Emergency Department Use among Michigan Children with Special Health Care Needs: An Introductory Study

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Objective. To describe patterns of emergency department (ED) use among children dual-enrolled in Medicaid and Michigan's Children's Special Health Care Services (CSHCS).

Data Sources. Individual claims and enrollment data from Michigan's Medicaid and CSHCS programs for the period January 1, 1998, to June 30, 1999. Claims data were linked with eligibility data and then used to develop a 100 percent sample of claims for individuals enrolled in both Medicaid and CSHCS.

Study Design. Poisson regression analysis was used to examine the rate of ED use for dual-enrolled children. A time-varying hazard analysis was also used to examine the impact of changes over time. The key variables were gender, age, race, county of residence, Medicaid eligibility category, and qualifying diagnosis.

Principal Findings. Dual-enrolled children under one year of age, and those with qualifying diagnoses of anemia, hemophilia, asthma, epilepsy, and juvenile diabetes displayed especially high rates of ED use. Significant geographic variation in ED use remained after controlling for qualifying diagnoses, race/ethnicity, and other factors. African Americans displayed higher rates of ED utilization than non-Hispanic whites. Supplemental Security Income (SSI) recipients demonstrated higher utilization than other groups.

Conclusions. Children dually enrolled in CSHCS and Medicaid face diverse challenges of both poverty and chronic illness. Differences in patterns of use highlight the importance, but also the difficulty, of developing systems of care to manage complex chronic conditions in low-income populations.

Key Words. Emergency department, Medicaid, chronic illness, children with special health care needs, Title V

In 1998 children under 15 years of age made more than 22 million visits to emergency departments (EDs) (McCaig 2000). Children's patterns of ED use have important implications for public policy, clinical practice, and the well-being of children and their families. Inappropriate ED use may produce needless expenditure or may reflect cost-ineffective patient care. Emergency department utilization for emergent but preventable conditions may also

reflect access barriers to primary care. Such patterns may also reflect poor medical management of chronic conditions. In contrast, overly stringent efforts to discourage ED use may lead to improper handling of an emergent condition. Underutilization may produce adverse health outcomes or may ultimately produce needless expenditure due to delayed provision of appropriate care.

This constellation of issues has spawned a large literature on ED use in the general pediatric population. In recent years, much research has focused on the implications of managed care and different types of insurance on ED use (Butler 1998; Chande, Krug, and Warm 1996; Gadomski et al. 1995; Holl et al. 2000; Hodge 1999). Other pediatric research examines characteristics of children who are frequent ED users or who visit the ED as their usual source of care (Bond, Stearns, and Peters 1999; Halfon et al. 1996; Wilson and Klein 2000; Yamamoto et al. 1995; Zimmerman et al. 1996).

However, little research has been published regarding the causes and correlates of ED use among children with chronic or complex health conditions, also referred to as children with special health care needs. This population includes as many as 18 percent of U.S. children younger than 18—depending on the definition used—and may be growing (Newacheck et al. 1998).

Research on ED use within the general pediatric population may not be applicable to the unique circumstances of chronically or severely ill children. Care for children with special health care needs is often expensive and complex, and children with special health care needs often have frequent contact with health care delivery systems (Neff and Anderson 1995;

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Newacheck et al. 1998). Although some recent studies have described ED use by children with asthma (Halfon and Newacheck 1993; Lozano et al. 1997; Miller 2000; Price et al. 1999; Szilagyi et al. 2000), children with other chronic illnesses may experience quite different utilization and cost trends (Neff and Anderson 1995). A study by Reynolds et al. (1996) did describe variation in ED utilization by children with chronic conditions, but the study was conducted at a single pediatric ED over a brief period and did not examine the possible correlates of the variation observed.

Children with special health care needs are disproportionately poor and socially disadvantaged (Newacheck et al. 1998). On the other hand, children with acute or chronic conditions often have access to public assistance not available to other children. Most notably, child enrollment in Supplemental Security Income (SSI) has sharply increased in recent years (Garrett and Glied 2000; Perrin et al. 1999). Children eligible for SSI are generally provided with Medicaid coverage. Children with disabilities also receive non-Medicaid services based on Title V of the Social Security Act.

Previous research indicates that publicly insured children are more likely than uninsured or privately insured children to visit the ED (Chande, Krug, and Warm 1996; Halfon et al. 1996; McCormick et al. 2000; Shatin et al. 1998). No study has yet examined health services use by chronically ill children across the realm of public assistance programs. This research gap is increasingly important, as a growing number of states seek to improve access and to manage care and costs by moving Medicaid-enrolled children with special health care needs into capitated health plans (U.S. General Accounting Office 2000).

This paper provides a preliminary analysis of one important population of chronically ill children, those dually enrolled in Michigan's Medicaid and Title V programs for children with special health care needs. It provides the first detailed analysis of ED use within a dual-enrolled population of low-income children who have chronic health needs. It also provides a detailed analysis of how qualifying diagnosis, age, gender, race/ethnicity, Medicaid eligibility, and geography jointly influence ED use.

DATA AND METHODOLOGY

Program Description

Michigan's Title V program for children with special health needs, referred to as Children's Special Health Care Services (CSHCS), serves eligible children

from birth to age 21. The program also serves some older individuals who have cystic fibrosis or blood disorders such as hemophilia. Because more than 99 percent of our study subjects were younger than 21, we refer to them as children unless otherwise noted.

Eligibility for CSHCS is based on Michigan residency and qualifying diagnosis. Factors considered include the type, severity, and chronicity of medical condition, and the need for pediatric specialty care. Some prevalent disorders, such as autism, dyslexia, emotional and learning disorders, and mental retardation are not qualifying diagnoses. Type 2 diabetes is beyond the present scope of the CSHCS program.

The CSHCS program provides a wide range of specialty care and community support services related to qualifying diagnosis. Enrollees may also have Medicaid, MICHild (Michigan's CHIP program), or private insurance. Children's Special Health Care Services is the payer of last resort, which reimburses important services uncovered by other public and private plans.

Administrative Database

This study is based upon a 100 percent sample of paid claims from the Michigan Medicaid and CSHCS programs during the period January 1, 1998, to June 30, 1999. Based upon historical analyses of Medicaid and CSHCS claims, state program staff estimate a completion factor of more than 98 percent for available claims. Program enrollment and demographic characteristics were obtained from state CSHCS eligibility data, which were linked with claims data by encrypted ID numbers.

Although implementation of the CSHCS managed care alternative began during our study period, the preponderance of study subjects received coverage through the fee-for-service (known as the Basic Health Plan) service delivery option. Voluntary managed care enrollment, which began in September 1998, accounted for less than one percent of person-months over the period of the current study.

Study Population

The focus of our study is an economically disadvantaged subset of children enrolled in the CSHCS program—those also enrolled in Medicaid. To have the most complete claims data possible for dual-enrolled children, we focused on children who had no health insurance coverage other than Medicaid and CSHCS.¹ As discussed below, we performed sensitivity analysis to examine the impact of excluding children with other sources of insurance coverage. We

constructed two analysis files: one at the person-month level and one that aggregated person-months to the person level. In the person-month sample, we included only person-months of dual Medicaid and CSHCS enrollment and excluded person-months in which the subject had other health insurance coverage in addition to Medicaid and CSHCS. The resulting person-month sample consisted of 136,096 person-months of dual Medicaid/CSHCS enrollment and no other insurance.

To construct the person-level sample, we allowed for the possibility that some characteristics may change for a given person over time. Enrollment in Medicaid or CSHCS, the presence of other health insurance coverage, primary qualifying diagnosis, and some demographic characteristics may change due to changing health status, changing family composition and financial circumstances, administrative churning, and other factors. In addition, program enrollment dynamics are not yet well understood and could be related to ED utilization. To assess whether changes in enrollment affected ED use, we flagged individuals with discontinuous enrollment or intermittent coverage by other health insurance. Inclusion of this term had a small impact on our results.

We included individuals in the person-level sample if they were dually enrolled *for at least one month* and had no private coverage *in any month* during the study period. The resulting person-level sample consisted of 10,800 dual-enrolled individuals. Ninety-two percent of these individuals were continuously enrolled in both programs, with the remainder having some intermittent periods of enrollment. Person-months in which the individual was not dually enrolled were not included in our analyses.

Definition of ED Visits

Emergency department services for dual-enrollees were identified based upon procedure and revenue codes reported on administrative claims for professional and technical services during the study period. A claim was considered to be an ED visit based upon unique date of service for professional services coded with Current Procedural Terminology (CPT) codes 99281 through 99285.

In some instances, professional services claims were apparently not submitted, and only facilities charges were found for a given occasion of service. In these cases, an individual was considered to have had an ED visit if a claim with an identified ED revenue code was found for facility charges on a unique date of service and a corresponding professional services claim was not

found. All instances where a given patient had multiple professional or technical service claims for the same date of service were identified, and duplicate claims were eliminated from the analysis dataset.

Several study subjects were observed to have obtained ED services from more than one hospital or physician on a single date. These situations were believed to reflect the same episode of care, and were considered to be a single visit for the purposes of this study. In total, 6,277 unique ED visits were identified for our study population in person-months for which dual-enrolled study subjects had no other insurance coverage.

Independent Variables

The independent variables for our analyses are gender, age, race/ethnicity, Medicaid eligibility category, county of residence, and primary qualifying diagnosis. Medicaid eligibility category refers to seven categories of public assistance programs that form the basis of recipients' Medicaid eligibility. Two of these categories (SSI and TANF) refer to cash assistance programs that confer Medicaid eligibility. In addition, the Low Income Family (LIF) program provides Medicaid to families with low income. Healthy Kids is the main Medicaid program for children under 19. Medicaid for the Disabled is for disabled persons who do not otherwise qualify for SSI. Medicaid for Persons Under 21 and Medicaid for Caretaker Relatives both provide coverage to low-income recipients who do not otherwise qualify for cash assistance.

County of residence was included as a separate dummy variable whenever a county's dual-enrolled population accounted for at least two percent of the total dual-enrolled study sample. Remaining counties were grouped in the "Other" category.

Qualifying diagnosis is defined in CSHCS eligibility data by ICD-9-CM code.² For individuals with multiple diagnoses, the primary qualifying diagnosis is used for analysis. We grouped these codes into 14 diagnostic categories for detailed analysis. These diagnoses were chosen based on historic CSHCS expenditure and enrollment trends, as well as on the clinical judgment of the study team. See the appendix for definitions of the diagnostic categories.

Statistical Methodology

We employ two statistical approaches, using the PC-SAS software package version 6.12 (DiIorio 1991). Our first approach, Poisson regression, provides

an aggregate analysis of ED utilization for each individual over the entire period of dual enrollment and seeks to predict the rate of ED use based upon individual characteristics (Cameron and Trevidi 1998; Pollack et al. 2002). In particular, if individual j is observed for T_j periods of available data, we assume that the probability of M visits to an ED during that period is given by

$$P_{M,j} = \frac{(\lambda_j T_j)^M}{M!} \exp[-\lambda_j T_j] \quad (1)$$

Here λ_j is the arrival rate for ED visits and is presumed to be a function of some vector X_j of personal characteristics. X_j includes race/ethnicity, gender, primary qualifying diagnosis, and county of residence. Program exposure T_j is the number of months that individual j is observed as being dual-enrolled without other health insurance coverage.

We assume that λ_j takes the form

$$\lambda_j = \exp[X_j \beta] \quad (2)$$

Here β is a set of coefficients estimated from the available data. Given this specification, estimated coefficients are most interpretable when converted to the incidence rate ratio, $IRR = \exp[\beta]$. For each explanatory variable, the IRR represents the proportional change in the rate of ED use associated with a one-unit change in the independent variable. For example, we find below that African Americans have an IRR of 1.22 when compared with the default category of non-Hispanic whites. This implies that African Americans have a 22 percent higher rate of ED use within a given person-month.

One shortcoming of Poisson regression is that it predicts narrow variance in the rate of ED use. This assumption does not bias the coefficients, but it can produce overly tight standard errors. Because actual ED use reflects unobserved differences in health status, family characteristics, and preferences that vary widely across patients, observed utilization often displays higher variance than the Poisson model allows. We adjust our standard errors empirically for this overdispersion. In particular, if the estimated ED arrival rate is λ , the corresponding variance is posited to be $\phi\lambda$. These adjustments do not alter our coefficients, but they do increase associated standard errors. We use the *SAS* GENMOD procedure to calculate all coefficients and standard errors.

Our second analytical approach was to perform a time-varying hazard analysis using a multivariate logistic regression analysis. The dependent variable is the probability of an ED visit in a given person-month, taking into account any changes in an individual's enrollment status and related

characteristics. Because the mean number of monthly ED visits is small, logistic regression closely approximates a proportional hazard model (Abbott 1985). In particular, for individual j in the k^{th} month, we create a dummy variable $v_{j,k}$ which is set to 1 if that individual made at least one ED visit in the given month, and is set to zero otherwise. We then estimate the logistic regression model

$$\Pr[v_{j,k} = 1] = \frac{\exp[\gamma X_{j,k}]}{1 + \exp[\gamma X_{j,k}]} \quad (3)$$

Individual preferences, family circumstances, and other factors suggest that there will be correlations in the error term over time for the same person. We therefore estimate equation (3) within a Generalized Equation Estimation (G.E.E.) framework. We again use the GENMOD procedure to compute coefficients and standard errors. We use an exchangeable within-group correlation matrix in our G.E.E. analysis.

Because we seek to examine a single medical encounter that occurs on a specific day rather than an aggregate measure covering the entire period of dual enrollment, we can also provide more precise examination of time-varying factors such as the presence of other insurance and enrollment in public assistance programs. We therefore use person-month eligibility data to compute appropriate values for enrollment and demographic characteristics during the month in which ED services were received.

Additional Analyses

The impact of specific diagnoses may vary by age, race, Medicaid eligibility category, and other factors. We therefore explored several interactive specifications to examine the magnitude of such effects. In general, we had little information a priori concerning which interaction effects might be most important. We therefore explored interaction effects by estimating the main person-year G.E.E. model within different population subgroups. Because this approach produces a very large set of point estimates, we summarize the main results. A full set of parameter estimates is available from the authors.

RESULTS

Descriptive Results

Table 1 shows descriptive statistics for dual-enrolled children without other health insurance. Fifty-five percent were male. Under one percent ($n = 43$)

Table 1: Descriptive Statistics for Dual Medicaid/CSHCS Enrollees without Other Insurance

January 1998–June 1999										
	Persons*		Person Months [†]		ED Visits [‡]					
	No.	%	No.	%	No.	%	Rate	SD	CV	
Total	10,800	100	136,096	100	6,277	100	0.55	1.63	2.80	
Demographic Characteristic										
Gender										
Male	5,937	55.0	74,841	55.0	3,513	56.0	0.56	1.64	2.77	
Female	4,863	45.0	61,255	45.0	2,764	44.0	0.54	1.61	2.84	
Age										
Under 1 year	1,596	14.8	9,820	7.2	1,332	21.2	1.63	1.86	2.23	
1 to 4 years	2,810	26.0	36,709	27.0	1,871	29.8	0.61	1.65	2.48	
5 to 9 years	2,829	26.2	39,235	28.8	1,330	21.2	0.41	1.43	3.04	
10 to 14 years	2,014	18.6	28,112	20.7	894	14.2	0.38	1.49	3.35	
15 to 20 years	1,508	14.0	21,554	15.8	828	13.2	0.46	1.81	3.30	
21 years and older	43	0.4	666	0.5	22	0.4	0.40	1.05	2.06	
Race/Ethnicity										
White	5,586	51.7	71,244	52.3	2,595	41.3	0.44	1.32	2.84	
Black	3,321	30.8	39,635	29.1	2,514	40.1	0.76	2.06	2.73	
Hispanic	387	3.6	4,648	3.4	235	3.7	0.61	1.20	2.41	
Other	315	2.9	4,267	3.1	157	2.5	0.44	1.63	2.51	
Unknown	1,191	11.0	16,302	12.0	776	12.4	0.57	1.53	2.53	
Medicaid Eligibility Category [§]										
SSI	4,660	43.1	71,649	52.6	3,282	52.3	0.55	1.90	2.70	
TANF	1,815	16.8	15,589	11.5	1,179	18.8	0.91	1.68	2.58	
Healthy Kids	2,518	23.3	26,368	19.4	974	15.5	0.44	1.14	2.95	
Medicaid for Persons under 21	782	7.2	10,131	7.4	393	6.3	0.47	1.50	2.99	
Medicaid for the Disabled	344	3.2	4,729	3.5	159	2.5	0.40	1.32	2.86	
Medicaid for Caretaker Relatives	674	6.2	7,587	5.6	283	4.5	0.45	1.07	2.54	
Other Eligibility	7	0.1	43	0.0	7	0.1	1.95	2.24	2.24	
County of Residence										
Berrien	251	2.3	3,165	2.3	93	1.5	0.35	1.19	3.22	
Calhoun	225	2.1	2,685	2.0	110	1.8	0.49	1.26	2.59	
Genesee	573	5.3	6,956	5.1	345	5.5	0.60	1.37	2.28	
Ingham	371	3.4	4,871	3.6	232	3.7	0.57	1.55	2.48	
Jackson	196	1.8	2,610	1.9	115	1.8	0.53	1.57	2.68	
Kalamazoo	244	2.3	3,064	2.3	148	2.4	0.58	2.65	4.36	
Kent	533	4.9	6,809	5.0	312	5.0	0.55	1.52	2.59	
Macomb	375	3.5	4,633	3.4	236	3.8	0.61	2.12	3.37	
Muskegon	192	1.8	2,653	1.9	117	1.9	0.53	1.75	2.88	
Oakland	516	4.8	6,520	4.8	251	4.0	0.46	1.42	2.93	
Saginaw	393	3.6	4,894	3.6	273	4.3	0.67	1.58	2.28	

continued

Table 1. *Continued*

January 1998–June 1999										
	Persons*		Person Months [†]		ED Visits [‡]					
	No.	%	No.	%	No.	%	Rate	SD	CV	
St. Clair	185	1.7	2,497	1.8	89	1.4	0.43	1.79	3.72	
Wayne	3,356	31.1	39,637	29.1	2,443	38.9	0.74	1.92	2.64	
Other Counties	3,390	31.4	45,102	33.1	1,513	24.1	0.40	1.23	2.75	
Selected Diagnoses										
Anemias	445	4.1	5,406	4.0	515	8.2	1.14	2.79	2.41	
Asthma	401	3.7	4,671	3.4	243	3.9	0.62	1.42	2.35	
Cerebral Palsy	1,535	14.2	22,377	16.4	865	13.8	0.46	1.41	2.51	
Cleft Palate and Lip	506	4.7	6,750	5.0	196	3.1	0.35	1.09	2.81	
Congenital Heart Anomalies	372	3.4	4,633	3.4	225	3.6	0.58	1.42	2.35	
Cystic Fibrosis	142	1.3	1,978	1.5	83	1.3	0.50	1.25	2.14	
Diseases of the Ear and Mastoid Process	1,347	12.5	16,536	12.2	370	5.9	0.27	0.83	3.02	
Epilepsy	367	3.4	4,652	3.4	277	4.4	0.71	1.67	2.21	
Hemophilia	113	1.0	1,666	1.2	148	2.4	1.07	4.35	3.32	
Juvenile Diabetes	430	4.0	4,953	3.6	294	4.7	0.71	1.73	2.53	
Leukemia	120	1.1	1,588	1.2	67	1.1	0.51	1.31	2.35	
Malignant Neoplasms	194	1.8	2,430	1.8	66	1.1	0.33	1.00	2.94	
Congenital Anomalies, NEC [¶]	959	8.9	11,964	8.8	515	8.2	0.52	1.50	2.80	
Respiratory Distress Syndrome	287	2.7	2,483	1.8	236	3.8	1.14	1.58	1.92	
Spina Bifida	250	2.3	3,858	2.8	181	2.9	0.56	1.46	2.02	
All Other Diagnoses**	3,332	30.9	40,151	29.5	1,996	31.8	0.60	1.75	2.91	
Infectious and Parasitic Diseases	34	0.3	515	0.4	14	0.2	0.33	1.08	2.61	
Neoplasms	144	1.3	1,701	1.2	67	1.1	0.47	1.31	2.82	
Endocrine Diseases	517	4.8	6,334	4.7	197	3.1	0.37	1.44	3.77	
Diseases of the Blood	18	0.2	272	0.2	4	0.1	0.18	0.73	3.29	
Mental Disorders	6	0.1	80	0.1	4	0.1	0.60	1.63	2.45	
Diseases of the Nervous System	629	5.8	8,293	6.1	403	6.4	0.58	2.07	3.23	
Diseases of the Circulatory System	125	1.2	1,517	1.1	110	1.8	0.87	2.76	3.13	
Diseases of the Respiratory System	9	0.1	139	0.1	4	0.1	0.35	0.73	1.63	
Diseases of the Digestive System	84	0.8	1,064	0.8	56	0.9	0.63	1.77	2.66	
Diseases of the Genitourinary System	197	1.8	2,403	1.8	116	1.8	0.58	1.80	3.05	
Diseases of the Skin and Subcutaneous Tissue	7	0.1	112	0.1	1	0.0	0.11	0.38	2.65	

continued

Table 1. *Continued*

	January 1998–June 1999									
	Persons*		Person Months [†]		ED Visits [‡]					
	No.	%	No.	%	No.	%	Rate	SD	CV	
Diseases of Musculoskeletal System	220	2.0	2,696	2.0	61	1.0	0.27	0.82	2.97	
Other Specific Congenital Anomalies	524	4.9	6,562	4.8	398	6.3	0.73	1.73	2.28	
Certain Perinatal Conditions	402	3.7	4,204	3.1	323	5.1	0.92	1.91	2.38	
Symptoms and Ill-Defined Conditions	154	1.4	1,533	1.1	117	1.9	0.92	1.64	2.16	
Injury and Poisoning	262	2.4	2,726	2.0	121	1.9	0.53	1.46	3.16	

*Children dually enrolled in CSHCS and Medicaid, with no other insurance, during the period January 1998–June 1999.

†Person months in which children were dually enrolled in CSHCS and Medicaid, with no other insurance, during the period January 1998–June 1999.

‡Rate = visits per year (visit in person-month $\times$ 12 months/total person months), SD = standard deviation, CV = coefficient of variation (mean/SD).

§Based on program codes for public assistance program eligibility.

||Based on ICD-9-CM code for primary qualifying diagnosis in CSHCS eligibility data.

*NEC = not elsewhere classified; other specific congenital anomalies (e.g., limb deformities) are included below under “All Other Diagnoses.”

**Based on broad ICD-9-CM diagnostic category; excludes selected diagnoses listed above. Mental Disorders includes only Tourette’s disorder. Symptoms and Ill-Defined Conditions includes only Respiratory Abnormalities NEC. Other Specific Congenital Anomalies includes circulatory system anomalies, congenital hydrocephalus, and various limb deformities.

were over 21 years old. Fifty-two percent of children were listed as white, 31 percent were African American, and 4 percent were Hispanic/Latino. About one-third of study children lived in Wayne County, which includes Detroit.

Cerebral palsy (CP) was the most prevalent qualifying diagnosis, accounting for 16 percent of person-months, followed by diseases of the ear and mastoid process, which accounted for 12 percent. The 15 diagnoses selected for in-depth study accounted for approximately 70 percent of the study population.

Twenty-four percent of the study population visited the ED at least once between January 1998 and June 1999, for a total of 6,277 visits. Just under half of these children had one ED visit, while slightly less than two percent had more than 10 ED visits, with a maximum of 39 visits. The mean rate of ED use, shown in Table 1, was adjusted for duration of program enrollment so that it can be interpreted per person per year.

As illustrated in Table 1, rates of ED use varied substantially across the sample. Emergency department utilization differed substantially by age, with infants (those younger than one year) having about three times the rate of ED use as other age categories. African American and Hispanic/Latino children displayed higher rates of ED use than did non-Hispanic whites. Rates also differed by qualifying diagnosis, with anemia, hemophilia, and respiratory distress syndrome associated with sharply elevated use. Receipt of SSI and TANF were associated with higher ED use than were other categories. Emergency department use among the seven children included in the "Other Eligibility" category was also very high. Two urban counties (Wayne and Saginaw) demonstrated the highest rate of ED use. The relative variation in ED use, indicated by the coefficient of variation (CV) in ED use (see far right column) was remarkably similar for most of the subgroups.

Regression Results

Table 2 shows the estimated incidence rate ratios from both Poisson and G.E.E. regressions. Gender was not a statistically or clinically significant predictor of ED use. In contrast, age was a critical factor even after adjusting for qualifying diagnosis and for other factors. In both models, infants had far higher rates of ED utilization than did older age groups.

African Americans and Hispanics displayed higher utilization than did non-Hispanic whites, though this difference was statistically significant only for African Americans. Unadjusted, observed African American utilization was nearly 50 percent higher than was found among non-Hispanic whites. Adjusting for other covariates, African Americans were predicted to have more than 20 percent higher utilization. In part, differences were reduced because African Americans are overrepresented in diagnostic categories associated with high ED use. African Americans accounted for almost 80 percent of anemias, due to the prevalence of sickle-cell disorders within this population.

We also found statistically significant differences in ED use across Medicaid eligibility categories. In both the Poisson and G.E.E. specifications, SSI recipients displayed higher rates of ED use than did other Medicaid eligibility categories. The small "Other Eligibility" category was also associated with increased use.

The large (relatively low-utilization) diagnosis "diseases of the ear and mastoid process" is the reference category in our statistical regressions. The qualifying diagnoses of anemias, asthma, epilepsy, hemophilia, or juvenile diabetes were associated with higher ED use.³ The qualifying diagnoses of cleft

Table 2: Emergency Department Utilization Regression Results

<i>Parameter</i>	<i>Poisson Regression</i> [†]			<i>G.E.E Regression</i> [‡]		
	<i>95% Confidence Limit</i>			<i>95% Confidence Limit</i>		
	<i>IRR</i>	<i>Lower</i>	<i>Upper</i>	<i>IRR</i>	<i>Lower</i>	<i>Upper</i>
Gender						
Male	1.000	1.000	1.000	1.000	1.000	1.000
Female	1.009	0.942	1.080	1.000	0.915	1.094
Age						
Under 1 year	1.000	1.000	1.000	1.000	1.000	1.000
1 to 4 years	0.505	0.449	0.568***	0.769	0.663	0.891***
5 to 9 years	0.325	0.285	0.372***	0.479	0.404	0.569***
10 to 14 years	0.314	0.271	0.363***	0.415	0.344	0.502***
15 to 20 years	0.423	0.363	0.493***	0.566	0.466	0.688***
21 years and older	0.190	0.100	0.361***	0.404	0.215	0.756**
Race/Ethnicity						
White	1.000	1.000	1.000	1.000	1.000	1.000
Black	1.219	1.108	1.342***	1.260	1.106	1.435***
Hispanic	1.178	0.980	1.417	1.210	0.951	1.540
American Indian	0.924	0.570	1.496	0.985	0.543	1.788
Other	0.955	0.747	1.220	0.908	0.677	1.217
Unknown	1.012	0.901	1.138	0.960	0.826	1.116
Medicaid Eligibility Category [§]						
SSI	1.000	1.000	1.000	1.000	1.000	1.000
TANF	0.702	0.632	0.780***	0.755	0.660	0.865***
Healthy Kids	0.620	0.555	0.693***	0.723	0.642	0.814***
Medicaid for Persons	0.753	0.652	0.871***	0.788	0.665	0.933
Under 21						
Medicaid for the Disabled	0.803	0.646	0.998*	0.835	0.694	1.005
Medicaid for Caretaker	0.605	0.509	0.718***	0.685	0.578	0.812***
Relatives						
Other Eligibility	5.373	1.839	15.693**	3.241	0.831	12.644
County of Residence						
Wayne	1.000	1.000	1.000	1.000	1.000	1.000
Berrien	0.579	0.437	0.769***	0.551	0.383	0.791**
Calhoun	0.872	0.671	1.134	0.814	0.589	1.124
Genesee	0.955	0.817	1.117	0.957	0.784	1.168
Ingham	0.943	0.781	1.138	0.886	0.685	1.147
Jackson	1.047	0.808	1.357	1.025	0.736	1.428
Kalamazoo	0.914	0.727	1.148	0.836	0.587	1.193
Kent	0.989	0.838	1.167	0.886	0.713	1.100
Macomb	1.110	0.918	1.342	0.807	0.602	1.083
Muskegon	1.006	0.779	1.298	0.823	0.601	1.127
Oakland	0.862	0.718	1.034	0.777	0.615	0.982*
Saginaw	1.044	0.878	1.241	1.053	0.845	1.311
St. Clair	0.837	0.624	1.124	0.746	0.486	1.144

continued

Table 2. *Continued*

<i>Parameter</i>	<i>Poisson Regression</i> [†]			<i>G.E.E Regression</i> [‡]		
	<i>95% Confidence Limit</i>			<i>95% Confidence Limit</i>		
	<i>IRR</i>	<i>Lower</i>	<i>Upper</i>	<i>IRR</i>	<i>Lower</i>	<i>Upper</i>
Other Counties	0.800	0.719	0.891***	0.782	0.681	0.899***
Selected Diagnoses						
Diseases of the Ear and Mastoid Process	1.000	1.000	1.000	1.000	1.000	1.000
Anemias	3.105	2.575	3.744***	2.557	2.004	3.263***
Asthma	2.503	2.006	3.125***	2.276	1.759	2.944***
Cerebral Palsy	1.551	1.312	1.834***	1.466	1.216	1.768***
Cleft Lip or Palate	1.117	0.879	1.418	1.084	0.834	1.411
Cystic Fibrosis	1.926	1.387	2.674***	1.687	1.164	2.446**
Congenital Heart Anomalies	1.463	1.159	1.848**	1.484	1.126	1.956**
Epilepsy	2.492	2.015	3.081***	2.163	1.655	2.827***
Hemophilia	4.222	3.229	5.522***	2.569	1.579	4.179***
Juvenile Diabetes	3.058	2.473	3.780***	2.809	2.170	3.638***
Leukemia	1.879	1.319	2.677***	2.097	1.357	3.239***
Malignant Neoplasms	1.178	0.825	1.682	1.256	0.846	1.867
Other Congenital Anomalies, NEC*	1.545	1.284	1.861***	1.500	1.207	1.863***
Respiratory Distress Syndrome	1.637	1.283	2.089***	1.632	1.180	2.256**
Spina Bifida	1.703	1.335	2.171***	1.605	1.209	2.131**
All Other Diagnoses ^{††}						
Infectious and Parasitic Diseases	1.018	0.492	2.103	1.206	0.531	2.738
Neoplasms	1.777	1.247	2.532**	1.654	1.021	2.680*
Endocrine Diseases	1.256	0.992	1.591	1.203	0.910	1.589
Diseases of the Blood	0.736	0.193	2.805	0.787	0.139	4.453
Mental Disorders	2.206	0.578	8.419	2.444	0.341	17.547
Diseases of the Nervous System	1.947	1.605	2.362***	1.570	1.231	2.003***
Diseases of the Circulatory System	2.574	1.921	3.449***	2.145	1.334	3.450**
Diseases of the Respiratory System	1.045	0.274	3.993	0.990	0.398	2.464
Diseases of the Digestive System	2.400	1.636	3.519***	2.094	1.199	3.660**
Diseases of the Genitourinary System	1.993	1.498	2.652***	1.690	1.182	2.415**
Diseases of the Skin and Subcutaneous Tissue	0.644	0.045	9.252	0.362	0.053	2.492
Diseases of Musculoskeletal System	1.037	0.717	1.500	1.093	0.712	1.678

continued

Table 2. *Continued*

<i>Parameter</i>	<i>Poisson Regression[†]</i>			<i>G.E.E Regression[‡]</i>		
	<i>95% Confidence Limit</i>			<i>95% Confidence Limit</i>		
	<i>IRR</i>	<i>Lower</i>	<i>Upper</i>	<i>IRR</i>	<i>Lower</i>	<i>Upper</i>
Other Specific Congenital Anomalies	2.013	1.654	2.450***	2.004	1.568	2.560***
Certain Perinatal Conditions	1.820	1.461	2.267***	1.847	1.407	2.425***
Symptoms and Ill-Defined Conditions	1.940	1.446	2.602***	2.108	1.464	3.035***
Injury and Poisoning	1.692	1.278	2.240***	1.418	0.991	2.029

Levels of significance:

* < 0.05;

** < 0.01;

*** < 0.001

[†]Based on 10,800 children enrolled in both CSHCS and Medicaid, with no other insurance, from January 1998 to June 1999.

[‡]Based on 136,096 person months in which children were dually enrolled in CSHCS and Medicaid, with no other insurance, from January 1998 to June 1999.

[§]Based on program codes for public assistance program eligibility.

^{||}Based on ICD-9-CM code for primary qualifying diagnosis in CSHCS eligibility data.

^{*}NEC = not elsewhere classified; other specific congenital anomalies (e.g., limb deformities) included below under "All Other Diagnoses."

^{††}Based on broad ICD-9-CM diagnostic category; excludes selected diagnoses listed above. Mental Disorders includes only Tourette's disorder. Symptoms and Ill-Defined Conditions includes only Respiratory Abnormalities NEC. Other Specific Congenital Anomalies includes circulatory system anomalies, congenital hydrocephalus, and various limb deformities.

lip or palate and malignant neoplasms exhibited low ED use similar to the ear and mastoid category. Patterns were similar using the G.E.E. regression.

We also performed sensitivity analysis in which we included person-months when dual-enrollees had other insurance. Other insurance was associated with sharply lower ED use. We also found larger county and race/ethnicity effects when we included these person-months. Excluding observations with other coverage may therefore somewhat understate the role of sociodemographic factors correlated with private coverage.

Interaction Analyses

Although we estimated many interactive models, we found age by diagnosis, age by Medicaid-eligibility category, race by age, and seasonality by diagnosis to be the most important. Detailed results are available from the authors.

Age by Diagnosis. Because age and qualifying diagnosis were such critical factors, we investigated whether age-patterns of ED use differed across diagnostic categories. For example, among dual-enrollees between one and four years of age, leukemia, and respiratory distress syndrome were associated with especially high utilization when compared with the reference ear and mastoid diagnosis. Point estimates for children with leukemia, and respiratory distress syndrome between the ages of five and nine years were much smaller.

In contrast, hemophilia, asthma, and anemias were associated with heightened ED use among children between the ages of ten and fourteen. For several qualifying diagnoses, we observed virtually no ED visits among children older than fourteen. For other diagnoses, including cystic fibrosis, juvenile diabetes, hemophilia, and epilepsy, ED use was greatest among children aged fourteen and older.

Medicaid Eligibility Category and Age. We also observed differences between SSI and TANF recipients that increased with child age. Among one-to four-year-olds, TANF recipients had an incidence rate ratio of 0.76 when compared with SSI recipients. Among children ages five to nine, the IRR associated with TANF declined to 0.46 and remained below 0.50 in older age groups.

Seasonality by Diagnosis. Because ED use may reflect seasonal differences in children's susceptibility to illness, we included season in the regression analysis. We found slightly higher ED use during the spring (March, April, and May) than in other seasons. Analysis of interactions between season and respiratory diagnoses (asthma, cystic fibrosis, and respiratory distress syndrome) yielded statistical significance only for respiratory distress syndrome. Emergency department visits were highest during winter and lowest during spring. The IRR for spring compared to winter is 0.58.

Interactions by Race. Different patterns in utilization by race/ethnicity are of special concern to both policymakers and researchers. We therefore paid special attention to differences between African Americans and whites in our data. We estimated our Poisson regression models separately for the two groups. We also estimated pooled specifications (not shown) in which we examined specific interactions such as different age-patterns of utilization between the two groups.

Table 3 shows the result of our subgroup regressions. Although the coefficients were significantly different between the two groups ($p < .001$), utilization patterns were similar across county of residence, programmatic categories, qualifying diagnoses, and age. Within our most prevalent diagnoses, the African American sample yielded notably larger point

Table 3: Emergency Department Utilization: Subgroup Regression Results

	<i>Poisson Regression</i> [†]					
	<i>African American</i>			<i>White</i>		
	<i>IRR</i>	<i>Lower</i>	<i>Upper</i>	<i>IRR</i>	<i>Lower</i>	<i>Upper</i>
Gender						
Female	1.000	1.000	1.000	1.000	1.000	1.000
Male	1.007	0.895	1.133	1.000	0.914	1.094
Age						
Infant	1.000	1.000	1.000	1.000	1.000	1.000
1 to 4 years	0.493	0.409	0.594***	0.701	0.609	0.807***
5 to 9 years	0.348	0.283	0.428***	0.397	0.338	0.467***
10 to 15 years	0.365	0.295	0.452***	0.431	0.370	0.503***
15 to 20 years	0.670	0.533	0.842***	0.461	0.388	0.546***
21 years and older	0.170	0.039	0.751*	0.238	0.114	0.496***
Medicaid Eligibility Category [§]						
SSI	1.000	1.000	1.000	1.000	1.000	1.000
TANF	0.669	0.571	0.785***	0.860	0.739	1.000*
Healthy Kids	0.612	0.486	0.771***	0.672	0.594	0.759***
Medicaid for Persons Under 21	0.752	0.607	0.934**	0.692	0.567	0.845***
Medicaid for the Disabled	0.793	0.529	1.188	0.995	0.786	1.258
Medicaid for Caretaker Relatives	0.596	0.444	0.801***	0.758	0.620	0.926**
Other Eligibility	2.653	0.147	47.746	10.873	3.482	33.954***
County of Residence						
Wayne	1.000	1.000	1.000	1.000	1.000	1.000
Berrien	0.608	0.400	0.923*	0.486	0.314	0.753***
Calhoun	0.809	0.495	1.324	0.858	0.607	1.215
Genesee	0.924	0.710	1.203	1.041	0.826	1.312
Ingham	0.766	0.512	1.147	1.263	0.980	1.628
Jackson	1.582	0.901	2.781	1.085	0.799	1.473
Kalamazoo	0.982	0.683	1.413	1.183	0.877	1.596
Kent	0.798	0.569	1.119	1.250	0.998	1.567
Macomb	1.908	1.314	2.770***	1.025	0.806	1.303
Muskegon	1.089	0.704	1.685	0.852	0.593	1.223
Oakland	0.815	0.568	1.170	0.998	0.789	1.261
Saginaw	0.893	0.654	1.218	1.203	0.928	1.560
St. Clair	0.391	0.092	1.657	1.051	0.782	1.413
Other Counties	0.602	0.409	0.885**	0.888	0.762	1.034
Selected Diagnoses						
Diseases of the Ear and Mastoid Process	1.000	1.000	1.000	1.000	1.000	1.000
Anemias	3.518	2.540	4.873***	2.647	1.473	4.755**
Asthma	3.553	2.410	5.239***	1.688	1.260	2.261***
Cerebral Palsy	1.863	1.334	2.602***	1.309	1.076	1.592**
Cleft Lip or Palate	0.912	0.507	1.639	1.005	0.778	1.299
Cystic Fibrosis	2.757	1.238	6.135*	1.386	0.968	1.983

continued

Table 3. *Continued*

	<i>Poisson Regression</i> [†]					
	<i>African American</i>			<i>White</i>		
	<i>IRR</i>	<i>Lower</i>	<i>Upper</i>	<i>IRR</i>	<i>Lower</i>	<i>Upper</i>
Congenital Heart Anomalies	1.784	1.108	2.870*	1.036	0.773	1.388***
Hemophilia	6.445	4.180	9.937***	2.386	1.605	3.548***
Juvenile Diabetes	3.583	2.430	5.283***	2.660	2.077	3.407***
Leukemia	2.545	1.172	5.528*	1.804	1.226	2.655**
Malignant Neoplasms	1.544	0.811	2.940	0.816	0.509	1.308
Other Congenital Anomalies, NEC*	1.629	1.110	2.391*	1.290	1.043	1.595*
Respiratory Distress Syndrome	2.245	1.486	3.392***	1.824	1.317	2.528***
Spina Bifida	1.245	0.711	2.181	1.773	1.353	2.322***
All Other Diagnoses ^{††}						
Infectious and Parasitic Diseases		No cases		0.822	0.338	1.999
Neoplasms	1.252	0.535	2.929	1.681	1.155	2.446**
Endocrine Diseases	2.092	1.378	3.175***	0.859	0.630	1.172
Diseases of the Blood		No cases		1.054	0.328	3.384
Mental Disorders		No cases		2.420	0.751	7.794
Diseases of the Nervous System	3.184	2.187	4.635***	1.339	1.062	1.688*
Diseases of the Circulatory System	5.907	3.789	9.211***	1.261	0.795	2.000
Diseases of the Respiratory System	0.705	0.039	12.692	0.457	0.045	4.644
Diseases of the Digestive System	4.081	2.195	7.587***	1.580	0.976	2.557
Diseases of the Genitourinary System	1.682	0.929	3.047	2.458	1.790	3.374***
Diseases of the Skin and Subcutaneous Tissue		No cases		0.458	0.045	4.652
Diseases of Musculoskeletal System	0.903	0.445	1.829	1.393	0.939	2.066
Other Specific Congenital Anomalies	3.052	2.119	4.396***	1.570	1.235	1.996***
Certain Perinatal Conditions	2.788	1.893	4.109***	1.563	1.182	2.067**
Symptoms and Ill-Defined Conditions	2.746	1.642	4.592***	1.520	1.027	2.249*
Injury and Poisoning	2.111	1.329	3.352***	1.618	1.110	2.357*

Levels of significance:

* < 0.05;

** < 0.01;

*** < 0.001.

[†]Based on 10,800 children enrolled in both CSHCS and Medicaid, with no other insurance, from January 1998 to June 1999.[§]Based on program codes for public assistance program eligibility.^{||}Based on ICD-9-CM code for primary qualifying diagnosis in CSHCS eligibility data.^{*}NEC = not elsewhere classified; other specific congenital anomalies (e.g., limb deformities) included below under "All Other Diagnoses."^{††}Based on broad ICD-9-CM diagnostic category; excludes selected diagnoses listed above. Mental Disorders includes only Tourette's disorder. Symptoms and Ill-Defined Conditions includes only Respiratory Abnormalities NEC. Other Specific Congenital Anomalies includes circulatory system anomalies, congenital hydrocephalus, and various limb deformities.

estimates of incidence rate ratio for asthma, anemias, and hemophilia. Differences in ED use between SSI and TANF recipients were slightly higher in the African American than in the white group, though these differences were not statistically significant.

In our pooled, interaction specification, we examined black–white differences in age and qualifying diagnoses. We found that black–white differences in ED utilization increased significantly with age. Among one- to four-year-olds, controlling for other factors, the estimated IRR for African Americans was statistically insignificant. The IRR for African Americans steadily increased with age, and exceeded 1.35 among children aged 15 and above. (Differences were concentrated in the group aged 15–20. Results were not significantly within the small group of individuals age 21 and older.)

We then estimated diagnosis-specific interactions to examine how black–white differences varied across diagnoses. Racial differences were significant in only two of these categories. Compared with non-Hispanic whites with the same qualifying diagnoses, African Americans showed significantly higher ED use for nervous system disorders (IRR = 1.73) and endocrine disorders (IRR = 2.54). African Americans showed notably lower rates of ED use for neoplasms (IRR = 0.57), though the latter finding was not statistically significant.

SUMMARY AND DISCUSSION

This paper provides detailed descriptive analyses of ED use within an important population of children—those challenged both by poverty and by complex illness. Our analyses were not designed to explore whether observed use of the ED was medically or economically appropriate. We do not examine the intensity or specific services performed in the ED. Thus, our results should not be interpreted as indicating overuse or underuse of ED services within any population. Rather, we hope that our findings illuminate key sources of variation in ED use within this important population.

Infants exhibited rates of ED use (1.63 visits per person-year) more than twice as high as those of any other age group. No prior study has permitted such detailed comparisons among children of different ages, whether among children with special health needs or among children in general. Studies that have examined children's ED use by age have shown substantial differences between infants and older children. A recent national estimate of ED use among the general population of children under 15 years was 0.37 visits per

person-year (McCaig 2000), and a separate analysis of infants alone found an overall rate of 0.94 ED visits per person-year (Sharma et al. 2000).

The high rate of ED use for infants is consistent with clinical practice. In general, infants have more limited physiologic reserve than older children and are susceptible to more rapid deterioration of their health status in the setting of acute illness. Infants under three months of age, in particular, are more susceptible than older children to severe systemic infection because of their immature immune system. Moreover, infants cannot articulate their complaints and may therefore require more extensive effort to diagnose than older children (McCarthy 2000). As a result, the accepted standard of care sets a low threshold for prompt laboratory evaluation (e.g., tests of blood, urine, and cerebrospinal fluid) for infants who may be acutely ill (Baraff et al. 1993). Emergency departments may be better equipped for such evaluations than many primary care settings.

Children with diagnoses of hemophilia, juvenile diabetes, anemias, asthma, and epilepsy, use the ED especially frequently. These diagnoses are often susceptible to acute, potentially life-threatening exacerbations that require emergent evaluation and treatment. Children with hemophilia may develop severe bleeding, while diabetic children are at risk for dangerously uncontrolled blood glucose levels. As expected, children with conditions typically remediable through elective surgery—for example, cleft lip or palate, or diseases of the ear and mastoid process—had lower-than-average rates of ED use. Because some conditions make children especially susceptible to acute illness or urgent medical needs, expectations for appropriate ED use must be sensitive to specific diagnoses.

Emergency department use also varies among children with the same qualifying diagnosis. We suspect that such within-diagnosis variation reflects underlying heterogeneity in illness complexity and severity. For instance, some children with hemophilia develop resistance to available treatment modalities (Gill 1999).

Variation in ED use may also reflect other access barriers to primary care, including the absence of a “medical home,” or varying continuity of primary care services (Halfon et al. 1996; Christakis et al. 1999; Jones et al. 1999; Wilson and Klein 2000). Adjusting for diagnoses and other factors, African Americans had roughly 20 percent higher ED use. Further, unadjusted for potential confounders, African Americans have roughly 50 percent higher ED use than non-Hispanic whites. These patterns are consistent with the possibility that diagnoses prevalent among African Americans are undertreated in the primary care setting.

We also examined interaction effects. The effects of qualifying diagnosis on ED use depended in part on child age and seasonality. These patterns matched clinically plausible accounts. Children with respiratory distress syndrome were significantly more likely to visit the ED in winter; this is likely because of the higher incidence of upper respiratory tract infections during fall and winter months (Herendeen and Szilagyi 2000). We did not observe seasonal effects for such respiratory conditions as asthma and cystic fibrosis. In certain conditions, exposure to airborne irritants or the adequacy of maintenance therapy may be more important in precipitating acute illness. These factors may not exhibit the same seasonality as do upper respiratory infections.

We did not examine whether ED visits led to hospital admission, or attempt to identify evidence of an outpatient medical home. We are now analyzing diverse measures of resource consumption to explore these questions in greater detail. Such analyses may suggest principles of clinical management that help develop standards for medical and nonmedical service delivery in the ED, inpatient, and outpatient settings.

Our analyses also revealed significant differences in ED use across public programs. Recipients of SSI used the ED significantly more often than did recipients of TANF or children who were Medicaid-eligible for other reasons. These effects were greatest among older children. Children eligible for SSI may be more easily identified later in childhood. Higher ED use among SSI recipients may also reflect the fact that SSI is the predominant form of eligibility defined by medical, as well as monetary, need. By design, SSI-eligible children meet stringent disability criteria, while other Medicaid-eligible children experience a wider range of illness severity. The SSI eligibility process, therefore, may select children with greater disability—and perhaps greater need for ED resources—than is found within the broader population of children with special needs.

Differences in ED use by SSI status increase with age. These results may suggest that health differences between SSI and TANF recipients increase over childhood. Alternatively, chronically ill children may sort into SSI as their medical situation becomes sufficiently well understood and well documented to justify SSI coverage.

We observed significant geographic variation in children's ED use, although the effect was smaller than for children's age, diagnosis, and Medicaid eligibility category. Controlling for age, gender, race/ethnicity, qualifying diagnosis, and Medicaid eligibility status, children who reside in Michigan's largest urban area, Wayne County, used the ED significantly more

often than did children in many other, more rural areas. Other research has found that childhood ED use is higher in rural rather than urban areas (McCaig 2000; Sharma et al. 2000). Our findings may reflect the increased availability of specific pediatric emergency services in metropolitan areas suited to children with complex medical illness. They may also reflect a more expansive role of primary care providers in rural areas to coordinate outpatient care or to otherwise avoid the need for emergency services. Understanding the underlying determinants of geographic variations in ED use among children with special health needs is an important area for future research.

Our results must be interpreted in light of two main limitations. First, because the data used to conduct these analyses were constructed from CSHCS and Medicaid claims, we were forced to exclude dual-enrolled children with other insurance coverage over the study period. The inability to track ED use among these children underscores the importance of obtaining comprehensive claims data from both public and private sources to provide a complete account of ED use in this population. Understanding the dynamics of service use for children with multiple sources of insurance coverage is an especially complex issue for the development of capitation rates and managed care arrangements for children with special needs.

Second, dual-enrolled children are a self-selected population. An unknown population of Michigan children may have qualifying conditions (and may otherwise be eligible for Title V services) yet are not CSHCS-enrolled. Some of the children may be covered by S-CHIP, standard Medicaid, or private insurance. Our paper is pertinent to policy choices within the enrolled population. Further investigation is required before generalizing to nonenrolled populations.

CONCLUSIONS

Much existing research examines the role of inadequate coverage, poverty, lack of a medical home, and family and psychosocial factors in explaining children's use of the ED (Apter et al. 1997; Bond, Stearns, and Peters 1999; Butler 1998; Chande, Krug, and Warm 1996; Christakis et al. 1999; Halfon et al. 1996; Jones et al. 1999; Wilson and Klein 2000; Ziv, Boulet, and Slap 1998). These factors may be less applicable to dual-enrolled children, who have insurance coverage and may make frequent contact with providers in many settings.

The present analysis highlights an obvious clinical fact, but one easily overlooked in policy analysis of ED use. Children's age and underlying medical condition are associated with remarkably different levels of ED use. Although race, location, and other demographic variables matter, illness complexity and severity are the most important sources of variation in ED use among children with special health needs. For this reason, clinical and policy interventions designed to promote appropriate ED use must not only address important sociodemographic disparities and adverse incentives, but must also acknowledge the central clinical challenge raised by chronically ill populations: how to appropriately manage a complex and persistent medical condition over time.

The need to understand variations in children's health services use—and the related need to understand how such variation is influenced by health policy and service delivery—is particularly acute as states enroll children with special needs into managed care. Efforts to establish capitated rates that reflect the mix and intensity of required services raise particularly difficult challenges in this population. The diverse circumstances of dual-enrolled children underscore the importance, but also the difficulty, of these public management and research tasks.

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NOTES

1. At any time, approximately 20 percent of dual-enrolled children have private insurance, often through a parent's employer. If insurers offer generous ED coverage, privately insured children may use the ED without generating a Medicaid or CSHCS claim. State claims data may therefore be incomplete.
2. International Classification of Diseases, 9th Revision, Clinical Modification disease coding system.
3. We found similar effects for the six children listed with Tourette's syndrome. Tourette's syndrome is no longer a qualifying condition for CSHCS.

APPENDIX

ICD-9-CM Codes Associated with Diagnostic Categories

<i>Diagnostic Category</i>	<i>ICD-9-CM Codes*</i>
Anemias	2811, 2820-4, 2826-7, 284, 2850
Asthma	49311, 49390
Cerebral Palsy	3337, 3421, 343, 3440-5, 3448-9
Cleft Palate and Lip	749
Congenital Heart Anomalies	7450, 7452-6, 746 ($\times 74687$)
Cystic Fibrosis	2770
Diseases of the Ear and Mastoid Process	38032, 38050-3, 3811-3, 38160, 38181, 3821-3, 3831, 38322, 38330-2, 38389, 3841, 3849, 3850-1, 38521, 38530, 38582, 38589, 3859, 3864, 3868, 38800, 38843-4, 3885, 38861, 3888-9, 38901-3, 3891-2
Epilepsy	3451-7
Hemophilia	2860-4, 2866-9
Juvenile Diabetes	25001, 25011, 25021, 25031, 25041, 25051, 25061, 25071, 25081, 25091
Leukemia	204-6, 2072, 2078, 208
Malignant Neoplasms	140 ($\times 1408$), 141-9, 150-2, 153 ($\times 1535$), 154-9, 160-5, 170-5, 179, 180-9, 190-9
Other Congenital Anomalies	2579, 7430, 74310, 74312, 7432-5, 74361-3, 74366, 74369, 7438-9, 7440, 7442, 74441, 74481, 74484, 74489, 7449, 7480, 7482-9, 75010, 75013, 75021, 75026, 75029, 7503-4, 7511-3, 75161, 7518, 75210, 75240-1, 7525-9, 7530-2, 7535, 7537-9, 7540-2, 75481, 75489, 7550-1, 7560, 75610-3, 75615-9, 7564-7, 75681, 75689, 7569, 7570, 7572, 75731, 75733, 7578, 7594-7, 7598 ($\times 75983$)
Respiratory Distress Syndrome	769
Spina Bifida	741
All Other Diagnoses	
Infectious and Parasitic Diseases (001-139)	042, 0785, 0903, 0907, 0993, 11509, 11519, 135, 1370-3, 138-9
Neoplasms (140-239)	200-3, 2120-2, 2150, 2156-7, 2159, 2239, 2240-1, 2245-6, 2248-9, 225, 2270-1, 2273-4, 22802-04, 22809, 2281, 2337, 237 ($\times 2375-6$), 2385-6, 2388-9, 2397-9
Endocrine, Nutritional, and Metabolic Diseases, and Immunity Disorders (240-279)	242-3, 2449, 2461, 2520-1, 2530-5, 2538-9, 2550-4, 2556, 258, 2592-9, 262, 2630, 2632-9, 2681, 2698-9, 270-1, 2720-5, 2727-9, 2751, 2753, 2754 ($\times 27548$), 2771-3, 2775-9, 2788, 2790, 2799
Diseases of the Blood and Blood-Forming Organs (280-289)	2831, 2873, 2879, 2880-1
Mental Disorders (290-319)	30490, 30723
Diseases of the Nervous System and Sense Organs (320-389)	3209, 3222, 3229, 3239, 326, 330 ($\times 3309$), 3310-1, 3313-4, 3317, 33189, 3319, 3330, 3332, 3334, 3336,

continued

APPENDIX. *Continued*

<i>Diagnostic Category</i>	<i>ICD-9-CM Codes*</i>
	33382, 33389, 33390, 33399, 3340, 3348, 335 (×33523), 336, 340-1, 342 (×3421, 3428), 3480-1, 3484, 3488-9, 3491-2, 34981, 34989, 3499, 3508-9, 351, 352 (×3521), 3530, 3536, 3560-1, 3563, 3570-3, 3580, 3588-9, 3590-3, 36003, 36011, 36013, 36032, 36034, 3609, 3610, 36111v2, 3612, 3618-9, 36212-8, 36221, 36229, 36230-3, 36235-6, 36240, 36242-3, 36252-3, 3626 (×36264), 3627, 36281, 36283-4, 3630-2, 3634-9, 36411, 36422, 36424, 36442, 3645, 36460, 3647-9, 365 (×3560), 3660 (×36604), 3662-3, 36644-6, 3665, 3668-9, 36752, 37002-7, 37050, 3706, 37100, 37102-4, 37110-3, 37115-6, 3713, 3714 (×37143), 3715-7, 3718 (×37182), 3719, 37451, 3771, 37721, 37723, 37733, 3774-7, 3779, 3780-1, 37821-2, 37824, 3783, 37841, 3785, 3786 (×37861), 37871-2, 37883-7, 3789, 37904, 37911, 37916, 37919, 37923, 3793 (×37931), 37951
Diseases of the Circulatory System (390-459)	390, 391 (×3912), 392-6, 3970-1, 4011, 4021, 4029, 4031, 4039, 40410, 40413, 4049, 4051, 4059, 4109, 4140, 41411, 4148-9, 4150, 4160, 417, 4210, 4219, 42290-1, 42299, 423 (×4230), 4240-3, 42490, 4250-1, 4253-4, 4257-9, 4260-1, 4264-9, 4270, 42731-2, 428, 4290-1, 4293, 4295-6, 42981, 42989, 4299, 430-1, 4320-1, 4340-1, 4359, 436, 4373, 438 (×43853), 4420-8, 4439, 44489, 4449, 4460-1, 4463-7, 4475-6, 4480, 4533, 4571
Diseases of the Respiratory System (460-519)	47830-4, 4784, 4841, 4928, 494, 510, 5131, 515, 5163, 5168, 5172, 5181-2, 5185
Diseases of the Digestive System (520-579)	5200, 5204-5, 5218, 5240-2, 5244-6, 5248-9, 5303, 555-6, 5570, 5589, 5714-6, 5723, 5768, 579
Diseases of the Genitourinary System (580-629)	5810, 5812-3, 58189, 5819, 582, 583 (×5838), 5845-9, 585-6, 5880-8, 5900, 591, 5934-5, 5937, 59381, 5960, 5969
Diseases of the Skin and Subcutaneous Tissue (680-709)	6944, 6951-2, 6954, 6960-1, 7092
Diseases of the Musculoskeletal System and Connective Tissue (710-739)	7100-1, 7103-4, 7108-9, 71103, 71190, 713, 7140-2, 71430, 71432-3, 7144, 7149, 7150, 71598-9, 71610, 71800, 71820, 71823-4, 71828-9, 71830, 71838, 7184-5, 71860, 71880, 71884, 7198-9, 7200, 7209, 7210, 7212-3, 7215-6, 7218, 72190, 7220-7, 7229, 7230, 7239, 7240, 72702, 72781, 72810-1, 7282-3, 7286, 72889, 7301, 7307, 7320-7, 7329, 73320, 7334, 73382, 7360, 7363-4, 7366-9, 7370-1, 73720-2, 73734, 73739, 7374, 7378-9, 7380, 7386, 7388-9

continued

APPENDIX. *Continued*

<i>Diagnostic Category</i>	<i>ICD-9-CM Codes*</i>
Congenital Anomalies (740–759)	7420, 7422–9, 7451, 7457–9, 7470–3, 74741–9, 7476, 7478, 7543, 75441, 75450–1, 75459, 75460, 75462, 75469, 7547, 7552–5, 75560, 75739, 7599
Certain Conditions	765, 7674–7, 7685, 7707–8, 7710–2, 7718, 7744, 7752, 7756–7, 7762, 7775
Originating in the Perinatal Period (760–779)	
Symptoms, Signs, and Ill-Defined Conditions (780–799)	7824, 7843, 7845, 7849, 78609, 7958, 7980
Injury and Poisoning (800–999)	806, 85104, 8520, 8522, 8524, 885–6, 8870, 8872, 8874, 8876, 896, 8970, 8972, 8974, 8976, 9050–2, 9054, 9056, 9059, 9060–1, 9063–9, 907, 9080–1, 9083–4, 9086, 9089, 9090–4, 9099, 940, 94109, 9413–5, 94209, 9423–5, 94309, 9433–5, 94408, 9443–5, 94509, 9453–5, 9460, 9463–5, 947, 94811, 94821–2, 94831–3, 94841–4, 94851–5, 94861–6, 94871–7, 94881–8, 94891–9, 9490, 9492–5, 952, 956, 9586, 9661, 9832, 984, 9895, 9948, 9950, 9956, 9966 (×99660), 99668, 99681, 9970, 9975, 99760, 9989

*Most ICD-9 codes included the Michigan CSHCS program are specified at the four- or five-digit level; however, to simplify reporting in this table, three-digit codes are used if all four- and five-digit codes underneath it apply. Ranges do not necessarily imply a sequential list of codes, but rather than all valid codes within that range are included. Codes in parentheses proceeded by an “×” are excluded from the definition of that diagnostic category.

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