abstract

BACKGROUND AND OBJECTIVE: Child health is influenced by biomedical and socioeconomic factors. Few studies have explored the relationship between community-level income and inpatient resource utilization for children. Our objective was to analyze inpatient costs for children hospitalized with common conditions in relation to zip code-based median annual household income (HHI).

METHODS: Retrospective national cohort from 32 freestanding children's hospitals for asthma, diabetes, bronchiolitis and respiratory syncytial virus, pneumonia, and kidney and urinary tract infections. Standardized cost of care for individual hospitalizations and across hospitalizations for the same patient and condition were modeled by using mixed-effects methods, adjusting for severity of illness, age, gender, and race. Main exposure was median annual HHI. Posthoc tests compared adjusted standardized costs for patients from the lowest and highest income groups.

RESULTS: From 116,636 hospitalizations, 4 of 5 conditions had differences at the hospitalization and at the patient level, with lowest-income groups having higher costs. The individual hospitalization level cost differences ranged from $187 (4.1%) to $404 (6.4%). Patient-level cost differences ranged from $310 to $1087 or 6.5% to 15% higher for the lowest-income patients. Higher costs were typically not for laboratory, imaging, or pharmacy costs. In total, patients from lowest income zip codes had $8.4 million more in hospitalization-level costs and $13.6 million more in patient-level costs.

CONCLUSIONS: Lower community-level HHI is associated with higher inpatient costs of care for 4 of 5 common pediatric conditions. These findings highlight the need to consider socioeconomic status in health care system design and reimbursement calculations. Pediatrics 2013;132:e1592–e1601
Child health and development are impacted by biomedical and social factors, which have independent and interactive effects. Individual health is negatively affected by socioeconomic stressors, leading to poor health and higher health care utilization. The complex interplay of clinical, social, and other factors is illustrated in Fig 1. Children from low socioeconomic status (SES) families have myriad health problems. Among adults with chronic conditions, lower SES has been associated with longer hospital lengths of stay (LOS), higher costs of care, and higher risk of hospital readmissions. In contrast, there continues to be a paucity of data on the relationship between socioeconomic factors and hospital resource utilization among children. Higher inpatient mortality has been observed for low-income children with select conditions. In a single-center study in the 1980s, using race as a proxy for SES, nonwhite children had longer hospital LOS and higher costs. Yet an analysis using a national sample of administrative data revealed inconsistent relationships between community-level income and inpatient charges. In this study, we analyzed resource utilization by using standardized costs for hospitalized children at freestanding children's hospitals with common medical conditions in relation to the median household income (HHI) of the child's home zip code. We hypothesized that hospitalized children from areas with lower median HHI would have higher costs and that patients living in low-income zip codes would have higher costs across multiple stays for the same condition.

**METHODS**

**Study Design and Data Source**

Data for this multicenter retrospective cohort study were obtained from the Pediatric Health Information System (PHIS), which contains administrative data from 43 freestanding children's hospitals. Participating hospitals are located in noncompeting markets of 27 states plus the District of Columbia and account for 20% of all pediatric hospitalizations in the United States. For each hospital encounter, PHIS includes patient demographics, home zip code, up to 41 International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnoses, up to 41 ICD-9-CM procedures, and hospital charges for services. Charges are categorized into laboratory, imaging, pharmacy, and other (including room, nursing, supplies, and clinical charges). Each service is assigned a standardized cost. To derive these standardized costs, a charge master index was created, taking the median costs from all PHIS hospitals for each charged service. Thus, these costs represent the estimated cost of providing any particular clinical activity. The costs are not the cost to patients, nor do they represent the actual cost to any given hospital. This approach allows for cost comparisons across hospitals without biases arising from using charges or from deriving costs by using hospitals' ratios of costs to charges.

Data are deidentified before inclusion in the database but unique identifiers allow for longitudinal analyses across hospitalizations 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, KS), participating hospitals, and Truven Health Analytics (formerly Thomson Reuters Healthcare, New York, NY). In accordance with the Common Rule (45 Code of Federal Regulations 46.102 (f)) and the policies of The Children's Hospital of Philadelphia Institutional Review Board, this study using a deidentified data set was not considered human subjects research.

**Study Participants**

Data from 32 hospitals were included. Three hospitals were excluded due to lack of LOS values in hours, and 8 hospitals were excluded due to missing data required to assure the quality of standardized costs. Inpatient-status and observation-status hospitalizations during the 2 calendar years of 2010 and 2011 were included in analyses. Patients older than 18 years of age were excluded. All eligible patient stays during the study period were categorized by using All Patient Refined Diagnosis Related Groups (APR-DRGs), version 24 (3M Health Information Systems, St Paul, MN), based upon ICD-9-CM diagnosis and procedure codes assigned during each patient's episode of care. The APR-DRG system also provides a severity of illness score (1, minor to 4, extreme). Specific patient factors, such as diagnoses, procedures, and patient age are accounted for in severity levels generated through 3Ms proprietary algorithm.

The primary outcome variable was standardized cost of care adjusted for severity of illness. Analyses focused on 5 APR-DRGs that represent common reasons for hospitalization, categorized as acute exacerbations of chronic illness (asthma, diabetes), and acute infections (bronchiolitis and respiratory syncytial virus [RSV] pneumonia; pneumonia, other [ie, community-acquired pneumonia]; and kidney and urinary tract infections).

Median annual community-level HHI for the child's home zip code was obtained from 2010 US Census data. Zip code-based median HHI has been previously demonstrated to be a useful proxy for patient SES and social milieu when individual level data are unavailable. Median annual HHIs were split into 4 categories: HHI-1: $33,525 or less; HHI-2: $33,526 to $44,700; HHI-3: $44,701 to $67,050; and HHI-4: $67,051 or more. These categories
were based on US federal poverty guidelines for a family of 4. The HHI-1 limit is 1.5 times the poverty level income; HHI-2 is 1.5 to 2 times that; HHI-3 is 2 to 3 times; and HHI-4 is greater than 3 times the poverty level. These categories are the same or similar to categories reported in other studies.

Patient demographic variables included age, gender, race/ethnicity, and primary payer. 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. Race and ethnicity were included to describe the cohort. 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, The Children’s Health Insurance Program, and Title V. "Commercial" payer included employer-based (including TRICARE) and privately purchased health insurance. "Uninsured" included “self-pay” and “charity.” Other indicated Medicare, worker’s compensation, other governmental insurance, missing payer information, and no-charge.

**Data Analysis**

The hospitalization level analyses included costs associated with each hospital stay for a patient, independent of other stays. Patient level analyses incorporated repetitive admissions for a diagnosis (APR-DRG), so repeat hospitalizations can be detected, which would be particularly relevant for chronic conditions, such as asthma and diabetes.

Standardized costs within each cost category were modeled by using mixed-effects methods allowing for repeated measurements on hospitals through hospital random intercepts for both hospital- and patient-level analyses. A logarithmic transformation of the standardized costs provided an improved fit to the data. Models were built independently for each APR-DRG and were risk-adjusted by using the APR-DRG severity of illness levels. Models were also adjusted for age, gender, and race. Results were back-transformed onto the original cost scale. Posthoc tests were used to compare the adjusted standardized costs of patients in the lowest and highest HHI groups. Finally, to calculate the total “excess” cost associated with hospitalizations for patients from HHI-1 versus HHI-4, when statistically significant differences occurred, we subtracted the average total costs of HHI-1 stays from the costs of HHI-4 stays and multiplied that by the number of hospitalizations for HHI-1 children for each condition. As a secondary analysis, relative risk (RR) of public versus commercial insurance was evaluated for patients in the lowest and highest category of income. All statistical analyses were performed by using SAS version 9.3 (SAS Institute, Inc, Cary, NC). P < .05 was considered statistically significant.

**RESULTS**

A total of 105,624 patients had 116,636 hospitalizations for the 5 APR-DRGs. These represented 9.2% of all hospitalizations in the PHIS hospitals for the...
time period. Demographics and hospitalization characteristics are reported in Tables 1, 2, and 3. Patients from the lowest-income zip codes (HHI-1) had public insurance (75.0%) more often than commercial coverage (17.3%; RR, 3.3; 95% confidence interval: 3.2–3.4). Patients from HHI-4 were more likely to be covered by commercial insurance (54.0%) than public insurance (22.2%; RR, 4.4; 95% confidence interval: 4.2–4.6).

**Acute Exacerbations of Chronic Conditions**

Asthma (APR-DRG 141) and diabetes (APR-DRG 420) were the 2 chronic conditions included in this analysis.

**Asthma**

At the hospitalization level, stays were 5.6% more costly for patients from HHI-1 than from HHI-4 ($236 difference, P < .001; Table 4), with most of the differential related to other (primarily room) costs (Fig 2). LOS accounted for 47.8% of the variation. At the patient level, patients with asthma from HHI-1 had total costs 11.9% higher than for patients from HHI-4 ($543 difference; P < .001). At the patient level, all subcategories of costs except laboratory were significantly different across the HHI groups (Supplemental Tables 5 and 6).

**Diabetes**

At the hospitalization level, the difference in total costs between the lowest and highest-income group was $404 per hospitalization (6.4%; P = .012; Table 4, Fig 2). LOS accounted for 16.8% of the variation in standardized costs. At the patient level, the difference in total costs between the lowest and highest income group was $1087 (15%; P < .001). Differences in the standardized costs for all subcategories of costs, with the exception of laboratory and pharmacy, were significantly different across HHI groups (P < .01) and the lowest income HHI-1 group had the highest costs for all subcategory costs (Supplemental Tables 5 and 6).

**Infectious Conditions**

Bronchiolitis and RSV pneumonia (APR-DRG 138), pneumonia, other (APR-DRG 139, which includes community-acquired pneumonia), and kidney and urinary tract infections (APR-DRG 463) were the 3 infectious conditions included in this analysis.

**Bronchiolitis and RSV Pneumonia**

At the hospitalization level, there was a $353 (8.3%) difference in costs between the lowest and highest income groups (P = .001; Table 4) and 46.7% of

### TABLE 1

Study Sample Characteristics by Hospitalization for Entire Sample and by Median Annual HHI Categories

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total hospitalizations</td>
<td>11 6636</td>
<td>33 061</td>
<td>36 714</td>
<td>35 666</td>
<td>11 195</td>
</tr>
<tr>
<td>Patient age, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>35 675 (30.6)</td>
<td>10 435 (31.6)</td>
<td>11 670 (31.8)</td>
<td>10 641 (28.9)</td>
<td>2939 (26.2)</td>
</tr>
<tr>
<td>1–4</td>
<td>32 909 (28.0)</td>
<td>9865 (27.1)</td>
<td>10 160 (27.7)</td>
<td>10 131 (28.4)</td>
<td>3355 (30.0)</td>
</tr>
<tr>
<td>5–12</td>
<td>35 068 (30.1)</td>
<td>9785 (28.6)</td>
<td>10 773 (29.5)</td>
<td>10 937 (30.7)</td>
<td>3573 (31.9)</td>
</tr>
<tr>
<td>&gt;12</td>
<td>13 284 (11.4)</td>
<td>3876 (11.7)</td>
<td>4 111 (11.2)</td>
<td>3 957 (11.1)</td>
<td>1 340 (12.0)</td>
</tr>
<tr>
<td>Gender, boy</td>
<td>63 377 (54.3)</td>
<td>18 106 (54.8)</td>
<td>19 951 (54.3)</td>
<td>19 252 (54.0)</td>
<td>6 068 (54.2)</td>
</tr>
<tr>
<td>Patient race</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>45 319 (38.9)</td>
<td>7 796 (23.6)</td>
<td>15 176 (35.9)</td>
<td>17 464 (49.0)</td>
<td>6 885 (61.5)</td>
</tr>
<tr>
<td>African American</td>
<td>29 774 (25.5)</td>
<td>12 967 (39.2)</td>
<td>9 385 (25.6)</td>
<td>6 440 (18.1)</td>
<td>982 (8.8)</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>28 251 (24.2)</td>
<td>9 091 (27.5)</td>
<td>10 478 (28.5)</td>
<td>7 412 (20.8)</td>
<td>1 270 (11.3)</td>
</tr>
<tr>
<td>Asian</td>
<td>2554 (2.2)</td>
<td>258 (0.8)</td>
<td>653 (1.8)</td>
<td>937 (2.6)</td>
<td>706 (6.3)</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>521 (0.4)</td>
<td>221 (0.7)</td>
<td>132 (0.4)</td>
<td>132 (0.4)</td>
<td>36 (0.3)</td>
</tr>
<tr>
<td>Native Hawaiian or Other Pacific Islander</td>
<td>193 (0.2)</td>
<td>41 (0.1)</td>
<td>47 (0.1)</td>
<td>80 (0.2)</td>
<td>25 (0.2)</td>
</tr>
<tr>
<td>Other</td>
<td>10 024 (8.6)</td>
<td>2 687 (8.1)</td>
<td>2 843 (7.7)</td>
<td>3 201 (9.0)</td>
<td>1 293 (11.6)</td>
</tr>
<tr>
<td>Payer*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial/private/employer-based</td>
<td>36 778 (31.5)</td>
<td>5 702 (17.3)</td>
<td>10 187 (27.8)</td>
<td>14 840 (41.6)</td>
<td>6 049 (54.0)</td>
</tr>
<tr>
<td>Public</td>
<td>66 325 (56.8)</td>
<td>24 782 (75.0)</td>
<td>22 801 (62.1)</td>
<td>16 261 (45.6)</td>
<td>2 481 (22.2)</td>
</tr>
<tr>
<td>Uninsured</td>
<td>2258 (1.9)</td>
<td>681 (2.0)</td>
<td>784 (2.1)</td>
<td>657 (1.8)</td>
<td>154 (1.4)</td>
</tr>
<tr>
<td>Other</td>
<td>11 277 (9.7)</td>
<td>1 916 (5.8)</td>
<td>2 942 (8.0)</td>
<td>3 908 (11.0)</td>
<td>2 511 (22.4)</td>
</tr>
<tr>
<td>Complex chronic conditions$^e$</td>
<td>14 596 (12.5)</td>
<td>3 901 (11.8)</td>
<td>4 526 (12.3)</td>
<td>4 459 (12.5)</td>
<td>1 511 (13.5)</td>
</tr>
<tr>
<td>Hospital LOS, d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>2.2 (1.4)</td>
<td>2.2 (1.4)</td>
<td>2.2 (1.4)</td>
<td>2.2 (1.4)</td>
<td>2.2 (1.4)</td>
</tr>
<tr>
<td>Median (interquartile range)</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
</tr>
</tbody>
</table>

* Payer categories are categorized as private for commercial, employer-based, privately purchased insurance; public includes Medicaid (including Medicaid managed care), Children’s Health Insurance Program, and Title V; uninsured included self-pay and charity. Other indicated Medicare, worker’s compensation, other governmental insurance, missing payer information, and no-charge.
the variation was explained by differences in LOS. At the patient level, there was a $483 (10.3%) difference between the lowest and highest income groups (Supplemental Tables 5 and 6).

Pneumonia, Other
At the hospitalization level, there was a $187 (4.1%) difference in costs between the lowest and the highest income groups ($P = .009; Table 4). At the patient level, there was an overall difference ($P < .001), and the pairwise difference between HHI-1 and HHI-4 was $310 (6.5%; $P < .001). In the subcategories of costs, HHI-1 had the highest other costs, whereas HHI-4 had the highest laboratory costs (Supplemental Tables 5 and 6).

### Table 2: Distribution of Hospitalizations and Patients by Categories of Median HHI

<table>
<thead>
<tr>
<th>HHI of Zip Code</th>
<th>Count</th>
<th>Asthma</th>
<th>Diabetes</th>
<th>Bronchiolitis and RSV pneumonia</th>
<th>Pneumonia, Other</th>
<th>Kidney and Urinary Tract Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>$33,525 or Less</td>
<td>29953</td>
<td>9797 (32.7)</td>
<td>9432 (31.5)</td>
<td>10569 (32.7)</td>
<td>8408 (30.2)</td>
<td>4030 (32.7)</td>
</tr>
<tr>
<td>$33,526–$44,700</td>
<td>14240</td>
<td>3458 (24.3)</td>
<td>4275 (30.0)</td>
<td>9580 (29.6)</td>
<td>8961 (32.2)</td>
<td>3881 (31.5)</td>
</tr>
<tr>
<td>$44,701–$67,050</td>
<td>3219</td>
<td>9368 (29.0)</td>
<td>10569 (32.7)</td>
<td>9580 (29.6)</td>
<td>8961 (32.2)</td>
<td>3881 (31.5)</td>
</tr>
<tr>
<td>$67,051 or More</td>
<td>27804</td>
<td>7237 (26.0)</td>
<td>8408 (30.2)</td>
<td>8961 (32.2)</td>
<td>3881 (31.5)</td>
<td>3881 (31.5)</td>
</tr>
</tbody>
</table>

### Table 3: Demographics of Hospitalizations Across Conditions

<table>
<thead>
<tr>
<th>Age, y</th>
<th>Count</th>
<th>Asthma</th>
<th>Diabetes</th>
<th>Bronchiolitis and RSV pneumonia</th>
<th>Pneumonia, Other</th>
<th>Kidney and Urinary Tract Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>0 (0)</td>
<td>50 (0.4)</td>
<td>25855 (80)</td>
<td>4150 (14.9)</td>
<td>5620 (45.6)</td>
<td></td>
</tr>
<tr>
<td>1–4</td>
<td>8674 (29)</td>
<td>1371 (9.6)</td>
<td>6484 (20)</td>
<td>13667 (49.2)</td>
<td>2433 (19.8)</td>
<td></td>
</tr>
<tr>
<td>5–12</td>
<td>17908 (60)</td>
<td>6592 (48.3)</td>
<td>0 (0)</td>
<td>8098 (29.1)</td>
<td>2470 (20.1)</td>
<td></td>
</tr>
<tr>
<td>&gt;12</td>
<td>3371 (11.3)</td>
<td>6227 (43.7)</td>
<td>0 (0)</td>
<td>1889 (6.8)</td>
<td>1797 (14.6)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4: Unadjusted Analyses of LOS by HHI for Each Condition

There were no overall cost differences across the HHI categories for kidney and urinary tract infections where overall and HHI-1 versus HHI-4 differences were different. For asthma, LOS was 0.07 d ($P = .03$) longer and for kidney and UTI, LOS was 0.09 d longer for the lowest-income group compared with the highest-income group.
higher for the lowest income category compared with the highest (Supplemental Table 5). At the patient level, other costs were $306 higher for the lowest-income group compared with the highest ($P = .015; Fig 2, Supplemental Table 6).

**Aggregated Costs Differences**

When the standardized cost differentials for the 4 conditions with statistically significant differences in costs between HHI-1 and HHI-4 were summed to find the total excess costs associated with HHI-1, the total was $8.4 million in standardized cost across the 32 hospitals at the hospitalization level. When this same calculation was done at the patient level for the 4 conditions with statistically significant differences in costs between HHI-1 and HHI-4, the excess costs totaled $13.6 million.

**DISCUSSION**

We report on standardized costs of hospital care for common pediatric conditions in relation to patients’ home zip code median annual HHI from a large, national sample. We found higher costs of hospital care associated with lower income for most conditions. When considering costs of care at the hospitalization level, 3 of 5 conditions demonstrated significant differences; when considered at the patient level, 4 of the 5 demonstrated significant differences. The hospitalization level cost differences ranged from $187 (pneumonia) to $404 (diabetes), translating to differences of 4.1% to 8.3% in standardized costs, with lowest-income patients having

<p>| TABLE 4 Mean Adjusted Standardized Costs at the Hospitalization Level and Patient Level |
|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Hospitalization                               | Patient                                       |</p>
<table>
<thead>
<tr>
<th>APR-DRG</th>
<th>HHI-1 ($&lt;$33,525) ($)</th>
<th>HHI-2 ($33,526–$44,700) ($)</th>
<th>HHI-3 ($44,700–$67,050) ($)</th>
<th>HHI-4 ($&gt;$67,051) ($)</th>
<th>$P$ Overall*</th>
<th>$P$ HHI-1 Versus HHI-4b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>4477 (857.1)</td>
<td>4452 (851.7)</td>
<td>4434 (847.7)</td>
<td>4241 (808.4)</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Diabetes</td>
<td>6696 (308.8)</td>
<td>6717 (308.8)</td>
<td>6486 (297.5)</td>
<td>6292 (304)</td>
<td>.002</td>
<td>.012</td>
</tr>
<tr>
<td>Bronchiolitis and RSV pneumonia</td>
<td>4612 (634)</td>
<td>4518 (621)</td>
<td>4392 (603.7)</td>
<td>4259 (585.7)</td>
<td>.013</td>
<td>.001</td>
</tr>
<tr>
<td>Pneumonia, other</td>
<td>4732 (105.5)</td>
<td>4637 (101.8)</td>
<td>4570 (100.5)</td>
<td>4545 (111)</td>
<td>.011</td>
<td>.009</td>
</tr>
<tr>
<td>Kidney and urinary tract infection</td>
<td>4143 (843.3)</td>
<td>4038 (822.7)</td>
<td>4073 (830.5)</td>
<td>4099 (838)</td>
<td>.384</td>
<td>.642</td>
</tr>
</tbody>
</table>

Total difference for 4 conditions with significant results between HHI-1 and HHI-4 is $8.4 million at the hospitalization level and $13.6 million at the patient level.

* Mixed-effects methods allowing for repeated measurements on hospitals through hospital random intercepts, with models that included age, gender, and race as covariates for adjustment.

**FIGURE 2**

Mean adjusted standardized other costs of by HHI and APR-DRG at (A) hospitalization level and (B) patient level. The center point is the mean value, and the whiskers extend ±SD from it. These other costs represent those primarily for room and not costs for laboratory, imaging or pharmacy.
higher costs. Although these differences are relatively small for each hospitalization, when aggregated, our estimates for these conditions reveal a standardized-cost excess of $8.4 million for patients from the lowest income zip code group relative to the highest. Though payments may be larger for higher severity levels under a DRG system, social risk factors are not considered in severity equations.

As a result, hospitals may not be appropriately paid for the resources deployed to care for patients from low-income households. In a per diem reimbursement model, extra hospital days that do not meet inpatient criteria may not be reimbursed, although those extra days may be the ones that are required to ensure safe and effective discharge for disadvantaged patients. Moreover, at the patient level, the cost difference range was 6.5% (pneumonia) to 15.0% (diabetes), with an 11.9% difference for asthma, suggesting a potential financial burden within and across hospitalizations.

Chronic illnesses, such as asthma and diabetes, revealed greater differences in costs across income groups. This suggests acute encounter-specific needs may be greater among low-income families, perhaps reflecting poor disease control (not captured by severity adjustment in DRGs) or challenges with discharge that prolong LOS or require additional hospital resources. This postulate about longer LOS is supported by the frequent absence of differences (or small differences when they were found) in laboratory, imaging, or pharmacy costs across income groups. Differences in costs between the highest-income and lowest-income patients were most accentuated in the patient level analyses for chronic illnesses, suggesting multiple hospitalizations are a factor. This finding suggests that patients may be admitted more than once per year, with accruing costs of those hospitalizations raising patient-level averages.

The findings for diabetes reveal significant differences in costs at both the hospitalization and patient levels. LOS and other costs appear to be less important in explaining the differences in costs for hospitalizations for diabetes across income groups than for the other diagnoses examined. The large differences suggest that SES is an important influence both on resource utilization for each hospitalization and also on recurrent admissions, which is consistent with other studies on diabetes.44 The findings for kidney and urinary tract infections, in contrast, reveal no differences in costs across groups, except for other costs at the patient level.

These results have implications for health care planners and insurers in estimating potential costs of delivering care to patients of lower SES.17,18,24,48 By extension, these findings should be of great interest to health systems seeking to be accountable care organizations, as bearing the risk of disease will also mean becoming accountable for the excess costs associated with socioeconomic disadvantage.46,47 This echoes, in some ways, previous evaluation of Medicare’s prospective payment system, with analyses that justified the need for disproportionate share and outlier payments.15,48

This work also highlights the need to consider SES throughout the health care value chain, including in service design, care delivery, and reimbursement. A recent Robert Wood Johnson Foundation survey revealed that 4 of 5 physicians believe that patients’ social conditions directly lead to worse health and are as important to address as medical care, but lack confidence in their capacity to address these factors.40 To address this gap, and simultaneously improve health care operations and research, socioeconomic risk information about patients could be routinely collected and incorporated into the care of children.2,50,51 Social screening itself is both acceptable and teachable to providers.52,53 Furthermore, interventions directed toward addressing social disadvantage could be applied to the medical setting, as these are linked conceptually (Fig 1). Promising examples of such interventions include medical-legal partnerships,54 Health Leads,55 Camden Coalition,56,57 and Nurse-Family Partnerships.58

This analysis has several limitations. First, the sample is drawn from free-standing children’s hospitals, so findings may not generalize. Many hospitals included are located in urban areas, acting at once as local hospitals for urban populations and as referral centers for surrounding regions. As a result, selection bias may be a result, with the potential for patients from lower SES groups to have longer LOS because they live closer to the hospitals, whereas higher SES patients live further away and are transferred back to community hospitals. The reverse could also be true for some patients, with those living further away staying longer. In addition, readmissions for lower-severity illnesses may be at community hospitals that would not be reflected in PHIS. Were that true, and those patients lived in higher-income suburban zip codes, our sample would undercount repeat admissions for those patients, potentially biasing cost estimates for higher SES patients downward. In addition, we were unable to account for SES differences in referral patterns or family preferences for children’s hospitals. Therefore, differences based on income groupings may exist due to differences in types of patients seeking care at children’s hospitals. Also, we chose 5 common diagnoses, so our results may not apply to other conditions. Additionally, we used zip code-level income data to
approximate family-level income because no individual income demographics are captured in the PHIS data collected from member hospitals. Although this approximation has been used previously, it may result in biases of unknown direction or significance.38,39,42,43,59 Individual experiences within a zip code may also differ from zip code-wide experience (e.g., an individual household may have an income higher or lower than the median).60,61 Although zip code-based income measures have been found to have advantages over other zip code measures, such as education and occupation, all census-based variables aggregated at the zip code may diminish the effects of SES in comparison with smaller geographic units.38,39,43 Zip code-based SES variables are measures of neighborhood effects on health and not simply proxies for individual level SES. Although our study focused on median HHI, SES is multidimensional;62 the associations between inpatient costs and a broader range of SES measures should be examined in future studies. Finally, our costs and cost differentials are reported in standardized cost dollars, which are not the actual dollars spent. Nonetheless, these cost estimates are comparable across hospitals and closer to real expenditures than charges.31

CONCLUSIONS
We report on higher costs of inpatient care among several common pediatric conditions for patients from lower-income zip codes. Costs appear attributable to resource utilization outside of laboratory, imaging, or pharmacy costs, suggesting longer stays and other services are required for such patients. The current reimbursement system, however, does not explicitly acknowledge these increased costs. In particular, severity-adjusted payments in a DRG system would overlook these costs, and per diem reimbursement may not deem additional hospital days as medically justified. Further investigation is required to understand the full scope of how socioeconomic factors, and related policies, impact resource utilization, and how reimbursement models might more appropriately account for them.

REFERENCES


36. Averill RF, Goldfield N, Hughes JS. All Patient Refined Diagnosis Related Groups (APR DRGs), Version 24.0: Methodology Overview. 3M Health Information Systems Wallingford, CT: 3M Health Information Systems. 2007


58. Williams DR, Costa MV, Oduanlmi AO, Mohammed SA. Moving upstream: how interventions that address the social determinants of health can improve health and reduce disparities. *J Public Health Manag Pract*. 2008;14(suppl):S8–S17


(Continued from first page)

doi:10.1542/peds.2013-0619

Accepted for publication Sep 19, 2013

Address correspondence to Evan S. Fieldston, MD, MBA, MSHP, The Children’s Hospital of Philadelphia, 34th and Civic Center Blvd, CHOP North, Room 1516, Philadelphia, PA 19104. E-mail: fieldston@email.chop.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2013 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: Supported by internal funds from the Children’s Hospital Association and The Children’s Hospital of Philadelphia. Dr Macy received support from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (K23 HD070913) for research unrelated to this study.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.
Community Household Income and Resource Utilization for Common Inpatient Pediatric Conditions

Evan S. Fieldston, Isabella Zaniletti, Matthew Hall, Jeffrey D. Colvin, Laura Gottlieb, Michelle L. Macy, Elizabeth R. Alpern, Rustin B. Morse, Paul D. Hain, Marion R. Sills, Gary Frank and Samir S. Shah

*Pediatrics* 2013;132;e1592; originally published online November 25, 2013;
DOI: 10.1542/peds.2013-0619

Updated Information & Services
including high resolution figures, can be found at:
/content/132/6/e1592.full.html

Supplementary Material
Supplementary material can be found at:
/content/suppl/2013/11/19/peds.2013-0619.DCSupplemental.html

References
This article cites 56 articles, 18 of which can be accessed free at:
/content/132/6/e1592.full.html#ref-list-1

Citations
This article has been cited by 6 HighWire-hosted articles:
/content/132/6/e1592.full.html#related-urls

Subspecialty Collections
This article, along with others on similar topics, appears in the following collection(s):
Hospice/Palliative Medicine
/cgi/collection/hospice:palliative_medicine_sub

Permissions & Licensing
Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:
/site/misc/Permissions.xhtml

Reprints
Information about ordering reprints can be found online:
/site/misc/reprints.xhtml

PEDIATRICS is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. PEDIATRICS is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2013 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0031-4005. Online ISSN: 1098-4275.
Community Household Income and Resource Utilization for Common Inpatient Pediatric Conditions
Evan S. Fieldston, Isabella Zaniletti, Matthew Hall, Jeffrey D. Colvin, Laura Gottlieb, Michelle L. Macy, Elizabeth R. Alpern, Rustin B. Morse, Paul D. Hain, Marion R. Sills, Gary Frank and Samir S. Shah

*Pediatrics* 2013;132;e1592; originally published online November 25, 2013; DOI: 10.1542/peds.2013-0619

The online version of this article, along with updated information and services, is located on the World Wide Web at:
/content/132/6/e1592.full.html