Charges for Childhood Asthma by Hospital Characteristics

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ABSTRACT. *Background.* **The ownership, location, and teaching status of hospitals affect their missions, policies, finances, and operations.**

Objective. **This study assesses the relationship of hospital ownership, location, and teaching status with charges and length of stay for children with asthma, the most common reason for pediatric admission after birth.**

Methods. **All 28 545 complete records of patients ≤18 years of age with the principal diagnosis asthma in 1994 were extracted from the Healthcare Cost and Utilization Project Nationwide Inpatient Sample, providing a stratified sample of 735 nonfederal, acute-care hospitals in 17 states. Multiple regression analysis on log transformed data was used to calculate mean total charges and average length of stay (ALOS) after adjusting for illness severity and mortality risk (four All Patient Refined–Diagnosis Related Group classes based on secondary diagnoses and procedures); payer (Medicaid, private, uninsured, other); patient age, sex, income (four categories based on ZIP code of residence); state; bed size (three categories varying by location); hospital ownership; location; teaching status; and admission month.**

Results. **Asthma severity did not differ significantly by hospital location or teaching status. Nonprofit hospitals treated a slightly higher proportion of children with major or extreme severity asthma than either public or for-profit hospitals. Urban teaching hospitals treated more children with asthma who lived in low-income neighborhoods, were uninsured, or received Medicaid coverage than urban nonteaching hospitals. For-profit hospitals admitted fewer children with asthma from low-income areas than did public hospitals. The ALOS was 2.5 days and did not differ significantly by hospital ownership, location, or teaching status. However, the mean total charges, after adjusting for all other significant covariates, was higher at for-profit ($4203) than at nonprofit ($3640) or public hospitals ($3620). Average charges also were higher at urban teaching ($4230) and lower at rural institutions ($2910) compared with urban nonteaching hospitals ($3424).**

Conclusions. **Despite similar ALOS, mean charges for childhood asthma varied significantly by hospital ownership, location, and teaching status.**

Implications. **Additional clinical and outpatient data are needed to study variations in quality of care by hospital characteristics. With the proliferation of investor-owned hospitals, both the reasons for and the impact of higher average charges at for-profit institutions require additional investigation. With the expanding needs of the medically underserved, socially just policies are required for financing hospitals that care for a disproportionate share of economically disadvantaged children.** *Pediatrics* **1998;102(6). URL: http://www.pediatrics.org/cgi/content/full/102/6/e70;** ***hospital charges, length of stay, asthma, community hospitals, severity of illness index.***

ABBREVIATIONS. LOS, length of stay; NIS, Nationwide Inpatient Sample, 1988–1994; HCUP, Healthcare Cost and Utilization Project; HCUP-3 NIS, Healthcare Cost and Utilization Project, Nationwide Inpatient Sample, Release 3; ICD-9, International Classification of Diseases, Edition 9, Clinical Modification; APR–DRG, All Patient Refined–Diagnosis Related Group; ALOS, average length of stay.

Hospital charges are based in part on the fixed costs of maintaining a hospital, the marginal costs of caring for patients, and profit margin. The costs of caring for patients are related to the intensity, scope, and sophistication of services, as well as on the length of stay (LOS). The LOS is influenced by the severity of illness and practice patterns.

The ownership, location, and teaching status of hospitals affect their mission, policies, finances, and operations. Investor-owned, nonprofit, and public hospitals, as well as urban teaching, urban nonteaching, and rural hospitals, respond differently to health care reform, expansion in managed care systems, and cost-reduction strategies. In a study of Medicare patients, the costs of inpatient care and administration were higher at for-profit hospitals than at nonprofit or public institutions.[1] In another study, illness severity of adult patients and costs of admission were greater at teaching than at nonteaching hospitals.[2] However, no studies have focused on children.

Recent changes in the organization, financing, and delivery of health services may have dramatic effects on children, especially those with special health care needs or in poverty. Asthma is the most common chronic illness of childhood, affecting 4.8 million children[3,4] and accounting for 229 000 hospitalizations annually in the United States.[5] Children with asthma use significantly more health services and incur significantly higher costs than do other children using services.[6] Poor children with asthma have higher admission rates and bed days than nonpoor

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children.[7] Children with asthma who are enrolled in Medicaid generally have higher charges and longer stays than do those who are privately insured.[8]

We assessed the relationship of hospital ownership, location, and teaching status with severity-adjusted charges and LOS for children with asthma in 1994. The primary hypotheses were that total charges were higher at investor-owned hospitals than at nonprofit or public institutions and higher at urban teaching and lower at rural nonteaching than at urban nonteaching hospitals. This question has not been studied in pediatric patients. The secondary hypothesis was that public, nonprofit, and teaching hospitals provide care for a greater proportion of children experiencing major and extreme severity illness, living in low-income areas, receiving Medicaid or being uninsured than do for-profit and nonteaching hospitals.

METHODS

Design and Setting

The design of this project was a historical cross-sectional study of a stratified cluster survey of US community hospitals. The dataset used was the publicly available Nationwide Inpatient Sample (NIS), Release 3, for US hospital discharges occurring in 1994. The NIS is part of the Healthcare Cost and Utilization Project, 1988–1994 (HCUP-3) sponsored by the Agency for Health Care Policy and Research. The NIS contains uniform inpatient stay data collected from hospital discharge datasets maintained by state agencies, hospital associations, and other private data organizations. It is designed to approximate a 20% sample of US community hospitals stratified according to geographic region, ownership, location, teaching status, and bed size. Based on the American Hospital Association definition, community hospitals were defined as all nonfederal, short-term, general and special hospitals, including pediatric centers, whose facilities and services are available to the public. The NIS contains records for all discharges in the hospitals sampled. Release 3 of the NIS is drawn from 17 states (Arizona, California, Colorado, Connecticut, Florida, Iowa, Illinois, Kansas, Massachusetts, Maryland, New Jersey, New York, Oregon, Pennsylvania, South Carolina, Washington, and Wisconsin) and contains 6 385 011 inpatient records from 904 hospitals.

Patients and Hospitals

The 1994 NIS contains 79 652 discharges of patients of all ages with the principal diagnosis of asthma, representing 1.25% of all discharges. All 28 545 complete records of patients ≤18 years of age with the principal diagnosis of asthma in 1994 were extracted using SAS Institute software, providing a stratified sample from 735 community hospitals in 17 states. The principal diagnosis of asthma was defined in the International Classification of Diseases, 9th edition, Clinical Modification (ICD-9) codes between 493.00 and 493.91.

Discharges were excluded from the analysis if the patient died (n = 11) or was transferred to another acute-care hospital (n = 224), or if information was missing for variables used in the analysis (n = 2098; 6.8%). Because ethnicity was missing from 23% of records, this variable was excluded as an adjustment variable; however, these records were included in the overall study.

Measures

Total charges for all inpatient stays were initially reported by hospitals to state governments or hospital associations and then obtained by the HCUP.

Stratification of hospitals by geographic region, ownership, location, teaching status, and bed size ensures representation of the study population and generalizability of the findings. The regions were Northeast (Connecticut, Maine, New Jersey, New York, and Pennsylvania), Northcentral (Iowa, Illinois, Kansas, and Wisconsin), South (Florida, Maryland, and South Carolina), and West (Arizona, California, Colorado, Oregon, and Washington).

The ownership categories were private nonprofit, public, and private investor-owned. Private nonprofit hospitals were controlled by nongovernment, not-for-profit organizations, including religious organizations, community cooperative hospitals, and hospitals operated by fraternal societies. Public hospitals were controlled by a nonfederal government agency or the department of a state, county, city, city–county, or local hospital district or authority. Investor-owned hospitals were controlled on a for-profit basis by an individual, partnership, or profit-making corporation.

The locations were urban or rural. Urban hospitals were located inside a Metropolitan Statistical Area, which is a geographically defined, integrated social and economic unit with a large population base. Rural hospitals were located outside a Metropolitan Statistical Area.

A hospital was considered to be a teaching institution if it had either an American Medical Association-approved residency program or membership in the Council of Teaching Hospitals. Rural hospitals were not split according to teaching status because rural teaching hospitals were rare.

Hospital bed capacity was grouped into small, medium, and large categories. Bed size categories were specific to a hospital's location and teaching status. For example, medium was defined as 50 to 99 beds for rural, 100 to 199 beds for urban nonteaching, and 200 to 499 beds for urban teaching hospitals. The cutoff points for the bed size categories were consistent with those used in American Hospital Association Annual Statistics.

Severity of illness and risk of mortality levels were assigned to each patient discharge using All Patient Refined–Diagnosis Related Groups (APR–DRGs), version 12.0, software system for inpatient care. The APR–DRGs were developed jointly by 3M Health Information Systems (Wallingford, CT) and the National Association of Children's Hospitals and Related Institutions. The classification system was derived clinically and tested extensively with historical data. Relative to other DRG systems, APR–DRGs provide a more accurate and reliable method to classify patients for comparative reporting by data commissions as well as for hospital pricing and utilization management.[9]

The system divided the diagnosis related group asthma into four severity of illness and four risk of mortality subclasses. The severity and mortality classes were based on groups of patients who were physiologically and functionally similar and who had a comparable pattern of resource intensity. Each secondary diagnosis in the discharge record was assigned to one of the four illness severity levels and one of the four mortality risk levels. The assignment of a patient discharge to an illness severity or mortality risk subclass considered not only the severity level of the secondary diagnoses but also the interaction among secondary diagnoses, age, principal diagnosis, and presence of certain operating room and nonoperating room procedures. In the assessment of administrative data, the APR–DRG system is a reliable tool for case-mix adjustment.[10] Relative to other severity adjustment programs, the system provides improved predictive power and payment-to-actual-cost ratios that are substantially close to one for most groups of patients. Thus, they remove much but not all of the systematic biases in DRG classification.[9]

By the four APR–DRG illness severity classes, typical secondary diagnoses among children discharged with asthma are minor (eg, status asthma triggered by an acute upper respiratory infection), moderate (eg, an asthma exacerbation with pneumonia and atelectasis), major (eg, acute asthma in an infant with underlying bronchopulmonary dysplasia or a child with cystic fibrosis), and extreme (eg, asthma with respiratory failure requiring continuous mechanical ventilation).

Race/ethnicity categories included White, Black, Hispanic, Asian/Pacific Islander, and Native American. Patients were classified into one of four primary payer groups: Medicaid; private insurance (commercial, Blue Cross, health maintenance organization, and prepaid health plan); uninsured (self-pay and no charge); and other (CHAMPUS, Title V). They also were grouped into one of the four median annual household income categories based on ZIP code of residence: $0 to $25 000, $25 001 to $30 000, $30 001 to $35 000, and >$35 000. Although grouping household income by ZIP codes is imprecise for individuals, it is an established measure for ecologic studies. The narrow ranges of the income categories were defined by HCUP-3.

Analyses

Multiple regression analysis was used to evaluate the differences in mean total hospital charges and average LOS (ALOS) among different owner and location/teaching categories after adjusting for relevant patient and hospital characteristics. These characteristics included illness severity, mortality risk, payer, patient age, gender, income, state, location (urban or rural), bed size, ownership, teaching status, and month of the year. Race/ethnicity was excluded because observations for this variable were missing in 23% of records. Association between factors was assessed using the χ^2 test for independence.

Histograms of the raw data clearly indicated that both charges and LOS were skewed heavily to the right and, therefore, the analyses were performed on the log-transformed data. The LOS included zero as one of the possible values, hence, a 1 was added to all observations of this variable before the log transformation. The transformation induced approximate normality to the distributions and made the variability more similar among groups. Results were transformed into original units for presentation. Discharges were weighted in the statistical analyses to correspond to estimated discharges in the universe of US community hospitals using a weighting factor included in the HCUP data.

The stratified probability sampling scheme used to obtain the NIS data offered better precision but introduced more complexity in computing the standard errors and analyzing the data. The Survey Data Analysis Software System, Release 7.0, developed by the Research Triangle Institute, was used to perform the analyses. This system is designed specifically for analysis of correlated and weighted data in stratified cluster designs and finite population sampling such as the NIS.

Records with missing data were excluded. Besides ethnicity, the most frequently missing variables were patient income (n = 835; 2.7%), total charges (n = 740; 2.4%), and payer (n = 402; 1.3%). Overall, a total of 2098 (6.8%) records were excluded from the analyses because of missing data for at least one variable.

RESULTS

A total of 735 hospitals managing children with asthma were included in the 1994 sample (Table 1). The majority (68%) had private nonprofit ownership, 19% were publicly owned, and 13% were private for-profit hospitals. Approximately half of the hospitals were located in urban areas and were nonteaching centers, 34% were rural nonteaching hospitals, and 15% were urban teaching institutions. None of the investor-owned hospitals were teaching hospitals and most for-profit hospitals were urban and nonteaching. Most public institutions were rural, nonteaching hospitals. Other characteristics of hospitals in the sample, such as distribution by geographic region, were similar to community hospitals in the United States as a whole.[11] However, small teaching hospitals and large nonteaching hospitals were relatively oversampled.

Table 2 describes the characteristics of the children with asthma treated in hospitals with different forms of ownership. Most patients had minor or moderate severity illnesses and minor risk of mortality. Although the distribution of illness severity and mortality risk classes did not differ dramatically among hospital ownership groups, the variability was statistically significant (P = .026). In particular, the 3.5% of patients with asthma considered major or extreme severity at nonprofit hospitals was greater than the corresponding figure of 2.3% at for-profit hospitals (P = .014).

Infants and young children were admitted more frequently than were adolescents. The mean patient age was similar in each ownership group. Males were admitted more commonly than were females, regardless of hospital ownership. The proportion of children admitted for asthma who resided in a low-income neighborhood with median household annual income <$25 000 was significantly higher at public hospitals than at for-profit (P < .002) or nonprofit (P < .0001) hospitals. Most children with asthma were insured by Medicaid (52%) or private payers (39%). Public hospitals served a higher percentage of Medicaid and uninsured patients than did nonprofit hospitals (P < .0001). Most children admitted for asthma were white (32%) or black (30%). A relatively high percentage of black patients were served by public hospitals, especially in heavy urban areas in the Northeast. A comparatively high proportion of Hispanic children received care in for-profit institutions located in Florida, Texas, California, and other southwestern states.

Table 3 shows the number of patients with asthma by hospital location and teaching status. The distributions of illness severity were similar regardless of location or teaching status (P = .12). Urban teaching hospitals served a higher proportion of patients with asthma who were uninsured or were Medicaid recipients than did urban nonteaching (P = .0036) or rural (P = .0001) hospitals. The average patient age was similar among location and teaching groups. Males were admitted more frequently than were females, regardless of hospital location or teaching status.

A relatively high percentage of children residing in low-income areas were served by rural hospitals (P < .0001), and a comparatively greater proportion of patients living in high-income areas received care in urban nonteaching institutions. A relatively high proportion of white children were served by rural hospitals, whereas a greater share of black children received care in urban teaching institutions.

Table 4 reports unadjusted mean total charges and ALOS for children with asthma by hospital and patient characteristics and season. These findings are

TABLE 1. Number of Hospitals Managing Children With Asthma in the 1994 NIS by Hospital Location, Teaching Status, and Ownership

Hospital Location and Teaching Status	Urban Teaching	Urban Nonteaching	Rural Nonteaching	Totals
Totals	254 (34%)	372 (51%)	109 (15%)	735 (100%)
Hospital ownership				
Private nonprofit	88 (81%)	260 (70%)	151 (59%)	499 (68%)
Public	21 (19%)	37 (10%)	84 (33%)	142 (19%)
Private for-profit	0 (0%)	75 (20%)	19 (8%)	94 (13%)

Percentages calculated for each cell in a column group.

TABLE 2. Number of Children With Asthma in the 1994 NIS by Hospital Ownership and Other Characteristics

Hospital Ownership	Private Nonprofit	Public	Private For-profit	Totals
Totals	21 390 (75%)	5430 (19%)	1725 (6%)	28 545 (100%)
Illness severity				
1 Minor	16 182 (76%)	4161 (77%)	1351 (78%)	21 694 (76%)
2 Moderate	4515 (21%)	1117 (21%)	336 (19%)	5968 (21%)
3 Major	594 (3%)	124 (2%)	33 (2%)	751 (3%)
4 Extreme	99 (0.5%)	28 (0.5%)	5 (0.3%)	132 (0.5%)
Mortality risk				
1 Minor	20 481 (96%)	5111 (94%)	1612 (93%)	27 204 (95%)
2 Moderate	829 (4%)	289 (5%)	106 (6%)	1224 (4%)
3 Major	77 (0.4%)	29 (0.5%)	7 (0.4%)	113 (0.4%)
4 Extreme	3 (0.01%)	1 (0.02%)	0 (0%)	4 (0.01%)
Payer				
Medicaid	10 535 (49%)	3282 (61%)	923 (54%)	14 740 (52%)
Private	9016 (42%)	1432 (26%)	660 (38%)	11 108 (39%)
Uninsured	1145 (5%)	491 (9%)	83 (5%)	1719 (6%)
Other	694 (3%)	225 (4%)	59 (3%)	978 (3%)
Mean age, y	5.9	5.9	5.5	5.8
Male gender	13 263 (62%)	3283 (60%)	1037 (60%)	17 583 (62%)
Income by Residence				
$0–25 000	8646 (40%)	3180 (59%)	672 (39%)	12 498 (44%)
$25 001–30 000	4911 (23%)	1023 (19%)	480 (28%)	6414 (23%)
$30 001–$35 000	2672 (13%)	680 (12%)	272 (16%)	3624 (13%)
>$35 000	5161 (24%)	547 (10%)	301 (17%)	6009 (21%)
Race/ethnicity				
White	6888 (32%)	1453 (27%)	657 (38%)	8998 (32%)
Black	6145 (29%)	2077 (38%)	453 (26%)	8675 (30%)
Hispanic	1838 (9%)	583 (11%)	506 (29%)	2927 (10%)
Asian/Pacific Islander	212 (1%)	68 (1%)	17 (1%)	297 (1%)
Native American	130 (1%)	8 (0.1%)	1 (0.1%)	139 (0.5%)
Other	319 (1%)	655 (12%)	25 (1%)	999 (3%)
Missing	5858 (27%)	586 (11%)	66 (4%)	6510 (23%)

Percentages calculated for each cell in a column group.

not adjusted for any confounding factors and, therefore, should be interpreted with caution. Western, for-profit, urban teaching, and large hospitals posted the highest mean charges. Northcentral and rural nonteaching institutions accounted for the lowest average charges. Children with asthma at Northeastern hospitals experienced the longest ALOS, whereas those at Western institutions had the shortest stay. Increasing illness severity and mortality risk and decreasing income by residence was associated with higher mean charges and longer ALOS stays. In particular, Medicaid recipients, females, and Hispanic and Native American patients with asthma were billed for the highest average charges. Children insured by private payers and white patients had the lowest mean charges. Patients who were privately insured and patients of Asian/Pacific Island background had the shortest ALOS. The greatest share of hospitalizations and the highest mean charges occurred in fall and winter.

Table 5 reports the adjusted mean total charges and ALOS and the 95% confidence intervals obtained from the multiple regression analysis for children with asthma by hospital ownership, location, and teaching status. For children hospitalized with asthma, after adjusting for significant covariates including severity of illness, income, and payer, despite clinically similar ALOS, mean total charges were significantly higher at investor-owned than at nonprofit or public hospitals. Average charges also were significantly higher at urban teaching and lower at rural institutions than at urban nonteaching hospitals.

DISCUSSION

Hospital Ownership

Results of this study supported the primary hypotheses. Adjusted mean total hospital charges for children with asthma were higher at for-profit hospitals than at nonprofit or public hospitals. Nonprofit, public, and for-profit hospitals have different missions, policies, financing, and operations. They also tend to have different responses to market opportunities and competition as well as to government regulations and policies. In a study of 5201 acute-care hospitals, after adjustment for local wage levels, hospital reporting periods, and case mix, inpatient costs per discharge were higher at for-profit institutions ($8115) than at private nonprofit ($7490) or public hospitals ($6507). Much of the difference was associated with higher administrative costs ($2289, $1809, and $1432 per discharge, respectively).[1] However, the effect of administrative systems on improving clinical outcome, reducing LOS, or reducing bad debt is unknown.[12] Our investigation extended to children hospitalized with asthma the finding that investor-owned hospitals have higher mean total charges than nonprofit and public institutions.

A component of charges, net income, is influenced by multiple variables. In a 2-year study of the pediatric intensive care unit costs at New York Hospital–Cornell Medical Center, profit was significantly and adversely affected by outlier status, death, high mortality risk, interhospital transfer, emergency admission, young age, and mechanical ventilation. LOS,

TABLE 3. Number of Children With Asthma in the 1994 NIS by Hospital Location, Teaching Status, and Other Characteristics

Hospital Location and Teaching Status	Urban Teaching	Urban Nonteaching	Rural Nonteaching	Totals
Totals	13 134 (46%)	12 335 (43%)	3076 (11%)	28 545 (100%)
Illness severity				
1 Minor	9894 (76%)	9502 (77%)	2298 (75%)	21 694 (76%)
2 Moderate	2783 (21%)	2493 (20%)	692 (23%)	5968 (21%)
3 Major	373 (3%)	299 (3%)	79 (2%)	751 (3%)
4 Extreme	84 (0.2%)	41 (0.3%)	7 (0.2%)	132 (0.5%)
Mortality risk				
1 Minor	12 548 (96%)	11 783 (96%)	2873 (94%)	27 204 (96%)
2 Moderate	524 (4%)	508 (4%)	192 (6%)	1224 (4%)
3 Major	60 (0.5%)	42 (0.3%)	11 (0.4%)	113 (0.4%)
4 Extreme	2 (0.1%)	2 (0.1%)	0 (0%)	4 (0.1%)
Payer				
Medicaid	7445 (57%)	5877 (48%)	1418 (46%)	14 740 (52%)
Private	4397 (33%)	5381 (43%)	1330 (43%)	11 108 (39%)
Uninsured	828 (6%)	687 (6%)	204 (7%)	1719 (6%)
Other	464 (4%)	390 (3%)	124 (4%)	978 (3%)
Mean age, y	5.7	5.9	6.0	5.8
Male gender	8082 (62%)	7622 (62%)	1879 (61%)	17 583 (62%)
Income by Residence				
$0–25 000	6481 (49%)	4226 (34%)	1791 (58%)	12 498 (44%)
$25 001–30 000	2651 (20%)	2845 (23%)	918 (30%)	6414 (22%)
$30 001–$35 000	1586 (12%)	1800 (15%)	238 (8%)	3624 (13%)
>$35 000	2416 (19%)	3464 (28%)	129 (4%)	6009 (21%)
Race/Ethnicity				
White	2616 (20%)	4889 (40%)	1493 (49%)	8998 (32%)
Black	4719 (36%)	3275 (27%)	681 (22%)	8675 (30%)
Hispanic	1534 (12%)	1227 (10%)	166 (5%)	2927 (10%)
Asian/Pacific Islander	180 (1%)	109 (1%)	8 (0.3%)	297 (1%)
Native American	102 (1%)	14 (0.1%)	23 (1%)	139 (0.5%)
Other	777 (6%)	213 (2%)	9 (0.3%)	999 (3%)
Missing	3206 (24%)	2608 (21%)	696 (23%)	6510 (23%)

Percentages noted for each cell in a column group.

death, interhospital transfer, and age correlated negatively with profit.[13]

Hospital Location and Teaching Status

Adjusted mean total charges also were higher at urban teaching and lower at rural hospitals compared with urban nonteaching institutions. Studies of illness severity and mean charges at teaching and nonteaching hospitals for hospitalized adults have yielded conflicting results. In the most relevant study of eight common conditions at hospitals in Boston, MA, severity was significantly higher at teaching hospitals, but the differences were small.[2] After adjusting for DRGs, costs were higher at tertiary teaching hospitals compared with other teaching and nonteaching hospitals. Specifically, among 744 adult patients with asthma and bronchitis, costs averaged $2865 at tertiary teaching, $2386 at other teaching, and $2087 at nonteaching hospitals.

In this study, the ALOS for all children with asthma was 2.5 days, identical to the mean stay for inpatients ≤14 years of age with asthma found in the 1994 National Hospital Discharge Survey.[5] It did not vary appreciably by hospital ownership, location, or teaching status. In another study, LOS for first or only asthma hospitalizations during 1989 through 1994 at a university-affiliated children's hospital was similar to local community hospitals in the same county.[14]

Government payment policies often differ according to urban or rural designation. Rural hospitals generally are smaller and offer fewer services than do urban institutions. The costs of living and associated costs of health care are lower in rural areas than in urban areas. Our investigation showed that rural institutions serve poorer white children with asthma and charge less than urban hospitals.

Teaching hospitals have a different mission and financial considerations do than nonteaching institutions. In addition to providing education and research, academic institutions generally are regional referral centers and serve high-cost and indigent patients. The viability of many teaching hospitals is threatened by competitive health care market forces and by potential reductions in federal financing of graduate medical education.[15] In particular, independent children's teaching hospitals that receive minimal federal Medicare graduate medical education funding are threatened by ever-tightening reimbursement (P. Willson, personal communication, National Association of Children's Hospitals and Related Institutions, 1988).

Severity of Illness

Evidence for the secondary hypothesis was less consistent than for the primary hypothesis. Severity of illness for children admitted for asthma did not differ significantly by hospital location or teaching status. Nonprofit hospitals treated a slightly higher proportion of children with major or extreme severity asthma than did either public or for-profit hospitals. Urban teaching hospitals treated more children with asthma who lived in low-income neighborhoods, were uninsured, or received Medicaid than

TABLE 4. Unadjusted Mean Total Charges and ALOS for Children With Asthma by Patient and Hospital Characteristics and Season

Hospital and Patient Characteristics	Mean Total Charges	ALOS, d
All patients and hospitals	$ 3674	2.5
Hospital region		
Northeast (CT, MA, NJ, NY, PA)	$ 3841	2.8
Northcentral (IA, IL, KS, WI)	$ 3308	2.4
South (FL, MD, SC)	$ 3502	2.4
West (AZ, CA, CO, OR, WA)	$ 4647	2.3
Hospital ownership		
Private nonprofit	$ 3560	2.5
Public	$ 3795	2.5
Private for-profit	$ 4628	2.5
Hospital location and teaching status		
Urban teaching	$ 4120	2.5
Urban nonteaching	$ 3604	2.4
Rural nonteaching	$ 2722	2.4
Hospital bed size		
Large	$ 3803	2.5
Medium	$ 3507	2.4
Small	$ 3544	2.4
Illness severity		
1 Minor	$ 3374	2.3
2 Moderate	$ 4418	3.0
3 Major	$ 7141	4.2
4 Extreme	$24 098	8.5
Mortality risk		
1 Minor	$ 3589	2.4
2 Moderate	$ 5387	3.2
3 Major	$11 802	5.0
4 Extreme	$25 316	12.6
Payer		
Medicaid	$ 4040	2.7
Private	$ 3223	2.2
Uninsured	$ 3549	2.3
Other	$ 3881	2.5
Age, y		
0–4	$ 3523	2.4
5–12	$ 3869	2.5
13–18	$ 3781	2.5
Gender		
Male	$ 3604	2.4
Female	$ 3791	2.5
Income by Residence		
$0–25 000	$ 3817	2.6
$25 001–30 000	$ 3667	2.5
$30 001–$35 000	$ 3642	2.4
>$35 000	$ 3391	2.2
Race/ethnicity		
White	$ 3097	2.3
Black	$ 3543	2.5
Hispanic	$ 4564	2.6
Asian/Pacific Islander	$ 3974	2.1
Native American	$ 4374	3.1
Season		
January–March (n = 7001; 25%)	$ 3785	2.6
April–June (n = 5837; 20%)	$ 3542	2.4
July–September (n = 5641; 20%)	$ 3628	2.4
October–December (n = 10 006; 35%)	$ 3704	2.5

TABLE 5. Adjusted Mean Total Charges and ALOS (95% Confidence Intervals) for Children With Asthma by Hospital Ownership and by Hospital Location and Teaching Status

	Mean Total Charges	ALOS, d
Hospital ownership		
Private nonprofit	$3640 ($3489–3798)	2.48 (2.42–2.53)
Public	$3620 ($3444–3805)	2.41 (2.26–2.57)
Private for-profit	$4203* ($3908–4520)	2.57 (2.41–2.73)
Hospital location, teaching status		
Urban teaching	$4230* ($3929–4555)	2.45 (2.35–2.56)
Urban nonteaching	$3424* ($3304–3548)	2.49 (2.43–2.56)
Rural nonteaching	$2910* ($2818–3005)	2.48 (2.42–2.55)

* $P \leq .001$ comparing this value with others. Variables included in the multiple regression analysis include illness severity, mortality risk, payer, age, gender, income, state, hospital ownership, location, teaching status, bed size, and month.

did urban nonteaching hospitals. Finally, for-profit hospitals admitted fewer children with asthma from low-income neighborhoods than did public hospitals; otherwise, for-profit hospitals were similar to public and nonprofit institutions with respect to socioeconomic variables.

Patients with more severe illnesses, especially those facing socioeconomic challenges, require the most complex and costly health care. Children with chronic illnesses are especially vulnerable in a competitive marketplace because of the higher ongoing cost associated with treating their illnesses and the inherent pressures to reduce services within capitated rates.[16]

Our analysis showed that the vast majority of hospitalized children had illnesses of minor or moderate severity. Although nonprofit hospitals had a slightly higher percentage of major or extreme severity cases than did for-profit institutions, the distributions of illness severity classes were fairly similar regardless of hospital ownership, location, or teaching status. Additional study is needed of charges, costs, and utilization of inpatient services for children with various special health care needs by hospital ownership, location, and teaching status.

Study Limitations

Analyses such as these that are based on administrative datasets can provide an inexpensive source of information with large sample size and nationally representative data. At the same time, hospital claims records pose important limitations. This dataset lacked important, complementary diagnostic and prognostic information available with concurrently collected clinical data. On the one hand, high-quality inpatient care including physician and nurse assessment and monitoring, pharmacologic, and respiratory therapy, and patient education may increase charges but improve long-term health outcomes. On the other hand, low-quality care may be associated with costly complications or may result in early discharge with ongoing asthma-related problems at home and school. This study could not assess any of these possible scenarios. Neither outpatient data for clinic or emergency department use nor pharmaceutical information was available, thus, the continuum of health care could not be evaluated. No patient identifiers were available in the dataset, therefore, readmitted patients could not be identified.

Study results may vary depending on which severity method is used for risk adjustment. No published outcome studies of children hospitalized with asthma have compared clinical measures with the APR–DRG classification system. Nevertheless, severity adjustment is essential before comparing patient outcomes across hospitals. Based on the consistent progression in mean charges and ALOS calculated for the assigned illness severity and mortality risk

levels alone (Table 4), the system was reasonably reliable.

Inaccurate, nonspecific, or underreported diagnosis codes may have resulted in analytic biases.[17] For example, patients hospitalized with the principal diagnosis of bronchospasm who were excluded from the sample population may have had asthma. As another example, those with a secondary diagnosis of hypoxemia that was not coded would have had a higher severity of illness than reported.

Finally, hospital charges are only approximately associated with the costs of care. Charges are the prices assigned for hospital services rendered. Most fee-for-service contracts between payers and hospitals are based on charges. However, hospital administrators and medical directors also are interested in knowing the cost of resources used to provide care. Moreover, public health officials would like to know the social and opportunity costs of providing health services for children with asthma compared with that for other populations. Hospital-specific charge-to-cost conversions would be needed to assess the influence of hospital ownership, location, and teaching status on the actual costs of such care.

Policy and Clinical Relevance

Pediatricians and other providers, health systems managers, purchasers, policymakers, and families want to know which organizational and financing arrangements meet the needs of children in the most efficient, effective, and equitable manner.

With the proliferation of investor-owned hospitals, both the reasons for and the impact of higher average charges at for-profit institutions require additional investigation. Between 1993 and 1996, the number of investor-owned community hospitals increased by 5.9% from 717 to 759, whereas the number of total community hospitals decreased by 2.4% from 5261 to 5134. During the same period, annual admissions to for-profit institutions increased 25.1%, whereas admissions to all community hospitals increased by 1.1%.[18] Our study did not assess whether the higher mean total charges at for-profit hospitals compared to charges at nonprofit and public institutions were attributable to higher fixed costs, marginal costs of more services rendered, or profit margins. Regardless of the causes, the impact of higher charges requires careful evaluation. Longitudinal studies are needed of inpatient charges and costs by hospital features for children with various conditions, especially those with special health care needs and in underserved populations.

With the growing needs of the medically underserved, socially just policies are required for financing hospitals that care for a disproportionate share of economically disadvantaged children. Socioeconomic and racial/ethnic differences in access to and outcomes of health care are widening in almost every major indicator of child health. Between 1989 and 1994, urban teaching hospitals provided a disproportionately large share of care for medically indigent and underserved members of minority and poor populations. Two thirds of patients admitted to public teaching hospitals and >50% of patients admitted to private nonprofit teaching hospitals had one or more risk factors for underservice (Medicaid, uninsured, minority, or poor).[19] For hospitals competing in the same market, those treating a disproportionate share of chronically ill children with common acute conditions will be at a financial disadvantage.[20]

This study revealed that public and rural hospitals served a higher share of children with asthma residing in poverty areas. It also showed that public and urban teaching institutions provided care for a greater proportion of children with asthma who were enrolled in Medicaid or were uninsured. To continue care to the underserved, these hospitals may need special financial support.

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