Clinical Outcomes among Transferred Children with Ischemic and Hemorrhagic Strokes in the Nationwide Inpatient Sample

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Introduction: Children with ischemic stroke (IS) and hemorrhagic stroke (HS) may require interfacility transfer for higher level of care. We compared the characteristics and clinical outcomes of transferred and nontransferred children with IS and HS. *Methods:* Children aged 1-18 years admitted to hospitals in the United States from 2008 to 2011 with a primary discharge diagnosis of IS and HS were identified from the National Inpatient Sample database by ICD-9 codes. Using logistic regression, we estimated the odds ratios (OR) and 95% confidence intervals (CI) for in-hospital mortality and discharge to nursing facilities (versus discharge home) between transferred and nontransferred patients. *Results:* Of the 2815 children with IS, 26.7% were transferred. In-hospital mortality and discharge to nursing facilities were not different between transferred and nontransferred children in univariable analysis or in multivariable analysis that adjusted for age, sex, and confounding factors. Of the 6879 children with HS, 27.1% were transferred. Transferred compared to nontransferred children had higher rates of both in-hospital mortality (8% versus 4%, $P = .003$) and discharge to nursing facilities (25% versus 20%, $P = .03$). After adjusting for age, sex, and confounding factors, in-hospital mortality (OR 1.5, 95% CI 1.1-2.4, $P = .04$) remained higher in transferred children, whereas discharge to nursing facilities was not different between the groups. *Conclusion:* HS but not IS was associated with worse outcomes for children transferred to another hospital compared to children who were not transferred. Additional study is needed to understand what factors may contribute to poorer outcomes among transferred children with HS. **Key Words:** Ischemic stroke—hemorrhagic stroke—transferred children—childhood stroke.

Introduction

Data from several studies suggest that facilities that offer specialty care, that have resources including intensive services, and that treat a large number of cases have better patient outcomes.[1-3] Patients with acute ischemic or hemorrhagic stroke (HS) often are transferred to larger hospitals including comprehensive stroke centers. Interhospital transfer can offer access to higher levels of care like dedicated neurointensive care or stroke units or specialized procedures that include interventional and neurosurgical services. These services are not available at all centers, and specialized stroke units and comprehensive stroke centers have been shown to improve patient outcomes.[4-6] Several adult studies have shown that outcomes among adult

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stroke patients are worse in those transferred from 1 hospital to another compared to those directly admitted (usually to a tertiary center).[7-12] To our knowledge, there are no data available on the clinical outcomes of children with stroke who are transferred compared to those who are directly admitted. The objective of this study was to determine whether a "transfer effect" on clinical outcomes exists in children with ischemic stroke (IS) and HS.

Methods

The analysis was based on data files from the National Inpatient Sample (NIS), 2008-2011. A comprehensive synopsis on NIS data is available at http://www.hcup-us.ahrq.gov.

We used the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) primary diagnosis codes (433-434 and 436-437) and (430-432) to identify children aged 1-18 years admitted primarily for IS and HS, respectively. Children were categorized as transfers or nontransfers which is a distinct variable in the NIS database that identifies whether a patient was transferred from a different acute care hospital. Patients with missing data regarding transfer were excluded.

Study variables included were as follows: age; sex; race/ethnicity; comorbidities obtained from the Agency for Healthcare Research Quality comorbidity data files including diabetes mellitus, hypertension, congestive heart failure, renal failure, chronic lung disease, deficiency anemia, valvular heart disease, fluid and electrolyte disorder, liver disease, acquired immunodeficiency syndrome, obesity, paralysis, solid tumor without metastasis, metastatic cancer, alcohol abuse, and coagulopathy.

ICD-9-CM secondary diagnosis codes were used to identify additional diagnoses and conditions. Secondary diagnosis codes included atrial fibrillation (427.3), nicotine dependence (305.1), and dyslipidemia (272.0). ICD-9-CM secondary diagnosis codes also identified secondary diagnoses in children with IS and HS like aphasia (784.3), hemiplegia and hemiparesis (342), migraine (346), cerebral artery dissection (443.2), anomalies of the cerebrovascular system which include cerebral arteriovenous malformations and other congenital anomalies of cerebral vessels (747.81), coma (780.01), fever (780.60), moyamoya disease (437.5), hydrocephalus (331.3-331.4), seizure (345), meningitis (320.0-322.9), congenital heart disease (745-747), altered mental status (780.97), cardiomyopathy (425), systemic lupus erythematosus (710), pneumonia (486, 481, 482.8, 482.3), urinary tract infection (599.0, 590.9), sepsis (995.91, 996.64, 038, 995.92, 999.3), deep venous thrombosis (451.1, 451.2, 451.81, 451.9, 453.1, 453.2, 453.8, 453.9), pulmonary embolism (415.1), illicit drug abuse (305.6-305.7), and sickle cell disease (282.6).

We also used ICD-9-CM primary and secondary procedure codes to estimate the percentage of children who underwent in-hospital procedures such as electrocardiogram (89.5), echocardiography (88.72), computed tomography (87.03), magnetic resonance imaging (88.91), ultrasound head and neck (88.71), valvular repair (35.0-35.9), cerebral angiography (88.41), thrombolytic therapy (99.10), craniotomy (01.2, 01.24), clipping (39.51, 39.52), coiling (39.71, 39.79), cardiopulmonary resuscitation (99.60), intubation (96.04), mechanical ventilation (96.72), transfusion (99.04), and gastrostomy (431.1-431.9).

Hospitals were categorized by geographic region in the United States as Northeast, Midwest, West, and South. The admitting hospitals were classified as teaching or nonteaching. Teaching hospitals were those with an American Medical Association-approved residency program or with membership in the Council of Teaching Hospitals.[13] Hospital size was characterized as small, medium, or large based on available hospital beds; thresholds for size classification are based on the hospital's location and teaching status. The definition of large size may vary from exceeding 325 to exceeding 450 acute hospital beds.

Outcome Measures

We determined the length of stay and hospital charges (amount billed for services, not amounts received in payment). Discharge status was categorized into home/self-care, nursing facility (includes skilled nursing facilities and inpatient rehabilitation), unknown, and in-hospital mortality.

Statistical Analysis

SAS 9.3 software (SAS Institute, Cary, NC) was used to convert NIS database data into weighted counts to generate national estimates following Healthcare Cost and Utilization Project recommendations. Children with IS and HS were analyzed separately. We performed univariable analyses with chi-square tests for categorical variables and *t*-tests for continuous variables to identify differences in study variables and endpoints between children who were transferred compared to those who were not transferred. Logistic regression was used to analyze the association between interfacility transfer and the odds of in-hospital mortality. Logistic regression was also used to analyze the association between interfacility transfer and the odds of discharge to a nursing facility among children discharged alive. Multivariable logistic regression models were constructed that adjusted for age (continuous variable), sex, and confounding factors that were significant ($P \le .05$) in univariable analyses. P values $\le .05$ were considered statistically significant.

Results

IS

Of the 2815 children aged 1-18 years with IS, 26.7% were transferred. Mean age and sex distribution in the transferred versus nontransferred groups were not different (Table 1).