Factors Associated with Variability in Outcomes for Children Hospitalized with Urinary Tract Infection

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Objectives To describe the variability in outcomes and care processes for children hospitalized for urinary tract infection (UTI), and to identify patient and hospital factors that may account for variability.

Study design Retrospective cohort of children 1 month to 12 years of age hospitalized for UTI at 25 children's hospitals from 1999 to 2004. We measured variability in length-of-stay (LOS), cost, readmission rate, intensive care unit admission, and performance of renal ultrasound and voiding cystourethrogram and identified patient and hospital factors associated with these outcomes.

Results The cohort included 20 892 children. There was significant variation in outcomes and processes of care across hospitals (eg, mean LOS, 2.1-5.0 days; patients with both imaging tests performed, 0.3%-72.9%). Older children had shorter LOS and were less likely to undergo imaging. Patients hospitalized at high volume hospitals were more likely to undergo imaging. Hospitals with high percentage of Medicaid patients had longer LOS and were less likely to perform imaging tests. Hospitals with a clinical practice guideline for UTI had shorter LOS and decreased costs per admission.

Conclusions The variability across hospitals may represent opportunities for benchmarking, standardization, and quality improvement. Decreased LOS and costs associated with clinical practice guidelines support their implementation. *(J Pediatr 2009;154:789-96)*

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A urinary tract infection (UTI) is 1 of the most common indications for hospitalization of infants and children in the United States, with >45 000 admissions per year.[1] Earlier surveys demonstrated significant variability in clinicians' reported management of inpatient conditions such as UTI,[2] but no studies have specifically addressed hospital variability in actual treatment and outcomes for children admitted with UTI. Variability in care represents potential waste in the health care system and an opportunity for quality improvement.[3] An essential step in decreasing variability in care is establishing benchmark data and identifying the factors that explain variability. Benchmarks serve to identify both average performance and the level achieved by high performers. Patient and hospital factors that explain variability in outcomes and process performance serve as potential targets for quality improvement intervention.

We sought to describe the variability in outcomes such as length-of-stay (LOS), costs, readmission rate, and intensive care unit (ICU) admission and process measures such as performance of renal ultrasound scanning and voiding cystourethrogram (VCUG) for children admitted with UTI. We then evaluated patient factors such as age and race and hospital factors such as use of clinical practice guidelines (CPG) associated with these outcomes.

CPG	Clinical practice guideline	OR	Odds ratio
ICD-9	International Classification of Diseases, Ninth Revision	PHIS	Pediatric Health Information System
		UTI	Urinary tract infection
ICU	Intensive care unit	VCUG	Voiding cystourethrogram
LOS	Length-of-stay		

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METHODS

Study Design

This was a retrospective cohort study of children hospitalized for UTI. The institutional review board at the Children's Hospital of Philadelphia approved the study.

Data Source

We used the Pediatric Health Information System (PHIS), an administrative database that contains inpatient data from 40 freestanding children's hospitals affiliated with the Child Health Corporation of America (Overland Park, Kansas). Contributing hospitals are located in 17 of the 20 major metropolitan areas in the United States. We obtained data for the 25 hospitals that had detailed data available from 1999 to 2004. The PHIS data includes detailed information on demographics, diagnoses, procedures, imaging, and repeat hospitalizations. Oversight of PHIS data quality and accuracy is a joint effort between Child Health Corporation of America, Thomson Healthcare (the data manager), and participating hospitals. Data are de-identified at the time of data submission and subjected to 175 reliability and validity checks. Data are accepted into the database when classified errors occur in <2% of a hospital's quarterly data.

Inclusion and Exclusion Criteria

We identified all children 1 month to 12 years of age discharged between 1999 and 2004 with a primary or secondary diagnosis of UTI or pyelonephritis (on the basis of *International Classification of Diseases, Ninth Revision* [ICD-9] codes 590.10, 590.11, 590.80, and 599.0). We excluded neonates from birth to 1 month of age because the ICD-9 code for UTI in this age group had modifications in 2002, and UTI in neonates likely has different pathophysiology and management than in older infants and children. We excluded children >12 years of age because of the higher potential of UTIs in this age group related to sexual activity and concurrent sexually transmitted disease. We only included each subject's first UTI admission. To define a cohort of otherwise healthy children with UTIs, we excluded subjects whose ICD-9 discharge codes indicated presence of a significant co-morbidity, such as malignancy, diabetes mellitus, human immunodeficiency virus, sickle cell disease, congenital immunodeficiencies, congenital cardiac disease, quadriplegia/paraplegia, neurogenic bladder, renal transplant, hydrocephalus and neurologic malformations, cystic fibrosis, and other organ transplant. We also excluded subjects who had any discharge diagnoses for which the UTI diagnosis had a high likelihood of being secondary, such as trauma, a surgical diagnosis (eg, appendicitis or fracture), and burns.

Outcomes

We analyzed the outcomes of LOS, adjusted costs per admission, ICU admission, readmission, and mortality and process performance for renal ultrasound scanning and VCUG during the hospitalization. In PHIS, the adjusted total costs are calculated from charges with a hospital specific ratio of cost-to-charges, with additional adjustment by the Center for Medicare wage index. ICU admission included admissions to medical ICUs, but not cardiac or surgical ICUs, because UTI would likely be a secondary diagnosis or complication in cardiac or surgical ICUs. The PHIS data did not allow for reliable delineation of transfers to the ICU from admissions directly to the ICU. Readmission was *a priori* defined as readmission within 30 days of first admission with a primary or secondary diagnosis of UTI. The performance of renal ultrasound scanning was defined as the presence of PHIS clinical transaction classification imaging codes 452040, 452041, 452042, 452045, 452046, 457041, or 457042; and the performance of VCUG was defined by the presence of clinical transaction classification imaging codes 454417, 454421, 454422, 454462, or 454463. The calculation of the percent of patients in whom VCUG and renal ultrasound were performed excluded patients >2 years old because the American Academy of Pediatrics' practice parameter on management of UTI applies specifically to children 2 to 24 months of age.[4] Our dataset did not capture radiology tests performed in the outpatient setting, and so our assessment of whether renal ultrasound scanning and VCUG were performed was limited to hospitalization only.

Patient Level Independent Variables

We, *a priori*, defined patient level independent variables. Age was analyzed categorically: at 1 to 2 months, 2 to 6 months, 7 to 23 months, and 2 to 12 years. Race was categorized as white, black, other, or missing on the basis of self-report from the PHIS data. The "other" category combined the relatively small number of children reported to be Asian, Native American, and "other." Insurance status at time of admission was categorized as no insurance, Medicaid, private, or "other" on the basis of report from hospitals. Ethnicity was self-reported Hispanic or non-Hispanic. We used the All Patient Refined-Diagnosis Related Group version 20 to adjust for severity of illness.

Hospital Level Independent Variables

Hospitals with >175 UTI admissions per year (approximately 1 every 2 days) were categorized as high volume. Hospitals with >65% of patients with no insurance or Medicaid were categorized as high Medicaid population hospitals (also described in some studies as "safety net" hospitals[5,6]). Before analyzing the administrative data, a research assistant or investigator (P.C.) administered a questionnaire via telephone to a physician representative at each hospital, preferably a clinical director when this position existed, who was a primary pediatric attending and indicated that they were familiar with the staffing and processes of care at their hospital. This questionnaire asked about staffing and management of UTI, including the type of attending staffing (ie, hospitalist versus community pediatrician), typical man-

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