cystitis. Previous work has suggested that principal diagnosis codes can be used to identify patients with UTIs,[23] and thus only patients with a primary diagnosis of UTI were included, in an effort to limit the number of patients with significant associated diagnoses that could influence admission rates. For generalizability, we aimed to identify an otherwise healthy population of young children presenting with a UTI, and although we excluded

patients with a chronic comorbid condition and patients with a UTI in the previous 12 months, we were unable to exclude all possible comorbidities that could influence admission. However, our estimates of admission rates are consistent with previous reports,[13,14] and with our exclusion criteria and large sample of patients, the trends observed are likely reflective of our target population.

Our sample represents children at major US pediatric medical centers, and our results might not be generalizable to other settings. Because the patients are tracked longitudinally at a single institution, we do not know whether any patients presented to a different institution for follow-up. Moreover, we cannot comment on other important clinical outcomes besides hospitalization and revisits for this population.

CONCLUSIONS

Substantial variation in admission rates exists for infants and children aged <2 years with a UTI. Although hospitals with lower admission rates at the index visit had higher ED revisit rates among children initially managed on an outpatient basis, those hospitals did not have an increase in revisits leading to hospitalization among young children aged 2 to 24 months, supporting the effectiveness of outpatient treatment for most pediatric UTIs, particularly in children aged >2 months. Further exploration of patient- and hospital-level factors in admissions and revisits are needed to better inform clinical decisions regarding hospitalization versus outpatient management for young children with UTIs.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at http://dx.doi.org/10.1016/j.acap.2018.05.011.

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