Variation in Inpatient Resource Utilization and Management of Apparent Life-Threatening Events

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Objective To report national variations in diagnostic approaches to apparent life-threatening events (ALTEs) and resource utilization.

Study design Using the Pediatric Health Information System, we studied children who were age 3 days to 5 months at admission and were discharged with an *International Classification of Diseases, Ninth* Revision (ICD-9) code potentially identifiable as ALTE. Multiple analysis of variance was used to determine whether the variances in adjusted charges, length of stay (LOS), and diagnostic studies were hospital-related after controlling for other covariates. Logistic regression was used to study the association of readmission rates with discharge diagnosis and specific diagnostic studies.

Results The study group comprised 12,067 patients, with a mean LOS of 4.4 days (standard deviation ± 5.6 days) and mean adjusted charges of $15,567 ($28,510) per admission. The mean in-hospital mortality rate was 0.56% (n = 68), and the rate of 30-day readmission was 2.5%. The most common discharge diagnoses were gastroesophageal reflux 36.9% (48.3%) and lower respiratory tract infection 30.8% (46.2%). Mean LOS, total adjusted charges, and use of diagnostic studies varied considerably across hospitals, and hospital-level differences were a significant contributor to the variance of these outcomes after controlling for covariates ($P < .001$). There was an increased likelihood of readmission for patients discharged with a diagnosis of cardiovascular disorders (odds ratio [OR] = 1.68; 95% confidence interval [CI] = 1.30 to 2.16) and gastroesophageal reflux (OR = 1.32; 95% CI = 1.03 to 1.69) compared with other discharge diagnoses.

Conclusions There is considerable hospital-based variation in care for patients hospitalized for conditions potentially identifiable as ALTE, particularly in the evaluation and diagnosis of gastroesophageal reflux, which may contribute to adverse clinical and financial outcomes. An evidence-based national standard of care for ALTE is needed, as are multi-institutional initiatives to study different diagnostic and management strategies and their effect on patient outcomes. *(J Pediatr 2008;152:629-35)*

An apparent life-threatening event (ALTE) is defined as an episode in the first year of life that appears potentially life-threatening to the observer and is characterized by some combination of color change, apnea, alteration in muscle tone, and choking or gagging.[1] The true incidence of ALTEs is largely unknown, but they may account for 2.3% of hospitalized children and 0.6% to 0.8% of all emergency department visits for children under age 1 year.[2,3] The most frequently reported underlying causes are gastroesphageal reflux (GER), seizures, and lower respiratory tract infection (LRTI); less common causes include pertussis, cardiac arrhythmias, nonaccidental trauma, and bacterial infections. The underlying etiology can be elusive; >50% of ALTEs are considered idiopathic.[3-7]

Infants who present to the clinician because of an ALTE, particularly those who subsequently appear well, pose a diagnostic and management dilemma. ALTEs typically evoke significant anxiety in caretakers, but a treatable diagnosis is seldom found, morbidity and mortality is poorly understood, and the risk of recurrence is unknown. Consequently, many children with ALTE are hospitalized and often undergo an extensive and potentially unfruitful evaluation, presumably to rule out serious underlying conditions. Recent research based in tertiary care academic centers suggests that children presenting to the emergency department with an ALTE may receive excessive medical intervention. A

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ALTE	Apparent life-threatening event	LOS	Length of stay
ANOVA	Analysis of variance	LRTI	Lower respiratory tract infection
CI	Confidence interval	OR	Odds ratio
GER	Gastroesophageal reflux	PHIS	Pediatric Health Information System
GI	Gastrointestinal		
ICD-9	*International Classification of Diseases, Ninth Revision*		

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study of 243 patients found that the likelihood of a positive result from a single test is low (34%) and that the likelihood of a result revealing the cause of the ALTEs is even lower (6%). Another study of 59 infants suggested that infants over age 30 days who experienced a single ALTE may be safely discharged from the emergency department without extensive diagnostic testing.[8,9]

The benefit of hospitalization and subsequent workup across larger populations remains largely unknown, however. Previous research on ALTE based at single institutions has lacked power to differentiate uncommon adverse events from underlying occult conditions.[3,10,11] The clinical applicability of the current published evidence is challenging and must overcome variations in case definitions of ALTE and the underlying etiologies. For example, a meta-analysis of ALTEs focusing on 8 studies involving 643 infants reported the most common etiology as GER (n = 227), yet there was considerable variation in these studies' definitions of both ALTE and GER.[2]

Reducing variation through evidence-based clinical guidelines has been a successful strategy for improving quality of care in other common pediatric conditions.[12,13] Given the relative lack of practical scientific evidence, few adequately tested guidelines, and a poor understanding of how management may prevent the rare but serious adverse event, we hypothesize that that there is wide variation in diagnostic evaluation and management strategies for children hospitalized for ALTE. We conducted a large retrospective study of previously healthy infants discharged with diagnoses potentially identifiable as an ALTE from 36 children's hospitals across the United States. Our first goal was to document variation in potentially modifiable areas of care, such as diagnostic testing and treatment, and to ascertain whether variation among hospitals is a contributing factor. Because concern about recurrence is believed to motivate inpatient evaluations, we also investigated the factors associated with readmission to the hospital after discharge.

METHODS

Data Source

In this study, we used the Pediatric Health Information System (PHIS) database developed by the Child Health Corporation of America.[14,15] This is an administrative database that includes hospital stay, demographic, and diagnostic data on freestanding children's hospitals. The database uses clinical transaction codes to map hospital-specific charge codes to categorical variables that are consistent across hospitals in the system.[16] The PHIS database represents 17 of the 20 major metropolitan areas and 70% of the freestanding children's hospitals in the United States.[17] The current analysis from hospitals and calendar quarters used the expanded data set, which contains more comprehensive data, including medications and diagnostic tests. The study protocol was approved by the Institutional Review Board of Children's Hospital and Regional Medical Center in Seattle, Washington. To preserve hospital anonymity, all results are presented without hospital identifiers.

Study Population

The study population included infants who were between age 3 days and 5 months on hospital admission and were discharged between January 1, 2000 and September 30, 2005. Criteria for inclusion were based on *International Classification of Diseases, Ninth Revision* (ICD-9) discharge codes. Because there is no ICD-9 code that explicitly denotes ALTE, patients were included in the study population if they had at least 1 of the following ICD-9 codes compatible with the definition of ALTE: apnea (786.03), respiratory problem of the newborn (770.8), syncope (780.2), altered consciousness (780.09), transient loss of consciousness (780.02), and cyanosis (782.5). Patients with additional discharge ICD-9 codes consistent with either previous illness or comorbid conditions (eg, prematurity, congenital heart disease, genetic conditions) were excluded. If an infant had more than 1 qualifying admission during the study period, only the first was included in the primary analysis (Appendix; available at www.jpeds.com). Subsequent admissions were defined using the same inclusion criteria as for readmission if occurring within 30 days of the index admission.

Outcomes and Other Variables of Interest

The outcomes of interest were length of stay (LOS), hospital charges adjusted for regional variations in costs of care, and readmission. LOS, in-hospital mortality, diagnostic testing, discharge diagnosis, and treatment with antibiotics or reflux medications were examined graphically to identify distribution and central tendencies. Adjusted charges were examined with respect to total hospital charges, as well as separately for pharmacy, imaging, and laboratory. The study population was coded for discharge ICD-9 codes compatible with the most common causes of ALTE; these categories were not mutually exclusive, because patients could have multiple discharge diagnoses. Diagnostic testing included laboratory tests, imaging, and other selected procedures. GER medications and antibiotics were limited to those used in the hospital; data on outpatient medications were not available.

The following characteristics were used as covariates in the analyses: age, sex, Medicaid status, and month of admission. These characteristics were selected a priori, because previous research has shown them to contribute to interhospital variation.[2-4] Age was modeled both dichotomously and as a linear term. To facilitate analysis, common etiologic discharge diagnoses with similar clinical characteristics were classified into subgroups: LRTI, GER, meningitis or sepsis, seizures, pertussis, and noncongenital cardiac causes.

Statistical Analysis

The distribution of covariates and outcomes were examined in a descriptive analysis. To illustrate variations in