Socioeconomic Status and Length of Hospital Stay in Children With Vaso-Occlusive Crises of Sickle Cell Disease

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Objective: To examine the association between socioeconomic status and length of hospital stay for vaso-occlusive crises in children with sickle cell disease.

Methods: 19,174 discharges (aged 1–20 years), with a primary diagnosis of sickle cell disease with crisis were analyzed from the Healthcare Cost and Utilization Project Kid Inpatient Database 2000. Socioeconomic status was assessed using an area-based measure, median household income by ZIP code and an individual-level measure, insurance status. We adjusted for age, gender, hospital location/teaching status, presence of pneumonia, number of diagnoses on record and number of procedures performed. Negative binomial regression models using generalized estimating equations (GEE) were used to assess length of stay.

Results: Socioeconomic status as measured by income was not associated with length of stay [incidence rate ratio (highest versus lowest category) = 1.04 (95% CI : 0.98, 1.11)]. In contrast, socioeconomic status as measured by insurance was associated with length of stay [adjusted incidence rate ratio = 1.04 (95% CI: 1.01, 1.08)], although the magnitude of this difference is small and not likely to be clinically important.

Conclusions: We found no evidence to suggest that socioeconomic status has any clinically important effect on length of hospital stay in children with vaso-occlusive crises in sickle cell disease.

Key words: socioeconomic status ■ sickle cell disease ■ vaso-occlusive crisis

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INTRODUCTION

Children from low socioeconomic status (SES), with and without chronic disease, have been shown to have worse health outcomes and higher utilization of health resources as compared to their more advantaged counterparts.[1-6] A previous study conducted in the United Kingdom found that children born into low social classes were more likely to be admitted to the hospital, have longer lengths of hospital stay overall and generate more costs during the first 10 years of life as compared to children born into higher social classes.[3] Impoverished cystic fibrosis patients have higher mortality, require more treatment for pulmonary exacerbations and have longer length of hospital stays than patients from more advantaged backgrounds.[1,2] Similar adverse outcomes have been identified for asthma patients who are poor.[4-6]

Vaso-occlusive pain crises (VOC) contribute to frequent emergency department visits and hospitalizations in a subset of patients with sickle cell disease.[7,8] The effects of SES on length of hospital stay for pediatric VOC is not known. Knowledge of these effects may be useful to health decision-makers when planning services for pediatric sickle cell patients.

The purpose of this study was to determine the association between SES and lengths of hospital stay (LOS) in children with vaso-occlusive crisis of sickle cell disease. We hypothesized that pediatric sickle cell patients with low SES would have longer LOS for VOC as compared to their more advantaged counterparts.

METHODS

Data were analyzed from the Healthcare Cost and Utilization Project (HCUP) Kids' Inpatient Database (KID) 2000. The KID is sponsored by the Agency for Healthcare Research and Quality. This database is the only all-payer inpatient care database for children aged ≤20 years of age drawn from 27 states. Included in the database is a sample of approximately 2.5 million un-weighted discharges that represent 7.2 million weighted discharges from over 2,500 U.S. community hospitals. The institutional review board at Boston University Medical Campus approved this study.

Patient Selection

Discharges, which included patients between the ages of 1–20 years with a primary diagnosis of sickle cell disease with crisis (International Classification of Diseases, 9th revision, Clinical Modification: (ICD-9-CM) code 282.62) and who were either insured through Medicaid or private insurance (including HMOs) were selected for analysis.

Child and Hospital Variables

Socioeconomic status was our primary independent variable. We used both an individual-level (insurance status) and an area-based measure (median household income by ZIP code) of SES. Insurance status, categorized as Medicaid or private, was abstracted from information provided on the patient's primary expected payer. Median household income by ZIP code was categorized in the KID data set into the following groups that were compared: $1–24,999, $25,000–34,999, $35,000–44,999 and ≥$45000.

LOS was our primary dependent variable. LOS was measured in days and calculated by subtracting the day of discharge from the day of admission. Therefore, same-day admissions were given the value of "0."

Table 1. Sociodemographic and case-mix characteristics of the study sample

Characteristic	N (%)	Medicaid (%) N=13,196	Private (%) N=5,978
Gender			
Male	9,342 (49)	47	50
Female	9,833 (51)		
Age Group (Years)			
1–5	2,759 (14)	14	14
6–10	3,669 (19)	19	20
11–15	5,164 (26)	26	30
16–20	7,583 (40)	41	36
Insurance			
Medicaid	13,196 (69)	-------	-------
Private	5,979 (31)		
Race		1	2
White	2,11 (1)	93	94
Black	16,451 (94)	3	2
Hispanic	558 (3)	3	2
Other	290 (2)		
Median ZIP Code Income		27	16
$1–24,999	4,459 (23)	39	30
$25,000–34,999	6,952 (36)	21	24
$35,000–44,999	4,215 (22)	14	30
≥$45,000	3,549 (19)		
Hospital Region		26	34
Northeast	5,498 (29)	14	7
Midwest	2,257 (12)	50	47
South	9,422 (49)	10	12
West	1,998 (10)		
Hospital Location/Teaching		7	5
Status	1,258 (7)	13	15
Rural	2,652 (14)	80	80
Urban nonteach	15,265 (79)		
Urban teach		44	42
NACHRI Hospital Type	7,818 (42)	24	26
Nonchildren's	4,500 (25)	32	32
Children's	5,866 (33)		
Children's unit		38	43
Number of Diagnoses on Record	7,624 (40)	53	50
1	9,930 (52)	9	7
2-4	1,621 (8)	30	25
≥5	5,511 (29)		
Any Procedures		10	6
Asthma	1,682 (8)	10	10
Pneumonia	1,950 (10)	15	14
Transfusion	2,906 (15)		

The following variables were examined as potential confounders: gender, age at time of admission and hospital location/teaching status. These variables were chosen because they have been shown previously in sickle cell disease and other diseases to have an independent effect on LOS.[1,2,9,10] Hospital region was also examined as a potential confounder, as regional variation in outcomes of sickle cell disease have been found to exist.[11] In addition, hospital type (categorized in the KID data set as children's, nonchildren's and children's unit in a general hospital) was also examined.

Age was grouped into four categories: 1–5 years, 6–10 years, 11–15 years and 16–20 years. These categories are similar to those chosen in previous studies that examined the natural history of sickle cell disease and the effect of age on length of hospital stay.[10,12] Hospital region was divided into four areas: northeast, south, midwest and west. Location/teaching status was categorized as rural, urban teaching and urban nonteaching. Because of the relative homogeneity of our sample, race was not examined as a potential confounder.

Table 2. Unadjusted length of stay for insurance group, sociodemographic and case-mix variables

Parameter	IRR	95% CI
Median Household Income by ZIP Code		
$1–24,999	1.04	(0.96, 1.12)
$25,000–34,999	0.98	(0.90, 1.25)
$35,000–44,999	0.97	(0.90, 1.05)
≥$45,000	1	----------
Insurance*		
Medicaid	1.08	(1.01, 1.12)**
Private	1	----------
Gender*		
Male	0.95	(0.09, 0.99)**
Female	1	----------
Age Group (Years)*		
16–20	1.58	(1.46, 1.72)**
11–15	1.31	(1.21, 1.40)**
6–10	1.08	(1.02, 1.15)**
1–5	1	----------
Hospital Region		
Northeast	0.90	(0.81, 1.01)
Midwest	0.89	(0.76, 1.03)
South	0.87	(0.78, 0.97)**
West	1	----------
Hospital Location/Teaching Status*		
Rural	0.79	(0.71, 0.88)**
Urban nonteaching	1.04	(0.87, 1.04)
Urban teaching	1	----------
NACHRI Hospital Type		
Nonchildren's	0.97	(0.90, 1.04)
Children's	1.05	(0.92, 1.19)
Children's unit	1	----------
Number of Diagnoses*		
≥5	2.48	(2.29, 2.69)**
2–4	1.36	(1.32, 1.47)**
1	1	----------
Number of Procedures*		
≥1	1.64	(1.55, 1.77)**
0	1	----------
Asthma*	1.12	(1.04, 1.20)**
Pneumonia*	1.47	(1.38, 1.55)**
Transfusion*	1.53	(1.42, 1.65)**

* Variable statistically significant in bivariate model; ** Statistically significant within category of the variable

Case-Mix Variables

Multiple variables were used to adjust for case-mix. The number of procedures performed and the number of diagnoses recorded during a hospitalization were used as markers for illness severity and overall health of patients.[12] The number of procedures performed was dichotomized as 0 vs. ≥1. The number of secondary diagnoses for each discharge was categorized as 1, 2–4 and ≥5.

In addition to the categorical variables of diagnoses and procedures, we also investigated specific procedures and secondary diagnoses, which may impact length of stay for vaso-occlusive crisis. Sickle cell patients with severe VOC or anemia may be treated with red blood cell transfusions. Therefore, this specific procedure was used as a marker of illness severity. Secondary diagnoses examined included asthma and pneumonia. These diagnoses were included because pulmonary complications may develop from severe or recurrent disease exacerbations and impact LOS for VOC.

Analytic Approach

All analyses were performed using the SAS® software package (SAS 8.1, Cary, NC). All our primary analyses were performed using the HCUP sample weights, enabling us to produce national estimates. Statistical significance was set at α=0.05. Only cases with complete LOS and covariate data were analyzed. No variable had >1% missing values.

Basic descriptive statistics were initially used to make comparisons between patients within the two insurance groups as well as between patients within the four categories of median household income by ZIP

code. Analysis of length of stay revealed that this variable was skewed, and the Shapiro Wilk test confirmed that this variable was not normally distributed. Based upon this result, simple regression analysis using Poisson regression was performed to examine the difference in length of hospital stay by insurance group as well as median household income by ZIP code category. LOS was modeled as an overdispersed Poisson variable. Therefore, negative binomial regression was used to examine the above-mentioned relationships. In addition, negative binomial regression was also used to examine the differences in length of hospital stay by sociodemographic and case-mix variables. Only those variables that were significant in the simple regression analysis were entered in the multivariate regression model. To account for clustering within hospitals, the generalized estimating equation (GEE) approach to negative binomial regression was performed. Incidence rate ratios (IRRs) were obtained by exponentiating the coefficients produced by negative binomial models.

RESULTS

We identified a total of 20,848 discharges with a primary diagnosis of sickle cell with crisis. Of these, 19,174 (92%) met inclusion criteria and were therefore included in the analyses.

Sociodemographic and case-mix characteristics are presented for our entire sample in Table 1. Medicaid was the primary insurance for 69% of discharges. Fifty-nine percent of discharges comprised the lowest two income categories. There were no clinically significant differences in the distribution of our sociodemographic or case mix-variables across our SES measures. The mean age (SD) at time of admission was 12.7 years (7.6), with 51% of discharges being female and 94% of them being black. The overall mean LOS (SD) was 4.7 days (5.9).

Length of Stay

Insurance group. The unadjusted mean (SD) length of stay for the Medicaid group was 4.0 (6.24) as compared to 3.0 (5.22) for the privately insured group. From our unadjusted regression analysis (Table 2), length of hospital stay in Medicaid patients is predicted to be 8% longer than privately insured patients.

Median household income. The unadjusted mean (SD) length of stay for each income level was as follows: 4.0 (6.24), 4.0 (5.8), 4.0 (5.4) and 4.0 (5.4), respectively. From our unadjusted regression analysis (Table 2), length of hospital stay in the lowest median household category is predicted to be 4% longer than the highest category. This difference is not statistically significant.

Sociodemographic and case-mix covariates. The unadjusted differences in the length of stay across all covariates are provided in Table 2. LOS at rural hospitals was longer than urban teaching hospitals. The oldest age groups had longer LOS than younger age groups. In addition, as the number of diagnoses and the number of procedures increased, LOS also increased. Patients with secondary diagnoses of asthma also had longer LOS.

Multivariate Models

The results of the GEE approach to negative binomial regression with insurance group as a proxy for socioeconomic status are presented in Table 3. Only significant covariates were retained in the model. After adjusting for significant covariates, LOS for Medicaid patients is 4% longer than privately insured patients (IRR: 1.04; 95% CI: 1.01–1.08).

DISCUSSION

This is the first study to examine the association between socioeconomic status and length of hospital stay for VOC in pediatric patients. We used insurance status and median household income by ZIP code as our measures for socioeconomic status. When median

Table 3. Adjusted length of stay for insurance group, sociodemographic and case-mix variables

Parameter	Estimate	95% CI
Insurance*		
Medicaid	1.04	(1.01, 1.08)**
Private	1	–
Gender*		
Male	0.95	(0.91, 0.99)**
Female	1	–
Age Group (Years)*		
16–20	1.54	(1.43, 1.64)**
11–15	1.35	(1.26, 1.44)**
6–10	1.05	(1.03, 1.15)**
1–5	1	–
Hospital Location/Teaching Status*		
Rural	0.71	(0.58, 0.88)**
Urban nonteaching	1.01	(0.86, 1.17)
Urban teaching	1	–
Number of Diagnoses*		
≥5	1.97	(1.83, 2.11)**
2–4	1.25	(1.21, 1.30)**
1	1	–
Number of Procedures*		
≥1	1.25	(1.19, 1.31)**
0	1	–
Asthma	0.93	(0.88, 1.0)
Pneumonia	1.25	(1.19, 1.31)**
Transfusion	1.05	(0.96, 1.14)

* Variable statistically significant in bivariate model; ** Statistically significant within category of the variable

household income served as our measure, there was no statistically significant difference in LOS by socioeconomic status. Although there is a statistically significant difference in LOS by insurance status, the magnitude of the difference is small (4%) and not likely to be clinically important for an individual child.

Our study suggests that with respect to SES, equity has been achieved in the inpatient management of VOC in children with sickle cell disease. This is good news. This finding is in contrast to previous studies of impoverished adult and pediatric patients which have shown that poor patients have longer lengths of stay for treatment of complications of their underlying disease.[1,2,13,14] There may be multiple reasons for our findings. First, the care of children with sickle cell disease is highly specialized and largely under the care of a limited number of physicians, both which may reduce variability of care. Second, many of the factors that mediate health in other chronic conditions may not be relevant for sickle cell disease. For other chronic conditions, such as cystic fibrosis, there is a much greater concern about compliance among poor patients, as many of those children are on multiple medications; decreased compliance could result in an increase in the severity of presentation and, therefore, increased length of stay.[1,2]

As expected, our results do show that the strongest predictors of LOS for sickle cell patients are factors associated with illness severity. Older age, increased number of secondary diagnoses, increased number of procedures and the presence of pneumonia all resulted in clinically important longer lengths of stay. The finding of no clinically important differences in the distribution of our severity measures across insurance and income categories is encouraging.

Future studies, inclusive of other measures of illness severity, are needed before conclusions can be drawn about the association between SES and disease severity in children with sickle cell disease.

The finding of a 30% shorter length of stay for discharges at rural hospitals compared to urban teaching hospitals is also intriguing. The longer LOS associated with urban teaching hospitals may be attributed to the increased intensity of services provided. These data do not allow judgments to be made about whether the longer LOS results in better outcomes.

There are a number of limitations of this study. First, this is a cross-sectional study; therefore, caution should be taken when drawing conclusions over time. Second, the data were not collected for the specific purpose of evaluating LOS in sickle cell patients. Certain clinical and laboratory values, which are known to be predictors of sickle cell disease severity, such as baseline white blood cell count, hemoglobin level and history of dactylitis, are not provided in the database.[15,16] This limited our ability to completely control for disease severity. Third, income and insurance status are just two measures of SES. Other measures of SES, such as parental occupation and education level, are not provided in the KID. However, these measures are accepted as reliable measures of SES,[1,2] and the inclusion of both an individual-level and area-level measure of SES avoids biases that may be associated with using one or the other.[17]

In conclusion, we have shown that in at least one important measure of healthcare utilization, LOS, pediatric sickle cell patients with VOC from lower socioeconomic status (using median household income and insurance as proxies) do not differ from their more advantaged counterparts. Future research should determine if SES affects other important outcomes in children with sickle cell disease, including mortality and health-related quality of life.

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