



Socioeconomic Status and Hospitalization Costs for Children with Brain and Spinal Cord Injury

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Objective To determine if household income is associated with hospitalization costs for severe traumatic brain injury (TBI) and spinal cord injury (SCI).

Study design Retrospective cohort study of inpatient, nonrehabilitation hospitalizations at 43 freestanding children's hospitals for patients <19 years old with unintentional severe TBI and SCI from 2009-2012. Standardized cost of care for hospitalizations was modeled using mixed-effects methods, adjusting for age, sex, race/ethnicity, primary payer, presence of chronic medical condition, mechanism of injury, injury severity, distance from residence to hospital, and trauma center level. Main exposure was zip code level median annual household income.

Results There were 1061 patients that met inclusion criteria, 833 with TBI only, 227 with SCI only, and 1 with TBI and SCI. Compared with those with the lowest-income zip codes, patients from the highest-income zip codes were more likely to be older, white (76.7% vs 50.4%), have private insurance (68.9% vs 27.9%), and live closer to the hospital (median distance 26.7 miles vs 81.2 miles). In adjusted models, there was no significant association between zip code level household income and hospitalization costs.

Conclusions Children hospitalized with unintentional, severe TBI and SCI showed no difference in standardized hospital costs relative to a patient's home zip code level median annual household income. The association between household income and hospitalization costs may vary by primary diagnosis. (*J Pediatr* 2016;169:250-5).

Lower community-level household income is associated with higher inpatient costs of care for common medical conditions in children, such as asthma, diabetes, and bronchiolitis.¹ In the US, patients from lower-resource backgrounds may consume more health care-related resources when they do seek care because of several factors including the lack of primary, secondary, and tertiary prevention measures; lack of timely access to care; higher risk of exposure to health-impairing environmental and behavioral issues; and lower adherence to treatments.^{1,2} Diagnoses associated with higher cost of hospitalizations, including acute trauma care, may be ideal targets for cost-mitigation strategies, such as case management.^{3,4} Efficient allocation of intensive and finite resources can be realized through identification of subgroups most likely to benefit from these services. Provision of acute trauma care is expensive, and injury is the leading cause of death and acquired disability in children.^{5,6} Because severe injuries result in high hospitalization costs, there is great potential for savings in the area of acute trauma care.

Socioeconomic disparities exist for many trauma-related outcomes in children. Minority and impoverished children have higher injury incidence, severity, and mortality rates, and have poorer functional outcomes after injuries.⁷⁻⁹ The etiology of the disparities in functional outcomes is multifactorial, and reflects differences in insurance status, access to acute and rehabilitation care, and social support systems.¹⁰ From a policy standpoint, it is important to determine if injured patients coming from areas with lower median household incomes experience higher hospitalization costs. Specifically, if economically disadvan-

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AIS	Abbreviated injury scale
FPL	Federal poverty level
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
ISS	Injury severity score
PHIS	Pediatric Health Information System
SCI	Spinal cord injury
TBI	Traumatic brain injury

tagged patients cost more to care for, hospitals that treated these patients could be disproportionately under-paid or even penalized by reimbursement policies, when these disparities are not considered in evaluation of these practices.^{11,12} However, research exploring hospitalization costs among injured children with varying household income is lacking. This study focused on severe traumatic brain injury (TBI) and spinal cord injury (SCI) because these are subcategories of unintentional injury that lead to more disability^{13,14} and higher societal cost¹⁵ than any other injuries in children.

The primary goal of this study was to examine the association between zip code-level median annual household income and costs of hospitalization among severely injured children. We hypothesized that patients from areas with lower median annual household income would have higher inpatient costs for severe TBIs and SCIs.

Methods

Data for this multicenter retrospective cohort study were obtained from the Pediatric Health Information System (PHIS), which contains administrative data from 43 free-standing children's hospitals. PHIS includes patient demographics, patient's home zip code, up to 41 *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnoses, up to 41 ICD-9-CM procedure codes, and hospital costs for services.

Data are deidentified prior to inclusion in the database, but unique identifiers allow for longitudinal analyses across visits for a single patient. Data quality and reliability are assured jointly by the Children's Hospital Association (formerly Child Health Corporation of America, Overland Park, Kansas), participating hospitals, and Truven Health Analytics (formerly Thomson Reuters Healthcare, New York, New York).¹⁶⁻¹⁹ In accordance with the Common Rule (45 CFR 46.102[f]) and the policies of The Children's Hospital of Philadelphia Institutional Review Board, this study using a deidentified dataset was not considered human subjects research.

Data from 43 hospitals were included. Inpatient-status and observation-status hospitalizations during the calendar years 2009-2012 were included in analyses.^{20,21} For the purposes of this study, severe TBIs and SCIs were identified by selecting ICD-9-CM coded diagnoses that represented abbreviated injury scale (AIS) scores of 4, 5, or 6 (on an ordinal scale of 1-6; 6 indicating highest severity) for the body region of the head and/or the spinal cord.²² The AIS is an anatomically based severity scoring system that is considered a global standard for injury data collection and analysis.²³ There were 134 possible ICD-9-CM TBI codes (109 AIS = 4, 14 AIS = 5, 11 AIS = 6) and 48 ICD-9-CM SCI codes (36 AIS = 4, 9 AIS = 5, 3 AIS = 6) that met eligibility criteria, and patients were included if they had 1 or more of these codes as a diagnosis for their hospital visit. Any admissions associated with a patient older than 18 years of age, intentional injury, death in the emergency department or during the hospitalization,

categorized as a readmission encounter (ie, subsequent admissions for the same injuries), or inpatient rehabilitation were excluded.

Outcome Variable

The primary outcome variable was the overall standardized hospital costs and categorized costs for children diagnosed with severe TBIs or SCIs. Within PHIS, each service or activity is assigned a standardized cost, derived from the median cost across all PHIS hospitals for that service.^{24,25} This approach allows for cost comparisons across hospitals without biases arising from using charges or from deriving costs using hospitals' ratios of costs to charges. Standardized costs were categorized into total, laboratory, imaging, pharmacy, and other.

Primary Independent Variable

Median annual household income for the child's home zip code was obtained from 2012 US Census Bureau data. Zip code-based median household income has been previously demonstrated to be a useful proxy for patient socioeconomic status when individual level data are unavailable.²⁶⁻²⁸ Household incomes were divided into 4 categories based on the US federal poverty level (FPL) for a family of 4.²⁹ These categories were household income-1, less than 1.5 times the FPL (\$34 575 or less); household income-2, 1.5-2 times the FPL (\$34 576-\$46 100); household income-3, 2-3 times the FPL (\$46 101-\$69 150), and household income-4, greater than 3 times the FPL (\$69 151 or more). These categories were the same or similar to categories reported in other studies.^{30,31}

Covariates

Injury severity score (ISS), a standardized summary of injury severity, were calculated by summing the squares of the AIS severity scores (1-6) of the 3 most severely injured body regions,²² which were mapped from all ICD-9-CM injury codes for the patient's visit. ISS ranges from 3-75, and a maximum AIS severity 6 in any body region defaulted to an ISS of 75.^{22,32,33} Intent and mechanism of injury were determined using the Centers for Disease Control and Prevention Matrix of E-Code Groupings.² E-codes supplement the primary ICD-9-CM diagnosis codes and categorize the external cause and intent of the injury.

Patient demographic variables included age, sex, race/ethnicity, primary payer, and the presence of a complex chronic medical condition. Race/ethnicity categories included white, black or African American, Hispanic or Latino, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, and other. The "other" category included unreported or missing data or any category not previously mentioned. The primary payer variable of "public" included Medicaid, Medicaid managed care, and Title V. "Commercial" payer included employer-based (including Tricare) and privately purchased health insurance. "Uninsured" included "self-pay" and "charity." "Other" payer indicated Medicare, worker's compensation, other governmental

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