Published in final edited form as:

Pediatrics. 2009 September ; 124(3): 926–934. doi:10.1542/peds.2008-3826.

Hospitalization Subsequent to Diagnosis in Young Patients With Diabetes in Chicago, Illinois

Carmela L. Estrada, MPH^a, Kirstie K. Danielson, PhD^a, Melinda L. Drum, PhD^b, and Rebecca B. Lipton, PhD^{a,b}

^a Institute for Endocrine Discovery and Clinical Care, University of Chicago, Chicago, Illinois

^b Department of Health Studies, University of Chicago, Chicago, Illinois

Abstract

OBJECTIVES—Rehospitalization after a diabetes diagnosis in youth signals the failure of outpatient management. We examined risk factors for rehospitalization among young patients with diabetes.

PATIENTS AND METHODS—We queried 535 participants diagnosed before 18 years of age from the Chicago Childhood Diabetes Registry. Demographic, social, and clinical data were used in logistic models of diabetes-related rehospitalization, as well as, among those rehospitalized, frequent ($\geq$ once per 2 years' duration) versus infrequent rehospitalization rates.

RESULTS—Mean (range) duration was 5.1 years (0.1–19.2 years). The sample was 55% non-Hispanic black, 11% non-Hispanic white, 26% Hispanic, and 7% other/mixed race; 86% had presumed type 1 diabetes; and 47% were underinsured. Overall, 46% reported rehospitalization for diabetes. In multivariable logistic regression, ever being rehospitalized was significantly associated with diabetes duration (per year, odds ratio [OR]: 1.26; $P < .01$), female gender (OR: 1.67; $P = .01$), underinsurance (versus private insurance; OR: 1.79; $P < .01$), presumed phenotype (non-type 1 diabetes versus type 1; OR: 0.32; $P < .01$), and diagnosis at a community hospital (versus tertiary care facility; OR: 1.96; $P < .01$) and tended to be higher for those of nonwhite race (OR: 1.94; $P = .07$). Among those rehospitalized, multivariable associations with frequent rehospitalization were presumed phenotype (non-type 1 diabetes versus type 1; OR: 2.74; $P = .04$), head of house hold not working (versus employed; OR: 1.88; $P = .02$), and younger age at questionnaire (per year; OR: 0.94; $P = .01$).

CONCLUSIONS—Rehospitalization is common in young patients with diabetes, especially for those with limited resources, indicating the need for improved outpatient services. Comprehensive initial education and support available to young patients with diabetes diagnosed at tertiary care facilities and their families may have lasting protective effects.

Keywords

hospitalization; diabetes; children; adolescents

In the United States, diabetes affects 2 to 3 of every 1000 young people, making it the second most common chronic disease of childhood and adolescence,¹ and the incidence is rising.² Specifically in Chicago, IL, the incidence of diabetes in individuals <18 years of age

Address correspondence to Carmela L. Estrada, MPH, Resurrection Health Care, 5747 West Dempster St, Morton Grove, IL 60053. cestrada@reshealthcare.org.

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

increased 2.7% per annum between 1994 and 2003.³ Clearly this implies the potential for major increases in the public health care burden of diabetes in youth unless short- and long-term complications of the disease are prevented. Previous research has shown that improved metabolic control decreases long-term complications, such as neuropathy, retinopathy, and nephropathy,^{4,5} as well as acute complications, such as ketoacidosis and severe hypoglycemia.⁶ When acute complications occur, rehospitalization is often necessary, signaling a failure in outpatient diabetes management. Theoretically, comprehensive outpatient treatment should lower health care costs related to preventable complications and long-term disability for youth with diabetes.

A systematic review of 32 publications on hospital admission patterns found that patients with type 1 diabetes are 3 times more likely to be hospitalized than nondiabetic populations.⁷ Although standards of diabetes care in youth have improved since the Diabetes Control and Complications Trial,⁴ rates of rehospitalization have not followed the same trend. Examination of temporal trends in 2 cohorts of patients with type 1 diabetes, 4 and 9 years after the Diabetes Control and Complications Trial, revealed that glycemic control and frequency of emergency department visits had significantly improved but inpatient admissions had not.⁸ A study using the Nationwide Inpatient Sample found that diabetes-related hospitalizations increased 38% between 1993 and 2004 in people <30 years old in the United States; however, this study could not differentiate between hospitalization at diagnosis and diabetes-related rehospitalizations.⁹

If rehospitalization is a sentinel event indicating inadequate outpatient diabetes management, then examining risk factors for rehospitalization may help address deficiencies in diabetes care for youth. We showed previously¹⁰ that rehospitalization is associated with female gender, diabetes duration, diagnosis at a community hospital, and lower socioeconomic status in the Chicago Childhood Diabetes Registry (CCDR); others reported similar associations.^{11–16} Additional risk factors implicated include older age,^{9,12,13,16} psychiatric conditions,^{6,17} hypertension,¹⁸ and higher insulin dose.⁶ The expansion of the CCDR database since our report in 2002 offers an opportunity to evaluate risk factors for rehospitalization in an ethnically diverse group of young patients, including individuals with both type 1 and non-type 1 diabetes. We further explored correlates for frequent rehospitalization.

PATIENTS AND METHODS

Study Sample

The CCDR is a citywide registry of Chicago residents diagnosed with diabetes before age 18 years ($N = 2451$) between 1985 and 2006.¹⁹ The primary source of case subjects was retrospective review of onset hospital records; secondary sources included American Diabetes Association camp lists, clinics, and the Illinois Department of Public Aid. Completeness of ascertainment was ~85% through 2003. By May 2007, we had contacted 581 people from the registry, of whom 535 (22% of the CCDR) responded to an interviewer-administered questionnaire about their diabetes experience. These individuals were traced and interviewed a mean 5.1 years (range: 0.1–19.2 years) after diagnosis. Those queried were similar to those who were not able to be interviewed ($n = 1916$) with respect to gender ($P = .60$) and race/ethnicity ($P = .20$), but they were younger at diabetes diagnosis (mean $\pm$ SD age: 9.4 ± 4.3 years [range: 0.5–17.9 years] vs 11.4 ± 4.4 years [range: 0.6–17.9 years]; $P < .01$). Adjusted for age at diagnosis, participants and nonparticipants did not differ in insurance status ($P = .12$) or type of hospital at diagnosis ($P = .19$). Participants and nonparticipants were also similar in presumed diabetes phenotype at onset ($P = .10$) on the basis of reported comorbidities (ie, acanthosis nigricans or polycystic ovarian syndrome),

obesity indicated by BMI at >95th age- and gender-specific percentile, or physician notes referring to atypical or type 2 phenotype.

CCDR Questionnaire

Trained research staff administered questionnaires according to a standardized protocol. The institutional review boards at the University of Chicago and other participating institutions citywide approved the study. Written informed consent from participants age ≥ 18 years of age and parents of children <18 years of age was obtained; children aged 12 to 18 years gave written assent. Approximately 27% of questionnaires were administered directly to the person with diabetes, 68% to a parent/guardian, and 5% to other relatives or caregivers. Demographics, social characteristics, diabetes management practices, health care resources, and rehospitalization information were collected, primarily by telephone (89%).

Dependent Variables

Rehospitalization was defined as an inpatient hospital admission because of diabetes after the time of initial diagnosis. Rehospitalization rate was calculated by dividing rehospitalization frequency by diabetes duration. On the basis of the median rate of 0.47 times rehospitalized per year of diabetes, rehospitalization was dichotomized into ≥ 1 rehospitalization per 2 years' diabetes duration (frequent) or less (infrequent). Reasons for rehospitalization were limited to 3 categories: low blood sugar (hypoglycemia or insulin reactions), high blood sugar (hyperglycemia, diabetic coma, or ketoacidosis), or other diabetes-related condition (secondary to another illness or insulin pump malfunction).

Independent Variables

Data on risk factors were obtained from the CCDR Questionnaire or medical charts. Race/ethnicity was defined as the common race/ethnicity of ≥ 3 grandparents; if <3 grandparents were from a common race/ethnic group, race/ethnicity was categorized as mixed. If race/ethnicity data were available for <3 grandparents, data from parents or from the participant alone were used. Race/ethnicity was categorized as non-Hispanic white (NHW), non-Hispanic black (NHB), Hispanic, or other/mixed. Private insurance consisted of any health management organization, preferred provider organization, or fee-for-service plan not affiliated with Medicaid or Public Aid. Underinsurance was defined as lacking health insurance or receiving Medicaid or Public Aid, because access to subspecialty care is often limited for these patients. Information on head-of-household work status, educational attainment, and annual household income was also obtained.

Boys between ages 13 and 17 years and girls between 12 and 17 years at diagnosis were classified as pubertal. We classified individuals who responded that they were not exclusively on insulin and/or ceased insulin use for >1 week after the honeymoon period (≥ 2 years after diagnosis) without severe reaction (ie, ketoacidosis, seizure, or coma) as having non-type 1 diabetes phenotype. Those not meeting these criteria were presumed to have the type 1 diabetes phenotype. Local hospitals were categorized into 2 groups by their level of pediatric diabetes care. Tertiary care facilities ($n = 11$) included university hospitals, the large public hospital serving the indigent, and 3 hospitals with pediatric endocrinology units; all of the others were deemed community hospitals.

Statistical Analysis

Logistic regression was used to model the following rehospitalization outcomes: ever rehospitalized, high blood sugar rehospitalization, and low blood sugar rehospitalization (versus never rehospitalized). In those ever rehospitalized, logistic regression was used to model their hospitalization rate (more than or equal to once versus less than once per 2

years' diabetes duration). Each covariate was first modeled separately, with the ever, high blood sugar, and low blood sugar rehospitalization models adjusted for diabetes duration. Variables significant at the $P = .15$ level, adjusted for diabetes duration, were entered into multivariable models. Two exceptions were household income, available for only 83% of participants, and diabetes treatment, which was collinear with diabetes phenotype. In multivariable analysis, the 3 minority race/ethnicity groups were collapsed, because results comparing NHW subjects with the 3 groups were similar. Backward selection was used to generate parsimonious models. Interactions between covariates in multivariable models were tested, but none were significant. All of the statistical analyses were performed by using the SAS 9.1 logistic procedure (SAS Institute Inc, Cary, NC).

RESULTS

Sample Characteristics

There were 535 participants in this analysis with mean age of 14.4 years (range: 2.4–30.9 years) and mean diabetes duration of 5.1 years (range: 0.1–19.2 years). Male subjects composed 44.5% of the sample. Participants were racially/ethnically diverse, including 55.1% NHB, 11.4% NHW, 26.4% Hispanic, and 7.1% other/mixed. Regarding diabetes diagnosis, 26.1% of participants were diagnosed during puberty, and 64.9% were diagnosed at a tertiary care facility. At time of data collection, nearly half (47.4%) of the participants were underinsured, and 27.6% had household incomes less than \$15 000 per year. Most participants had presumed type 1 diabetes (86.0%) and treated their diabetes with insulin only (88.0%). Nearly all of the participants checked their blood sugar more than once daily (94.0%) and saw a health care provider in the past year (98.7%), and of those, 80% visited tertiary care facilities. Approximately 9.0% of individuals reported not getting medical attention when needed during the past year.

Rehospitalization

Overall, 246 participants (46%) reported a diabetes-related rehospitalization. Table 1 reports participant characteristics by rehospitalization status (ever versus never rehospitalized for any diabetes-related reason) and diabetes duration-adjusted logistic regression models. Each year of diabetes duration was associated with 26% higher odds of rehospitalization ($P < .01$). Female subjects were more likely to be rehospitalized (odds ratio [OR]: 1.61; $P = .01$). NHBs had significantly greater odds of rehospitalization compared with NHWs (OR: 2.70; $P = .03$). Lower socioeconomic position, whether measured by insurance status, head of household work status, head of household education, or household income, was significantly associated with higher odds of rehospitalization.

Odds of rehospitalization more than doubled for those diagnosed in the late 1980s and early 1990s compared with those diagnosed after 2000, controlling for duration. Patients with presumed non-type 1 diabetes were less likely to be rehospitalized than those with presumed type 1 diabetes (OR: 0.40; $P < .01$); those on treatment other than insulin monotherapy also had lower odds of rehospitalization (OR: 0.36; $P < .01$). Age of diabetes diagnosis, frequency of blood glucose monitoring, feet checks, and ophthalmologic examinations were not significantly associated with rehospitalization. Individuals who did not get medical attention when needed in the past year had a higher likelihood of rehospitalization (OR: 1.94; $P = .05$). Diabetes diagnosis at a community hospital was significantly associated with greater odds of rehospitalization (versus a tertiary care facility; OR: 1.86; $P < .01$), but the type of hospital that patients were currently using was not associated with greater odds of rehospitalization.

In multivariable analysis (Table 2), odds of being rehospitalized were significantly higher with longer diabetes duration (per year; OR: 1.26; $P < .01$), female gender (versus male; OR: 1.67; $P = .01$), underinsurance (versus private insurance; OR: 1.79; $P < .01$), and diabetes diagnosis at a community hospital (versus a tertiary care facility; OR: 1.96; $P < .01$) and tended to be higher for those of nonwhite race/ethnicity (versus NHW; OR: 1.94; $P = .07$). Rehospitalization was significantly less likely for those with presumed non-type 1 diabetes phenotype (versus presumed type 1; OR: 0.32; $P < .01$).

Of the 246 participants ever rehospitalized, 198 (80.5%) reported rehospitalization for high blood sugar, 93 (37.8%) for low blood sugar, and 10 (4.1%) for other diabetes-related reasons. The duration-adjusted ORs (data not shown) and multivariable results (Table 2) for high blood sugar rehospitalizations were similar to those for being ever rehospitalized, with a stronger effect of race/ethnicity in the multivariable model that reached statistical significance (nonwhite versus NHW; OR: 3.03; $P = .01$).

For low blood sugar rehospitalization, diabetes duration-adjusted ORs were also similar to those for being ever rehospitalized, except low blood sugar rehospitalization was not significantly associated with race/ethnicity or year and hospital of diagnosis (data not shown). We found additional diabetes duration-adjusted associations of low blood sugar rehospitalization with diagnosis during puberty (OR: 0.50; $P = .04$) and checking blood glucose less than or once daily (versus more than once per day; OR: 0.45; $P = .05$). The multivariable model for low blood sugar (Table 2) was similar to the ever-rehospitalized model, except associations with nonwhite race and diagnosis in a community hospital were not statistically significant. In alternative models (data not shown), other socioeconomic indicators replaced insurance status (head of household unemployed [versus employed; OR: 2.49; $P < .01$], head of household not completing high school [versus completed high school; OR: 2.19; $P = .01$], or not getting medical care when needed [versus getting medical care; OR: 3.03; $P = .03$]), and older age at diabetes diagnosis was associated with lower odds of low blood sugar rehospitalization (per year; OR: 0.93; $P < .01$).

Rate of Rehospitalization

In univariate analysis (Table 3), frequent rehospitalization (≥ 1 time per 2 years' diabetes duration) was significantly associated with underinsurance (versus private insurance; OR: 1.77; $P = .03$) and unemployed head of household (versus employed; OR: 1.74; $P = .04$). Diabetes diagnosis before 2000 was negatively associated with frequent rehospitalization (versus diagnosis after 2000; OR: 0.35–0.39; global $P = .04$), as was having an ophthalmologic examination in the past year (versus not having one; OR: 0.57; $P = .04$).

In multivariable analysis (Table 4), frequent rehospitalization was significantly associated with presumed non-type 1 diabetes phenotype (versus type 1; OR: 2.74; $P = .04$) and head of household being unemployed (versus employed; OR: 1.88; $P = .02$); as current age increased, the likelihood of frequent rehospitalization decreased by 6% per year ($P = .01$). In an alternative model (data not shown), low household income (less than \$15 000 vs at or more than \$50 000 per year; OR: 3.14; $P = .04$) replaced head-of-household work status as a socioeconomic predictor of frequent rehospitalization.

DISCUSSION

This analysis presented the unique opportunity to examine inpatient hospital readmission as a proxy for lapses in chronic care in a large, ethnically diverse sample, with the added capacity to examine the presumed phenotype as a risk factor for rehospitalization. In this cohort of >500 young people with diabetes, rehospitalization was common, with 46% reporting rehospitalization at least once. As expected, the risk of rehospitalization was

higher with longer disease duration, increasing by ~25% per year. Multivariable analysis showed female gender, underinsurance, type 1 diabetes phenotype, and diagnosis at a community hospital were associated with higher odds for rehospitalization, controlling for diabetes duration. Those diagnosed before 2000 were more likely to be rehospitalized, possibly because of the far-reaching changes in standards of care for young people with diabetes during the period of data collection. However, this relationship disappeared when controlling for other factors. In addition, the likelihood of rehospitalization for hyperglycemia was higher for those of non-white race/ethnicity.

Diabetes diagnosis at a community hospital was significantly associated with higher odds of rehospitalization. From a policy perspective, this observation suggests that the strong initial support and age-specific diabetes education provided at diagnosis in tertiary care facilities may have lasting protective effects. Research from the Pittsburgh Epidemiology of Diabetes Complications Study cohort found that patients with type 1 diabetes receiving diabetes care from a specialist (versus generalist) from diagnosis had a lower risk of developing overt nephropathy, neuropathy, and coronary artery disease over 10 years of follow-up.²⁰ Of note, in our study, the majority of participants (80%) received their past year's health care in a tertiary care environment, and past year's source of health care (ie, tertiary care facility versus community hospital) was not significantly associated with hospital readmission. Offering initial diabetes education in a comprehensive, pediatric-friendly setting to newly diagnosed young patients may be a strategy for reducing the ongoing public health burden of childhood diabetes.

A recurring outcome in our analysis is that poor socioeconomic status contributes greatly to the risk of rehospitalization. We found that those underinsured had ~80% greater odds of rehospitalization compared with those with private insurance. This is consistent with a study that found that children in the United States with public or no medical insurance had a 39% increased risk of hospitalization for diabetes.²¹ In our data set, other socioeconomic factors, such as head-of-household unemployment or low household income, were also associated with greater odds of rehospitalization, further confirming that those with limited socioeconomic resources are at risk, by virtue of less access to high-quality outpatient care. Moreover, compared with NHWs, nonwhite race/ethnicity doubled the odds of rehospitalization and tripled the odds of high blood sugar rehospitalization. In children and adolescents, nonwhite race has been implicated as a major predictor of glycemic control, independent of other risk factors, such as gender, insurance status, BMI, and frequency of outpatient clinic visits for both type 1²² and type 2 diabetes.²³ Literature on health care disparities generally supports the premise that racial/ethnic gaps result from unmeasured social factors even in situations of apparent equality in health care access or financial resources.²⁴

With the rising incidence of type 2 diabetes in youth,² it is important to examine diabetes phenotype as a risk factor for poor outpatient management. Although the majority of participants in this study were classified as having type 1 diabetes, 14% were presumed to have a non-type 1 phenotype. Interestingly, although these individuals were less likely to be ever rehospitalized, among those readmitted, those who had the non-type 1 phenotype were significantly more likely to be rehospitalized frequently, that is, at least once every 2 years. This may reflect higher rates of comorbidities^{25,26} or the difficulty of arriving at an appropriate long-term treatment regimen. Previous research on rehospitalization in young people with type 2 diabetes is sparse. The SEARCH for Diabetes in Youth Study found that those with type 2 diabetes have increased recent hospitalizations compared with those with type 1 diabetes.²⁷ In any case, young patients with diabetes with atypical clinical presentations may be particularly open to lapses in chronic disease management. Diabetes

self-management and physician education programs focusing on youth should be actively promoted in response to the rise in early onset type 2 diabetes.

There are limitations to this study based on its cross-sectional design and use of medical charts and self-reported data, which may be subject to reporting error and misclassification. The questionnaires were conducted for more than a decade, when deterioration of the health care safety net could have increased barriers to adequate diabetes care; however, the time period of diagnosis was considered a potential confounder in analyses and did not modify results. Recall bias may have occurred, especially in participants with longer diabetes duration, and self-reported information was not verified using medical charts. However, the dichotomized rate of rehospitalization, which we analyzed, is less subject to recall bias than the actual count. The database contained no objective clinical measures of glycemic control or diabetes phenotype, that is, hemoglobin A1c, C peptide, or islet antibody levels. Finally, although queried participants were similar to nonparticipants in terms of race/ethnicity and gender, there may be unaccounted differences that may have resulted in selection bias.

CONCLUSIONS

With almost half of the youth with diabetes in Chicago reporting rehospitalization, this analysis demonstrates an important shortfall in adequate out-patient management. Strong patient and physician education programs specifically for pediatric diabetes and improving patients' ability to recognize and appropriately respond to hypoglycemia and hyperglycemia may be useful. Improving outpatient diabetes care for vulnerable populations, such as women and girls, nonwhites, and those with limited socioeconomic resources, is imperative to address this significant public health concern.

WHAT'S KNOWN ON THIS SUBJECT:When acute complications of diabetes occur, rehospitalization is often necessary, signaling a failure in outpatient care. Previous studies have shown that, whereas standards of diabetes care have improved, rates of rehospitalization have not followed the same trend.

WHAT THIS STUDY ADDS:In a diverse group of >500 people diagnosed with diabetes in youth from Chicago, IL, 46% reported diabetes-related rehospitalization. Controlling for diabetes duration, the odds of rehospitalization increased with female gender, underinsurance, type 1 diabetes phenotype, and diagnosis at community hospitals.

Acknowledgments

This research was supported by National Institutes of Health grants R01-DK44752 and P60-DK20595. We acknowledge CCDDR participants and families, and Rose Briars, Wendy Brickman, Paula Butler, Andrew Cooper, Steve Duck, Shirley Goodman, Latrisha Hampton, Arthur Kohrman, Mary Kreiter, Maureen Mencarini, Aida Pourbovali, Lydia Rodriguez, Tracie Smith, Sarah Sobotka, Myrtis Sullivan, and Fuad Ziai.

ABBREVIATIONS

CCDR	Chicago Childhood Diabetes Registry
NHW	non-Hispanic white
NHB	non-Hispanic black
OR	odds ratio

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TABLE 1

Demographic, Social, and Diabetes Characteristics According to Rehospitalization Status and Diabetes Duration-Adjusted ORs for Ever-Rehospitalized Subjects ($N = 535$)

Characteristic	Never Rehospitalized	Ever Rehospitalized	OR (95% Confidence Interval) for Any Rehospitalization	P.
Demographics and social characteristics				
<i>n</i> (%)	289 (54.0)	246 (46.0)	—	—
Age at questionnaire, mean (SD), y^a	13.4 (5.2)	15.7 (5.5)	0.99 (0.95–1.04)	.72
Gender, <i>n</i> (%)				.01
Male	143 (49.5)	95 (38.6)	Reference	
Female	146 (50.2)	151 (61.4)	1.61 (1.11–2.33)	
Race/ethnicity, <i>n</i> (%)				.02
NHW	46 (15.9)	15 (6.1)	Reference	
NHB	139 (48.1)	156 (63.4)	2.70 (1.39–5.23)	
Hispanic	84 (29.1)	57 (23.2)	1.79 (0.88–3.64)	
Other/mixed	20 (6.9)	18 (7.3)	2.07 (0.83–5.18)	
Insurance status at questionnaire ($n = 527$), <i>n</i> (%) ^b				<.01
Private	169 (59.3)	108 (44.6)	Reference	
Underinsured	116 (40.7)	134 (55.4)	1.96 (1.34–2.86)	
Head of household work status ($n = 533$), <i>n</i> (%)				0.01
Working full or part time	212 (73.4)	151 (61.9)	Reference	
Other ^c	77 (26.6)	93 (38.1)	1.64 (1.11–2.44)	
Head of household education ($n = 517$), <i>n</i> (%)				.01
Completed high school	227 (80.2)	164 (70.1)	Reference	
Less than high school	56 (19.8)	70 (29.9)	1.77 (1.15–2.74)	
Household income ($N = 445$), <i>n</i> (%)				<.01
\$50 000 per year or more	77 (30.6)	26 (13.5)	Reference	
\$15 000 to \$49 999 per year	125 (49.6)	94 (48.7)	1.97 (1.14–3.41)	
Less than \$15 000 per year	50 (19.8)	73 (37.8)	3.60 (1.97–6.58)	
Diabetes characteristics				
Diabetes duration at questionnaire, mean (SD), y^d	3.9 (3.2)	6.5 (3.4)	1.26 (1.19–1.34)	<.01
Diabetes diagnosis age, mean (SD), y^e	9.4 (4.3)	9.2 (4.4)	0.99 (0.95–1.04)	.72
Diagnosed during puberty, <i>n</i> (%) ^f	78 (27.0)	62 (25.2)	1.18 (0.77–1.79)	.45
Year of diabetes diagnosis, <i>n</i> (%)				.06
1985–1989	28 (9.7)	75 (30.5)	2.64 (1.17–5.95)	
1990–1994	66 (22.8)	79 (32.1)	2.01 (1.13–3.57)	
1995–1999	68 (23.5)	50 (20.3)	1.39 (0.79–2.47)	
2000 or later	127 (43.9)	42 (17.1)	Reference	
Presumed diabetes phenotype, <i>n</i> (%)				<.01
Type 1	234 (81.0)	226 (91.9)	Reference	
Non-type 1	55 (19.0)	20 (8.1)	0.40 (0.23–0.72)	

Characteristic	Never Rehospitalized	Ever Rehospitalized	OR (95% Confidence Interval) for Any Rehospitalization	P.
Current diabetes treatment (<i>N</i> = 532), <i>n</i> (%)				<.01
Insulin monotherapy	237 (82.6)	231 (94.3)	Reference	
Other treatment			0.36 (0.19–0.70) ^g	
Pills only	28 (9.8)	5 (2.0)		
Both insulin and pills	11 (3.8)	6 (2.5)		
No medications	11 (3.8)	3 (1.2)		
Diabetes management, <i>n</i> (%)				
Checks blood sugar >1 time per day (<i>N</i> = 455) ^h	234 (83.6)	195 (81.3)	0.83 (0.50–1.36)	.45
Checks feet ≥1 time per day (<i>N</i> = 530)	148 (51.8)	135 (55.3)	1.01 (0.70–1.46)	.96
Ophthalmologic examination in past year (<i>N</i> = 512)	170 (64.4)	145 (61.7)	0.90 (0.61–1.32)	.59
Past year health services use, <i>n</i> (%)				
Saw a health care provider (<i>N</i> = 532)	282 (97.6)	243 (98.8)	3.39 (0.84–13.70)	.09
Of those who saw a health care provider, <i>n</i> (%) ⁱ				
Tertiary care facility	234 (83.0)	187 (77.0)	Reference	
Community hospital	48 (17.0)	56 (23.0)	1.09 (0.68–1.75)	.71
Did not get medical attention when needed	16 (5.6)	30 (12.2)	1.94 (0.99–3.77)	.05
Hospital of diabetes diagnosis (<i>N</i> = 515), <i>n</i> (%) ⁱ				<.01
Tertiary care facility	206 (72.5)	128 (55.4)	Reference	
Community hospital	78 (27.5)	103 (44.6)	1.86 (1.26–2.75)	

— indicates no data.

^aRange of data are 2.6 to 29.9 and 2.4 to 30.9 years for never rehospitalized and ever rehospitalized subjects, respectively.

^bPrivate insurance consisted of those who reported using any health management organization, preferred provider organization, or fee-for-service plan not affiliated with Medicaid or the Illinois Department of Public Aid. Underinsurance included those lacking health insurance and those receiving Medicaid or Public Aid.

^cOther work status included unemployed, student, homemaker, retired, or disabled.

^dRange of data are 0.1 to 17.9 and 0.3 to 19.2 years for never rehospitalized and ever rehospitalized subjects, respectively.

^eRange of data are 0.6 to 17.8 and 0.9 to 18.0 years for never rehospitalized and ever rehospitalized subjects, respectively.

^fPuberty was defined as aged 13 to 17 years for boys and aged 12 to 17 years for girls.

^gPills only, both insulin and pills, and no medications were combined into other treatment.

^h*n* = 455 of 468 on insulin monotherapy.

ⁱTertiary care facilities (*n* = 11) included facilities affiliated with a university, the large public hospital serving the medically indigent, and hospitals with pediatric endocrinology units. All of the other hospitals and clinics were deemed community hospitals.

TABLE 2
Multivariable Logistic Regression Models for Ever, High Blood Sugar, and Low Blood Sugar Rehospitalization

Variable	ORs (95% Confidence Interval) vs Never RH			
	Ever Rehospitalization (N = 508 [227 Case Subjects])	P	High Blood Sugar Rehospitalization (N = 463 [182 Case Subjects])	P
Duration of diabetes, per year	1.26 (1.18–1.35)	<.01	1.25 (1.17–1.35)	<.01
Gender				
Male	Reference	.01	Reference	.04
Female	1.67 (1.12–2.48)		1.56 (1.02–2.39)	
Race/ethnicity				
NHW	Reference	.07	Reference	.01
Nonwhite ^a	1.94 (0.96–3.92)		3.03 (1.27–7.26)	
Insurance status at questionnaire ^b				
Private	Reference	<.01	Reference	<.01
Underinsured	1.79 (1.20–2.67)		1.85 (1.20–2.85)	
Presumed diabetes phenotype				
Type 1	Reference	<.01	Reference	<.01
Non-type 1	0.32 (0.17–0.59)		0.28 (0.14–0.56)	
Hospital of diabetes diagnosis ^c				
Tertiary care facility	Reference	<.01	Reference	<.01
Community hospital	1.96 (1.30–2.97)		2.42 (1.56–3.75)	
Low Blood Sugar Rehospitalization (N = 369 [88 Case Subjects])				
			1.26 (1.16–1.36)	<.01
			Reference	.02
			1.90 (1.10–3.27)	
			Reference	.37
			1.50 (0.62–3.64)	
			Reference	.03
			1.79 (1.04–3.27)	
			Reference	<.01
			0.15 (0.05–0.48)	
			Reference	.28
			1.37 (0.77–2.44)	

The number of case subjects in each multivariable regression model are lower than the overall number because of missing data on covariates. Other variables initially entered into models included head of household work status, head of household education, year of diabetes diagnosis, saw a health care provider in past year, and did not get medical attention when needed in past year.

^aNonwhite race/ethnicity includes NHB, Hispanic, and other/mixed.

^bPrivate insurance consisted of those who reported using any health management organization, preferred provider organization, or fee-for-service plan not affiliated with Medicaid or the Illinois Department of Public Aid. Underinsurance included those lacking health insurance and those receiving Medicaid or Public Aid.

^cTertiary care facilities (n = 11) included facilities affiliated with a university, the large public hospital serving the medically indigent, and hospitals with pediatric endocrinology units. All of the other hospitals and clinics were deemed community hospitals.

TABLE 3

Unadjusted ORs for Frequent Rehospitalization (Once or More per 2 Years' Diabetes Duration) in 246 Young Patients Rehospitalized at Least Once

Characteristics	OR (95% Confidence Interval) for ≥ 1 Time Rehospitalized per 2 y Duration	P
Demographics and social characteristics		
Age at questionnaire, per year	0.96 (0.91–1.00)	.06
Gender		.99
Male	Reference	
Female	1.00 (0.60–1.68)	
Race/ethnicity		.29
NHW	Reference	
NHB	1.90 (0.62–5.81)	
Hispanic	1.26 (0.38–4.17)	
Other/mixed	3.14 (0.75–13.16)	
Insurance status at questionnaire ($N = 242$) ^d		.03
Private	Reference	
Underinsured	1.77 (1.06–2.96)	
Head of household work status ($N = 244$)		.04
Working full or part time	Reference	
Other ^b	1.74 (1.04–2.94)	
Head of household education ($N = 234$)		.21
Completed high school	Reference	
Less than high school	1.43 (0.82–2.51)	
Household income ($N = 193$)		.09
\$50 000 per year or more	Reference	
\$15 000 to \$49 999 per year	1.40 (0.57–3.46)	
Less than \$15 000 per year	2.42 (0.95–6.14)	
Diabetes characteristics		
Diabetes diagnosis age, per year	1.00 (0.94–1.06)	.96
Diagnosed during puberty ^c	1.12 (0.63–1.99)	.71
Year of diabetes diagnosis		.04
1985–1989	0.35 (0.16–0.78)	
1990–1994	0.36 (0.16–0.78)	
1995–1999	0.39 (0.17–0.92)	
2000 or later	Reference	
Presumed diabetes phenotype		.09
Type 1	Reference	
Non-type 1	2.30 (0.88–5.98)	
Current diabetes treatment ($N = 245$)		.20
Insulin monotherapy	Reference	
Other treatment	2.20 (0.72–6.76) ^d	

Characteristics	OR (95% Confidence Interval) for ≥ 1 Time Rehospitalized per 2 y Duration	P
Pills only		
Both insulin and pills		
No medications		
Diabetes management		
Checks blood sugar ≥ 1 time per ($N = 225$) ^e	0.82 (0.43–1.58)	.55
Checks feet ≥ 1 time per ($N = 244$)	1.22 (0.74–2.02)	.44
Ophthalmologic examination in past year ($N = 235$)	0.57 (0.33–0.96)	.04
Past year health services use		
Saw a health care provider ($N = 246$)	0.28 (0.03–2.75)	.28
Of those who saw a health care provider ^f		
Tertiary care facility	Reference	.58
Community hospital	0.84 (0.46–1.54)	
Did not get medical attention when needed	1.01 (0.47–2.18)	.97
Hospital of diabetes diagnosis ($N = 231$) ^f		.87
Tertiary care facility	Reference	
Community hospital	0.86 (0.57–1.61)	

^aPrivate insurance consisted of those who reported using any health management organization, preferred provider organization, or fee-for-service plan not affiliated with Medicaid or the Illinois Department of Public Aid. Underinsurance included those lacking health insurance and those receiving Medicaid or Public Aid.

^bOther work status includes unemployed, student, homemaker, retired, or disabled.

^cPuberty was defined as aged 13 to 17 years for boys and aged 12 to 17 years for girls.

^dPills only, both insulin and pills, and no medications were combined into the other treatment category.

^e $n = 183$ of 225 on insulin monotherapy.

^fTertiary care facilities ($n = 11$) included facilities affiliated with a university, the large public hospital serving the medically indigent, and hospitals with pediatric endocrinology units. All of the other hospitals and clinics were deemed community hospitals.

TABLE 4

Multivariable Logistic Regression Models for Frequent Rehospitalization (Once or More per 2 Years' Diabetes Duration) in 246 Young Patients Rehospitalized at Least Once

Variable	OR (95% Confidence Interval) for ≥ 1 Time Rehospitalized per 2 y Duration (<i>N</i> = 244 [114 Case Subjects])	<i>P</i>
Age at questionnaire, per year	0.94 (0.89–0.99)	.01
Head of household work status		.02
Working full or part time	Reference	
Other ^a	1.88 (1.10–3.21)	
Presumed diabetes phenotype		.04
Type 1	Reference	
Non-type 1	2.74 (1.03–7.31)	

The number of cases in the multivariable regression model is lower than the overall number because of missing data on covariates. Other variables initially entered into models included insurance status at questionnaire, year of diabetes diagnosis, and ophthalmologic examination in the past year.

^a Other work status was defined as unemployed, student, homemaker, retired, or disabled.