The Impact of Psychiatric Comorbidities on Readmissions for Diabetes in Youth

Michelle M. Garrison, MPH$^{1,2}$
Wayne J. Katon, MD$^3$
Laura P. Richardson, MD, MPH$^{1,2}$

OBJECTIVE — Comorbid psychiatric disorders have been associated with poorer disease outcomes in diabetic youth. Less is known, however, about the relationship between psychiatric disorders and repeat hospitalizations for youth with diabetes.

RESEARCH DESIGN AND METHODS — We performed a retrospective cohort study using data from the Pediatric Health Information System, which included detailed discharge data from 37 noncompeting children’s hospitals in the U.S. Using logistic regression, we examined whether the presence of coded diagnoses for internalizing or externalizing disorders at an index hospitalization for diabetes was associated with increased risk for rehospitalization during follow-up (duration of follow-up ranged from 3 to 24 months). The analysis was stratified by age-groups, and we controlled for potential confounders including sex, age, race/ethnicity, type 1 versus type 2 diabetes, Medicaid status, intensive care unit utilization, length of stay during index admission, and duration of follow-up.

RESULTS — Among adolescents aged 13–18, internalizing disorders were associated with significantly increased odds of rehospitalization (odds ratio 1.79 [95% CI 1.27–2.52]); the point estimate for externalizing disorders was similar, but the finding was not statistically significant at the α = 0.05 level (1.74 [0.96–3.15]). No significant association between psychiatric diagnoses and odds of repeat hospitalization was observed in diabetic children aged 5–12 years.

CONCLUSIONS — Internalizing disorders are associated with increases in repeat hospitalizations for diabetes among adolescents. Future research is needed to explore the reasons for this finding, such as degree to which treatment nonadherence mediates this relationship and whether appropriate treatment of internalizing disorders results in improved diabetes outcomes and decreased readmissions.

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Several studies have shown an increased prevalence of psychiatric disorders among youth with diabetes (1). Comorbid emotional and behavioral disorders have been associated with poorer diabetes management outcomes in both youth (2–6) and adults (7–11) as well as with higher health care costs (9). Adverse diabetes outcomes that have been associated with psychiatric disorders in youth include elevated HbA1c levels, ketoacidosis, severe hypoglycemia, and hospitalization.

Several mechanisms have been proposed to explain the relationship between psychiatric disorders and poor diabetes outcomes. One proposed mechanism is nonadherence (12); studies have shown associations between psychiatric disorders and nonadherence to diet, exercise, and medications in both type 1 and type 2 diabetic populations (5,8,9,13–17). Another pathway between psychiatric disorders and poor diabetes outcomes that has been suggested is intentional self-harm, including overdose and overdose of insulin (14,18). There is also an increased incidence of eating disorders among both patients with diabetes and those with other psychiatric comorbidities; eating disorders in those with diabetes have been associated with intentional insulin omission (15,16). Others have suggested that the apathy and lack of self-care often seen in those with depressive or anxiety disorders could result in eating or exercise patterns that are detrimental to glycemic control (19). Some researchers have also proposed that an external factor such as family conflict or stress may be leading to both behavioral problems and poor diabetes management (6,20–22). As can be seen, these hypothesized mechanisms are all closely interrelated.

Studies examining the relationship between psychiatric disorders and diabetes outcomes in youth have demonstrated somewhat varied results, in part because of differing definitions of psychiatric disorders. Additionally, the findings of some studies suggest that internalizing symptoms (such as depression and anxiety) versus externalizing symptoms (such as impulsivity, hyperactivity, and aggression) may affect disease management outcomes differently (3,5,6).

In one large cohort study, DSM-IV psychiatric disorders were significantly associated with increased risks for both diabetic ketoacidosis and severe hypoglycemia, even after controlling for other expected risk factors (2). The prevalence of psychiatric disorders among those with no ketoacidosis episodes was 9.6%, whereas it was 18.7% in those with one episode and 34.4% in those with two or more episodes. This study also showed that the association between psychiatric disorders and ketoacidosis episodes was significantly stronger among adolescents than in younger children.

Among hospitalized adults, psychiatric comorbidities are associated with increased risk for hospital readmission for...
Table 1—ICD-9-CM diagnosis codes for internalizing and externalizing disorders

<table>
<thead>
<tr>
<th>Internalizing disorders</th>
<th>ICD-9-CM codes</th>
<th>Externalizing disorders</th>
<th>ICD-9-CM codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major depressive disorders</td>
<td>296.2x, 296.3x</td>
<td>Adjustment reaction, conduct</td>
<td>309.3x</td>
</tr>
<tr>
<td>Atypical depressive disorder</td>
<td>296.82</td>
<td>Conduct disorders</td>
<td>312.xx</td>
</tr>
<tr>
<td>Depressive type psychosis</td>
<td>298.0x</td>
<td>Oppositional disorder</td>
<td>313.81</td>
</tr>
<tr>
<td>Anxiety states</td>
<td>300.0x</td>
<td>Hyperkinetic syndromes, including ADHD</td>
<td>314.xx</td>
</tr>
<tr>
<td>Phobic disorders, obsessive-compulsive disorders, neurotic depression</td>
<td>300.2x, 300.3x, 300.4x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjustment reaction, depressive</td>
<td>309.0x, 309.1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-traumatic stress disorder</td>
<td>309.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depressive disorder, NOS</td>
<td>311.xx</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overanxious disorder</td>
<td>313.0x</td>
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</tbody>
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ADHD, attention deficit hyperactivity disorder; NOS, not otherwise specified.

medical illnesses (23), but few studies have examined the impact of comorbid psychiatric disorders on repeat hospitalizations among diabetic youth. One study found that adolescents with psychiatric disorders were more than five times as likely to exhibit serious nonadherence and that nonadherence was in turn associated with significantly higher hospitalization rates (14). Another small, longitudinal study also found that externalizing symptoms were significantly associated with repeat hospitalizations in diabetic youth (24). As repeat hospitalizations are also linked to increases in complications and mortality (25), this is an important issue to explore.

In this study, we sought to examine whether comorbid psychiatric disorders were associated with increased odds of re-admission among youth hospitalized for diabetes in a large national dataset. Because many studies have found different impacts on diabetes control between internalizing and externalizing disorders, we decided to examine them separately in this analysis.

RESEARCH DESIGN AND METHODS — We used the Pediatric Health Information System database developed by the Child Health Corporation of America, which includes demographic and diagnostic data on 37 freestanding, noncompeting children’s hospitals. The database uses the International Classification and Clinical Services codes (26) to map hospital-specific charge codes at the patient level to categorical variables across all hospitals. The database also includes diagnoses in the International Classification of Diseases–9th Revision, Clinical Modification (ICD-9-CM) format, as well as All-Patient Refined Diagnosis Related Groups and the associated Risk of Mortality categories, version 20. All patients in the Pediatric Health Information System database had a primary diagnosis coded at discharge, as well as up to 20 secondary diagnoses.

The study protocol was reviewed and approved by the Children’s Hospital and Regional Medical Center Institutional Review Board.

Our study included pediatric patients (aged 5–18 years) with discharge dates between 1 October 2001 and 1 July 2003 and a primary ICD-9 diagnosis of diabetes (250.xx) coded at discharge. The first identified diabetes hospitalization for each patient during the study period was considered the index admission. All analyses were stratified by age-group (children aged 5–12 years and adolescents aged 13–18 years), as previous research has shown considerable differences in the risks for readmission among adolescents and younger youth (27). Age was defined as the patient’s age at hospital admission for the index hospitalization.

Primary outcome
The primary outcome of the analysis was readmission, which was measured by whether there was a repeat admission for the patient at the same hospital during the study period (1 October 2001 to 30 September 2003) with an ICD-9-CM code for diabetes as the primary discharge diagnosis. The follow-up time period for assessment of readmission ranged from 3 to 24 months, depending on the date of the index discharge. Although some patients had more than one repeat admission during this time frame, we chose to measure the outcome dichotomously for our primary analysis.

Predictors and covariates
We examined whether an ICD-9-CM diagnostic code for internalizing disorders (depressive and anxiety disorder) or externalizing disorders (attention deficit, oppositional defiant, and conduct disorders) was present at discharge (Table 1). Other covariates included in the analysis were type 1 versus type 2 diabetes (as coded in the primary diagnosis code at discharge), Medicaid status (as a proxy for low socioeconomic status) (22,27,28), intensive care unit utilization during index admission, length of index admission, and patient age-group, sex, and race/ethnicity (2,27,29). For the latter, we included nonmutually exclusive variables for black race and Hispanic ethnicity, as previous research has demonstrated significant problems with access to care for both of these populations.

Statistical analyses
Descriptive analyses were performed, as were multivariate logistic regressions. All regression analyses included the covariates described above, as well as a cluster variable for hospital to account for the potential decreased variability within subjects at the same hospital versus at different hospitals (30,31). Because length of follow-up time for each individual varied with the date of the index admission, a covariate that measured the time between the index admission discharge date and the end of the study period was included in regression analyses to control for differences in follow-up.
RESULTS — Our study sample included 4,508 children and 3,094 adolescents who were hospitalized with diabetes; repeat hospitalizations were observed in 9% of the children and 16% of the adolescents (Table 2). Among the 904 individuals with repeat hospitalizations, 59% had a single repeat admission during the study period, 22% had two, and 9% had three, and the remaining 10% had four or more. There were significant differences in covariates across age-groups, most noticeably in the distribution of sex, race, Medicaid status, type 1 versus type 2 diabetes, and internalizing disorders. Children were more likely than adolescents to be male, to be non-Hispanic and white, and to have type 1 diabetes. Adolescents were more likely than children to have Medicaid as the primary payer and to have comorbid internalizing disorders. In the regression analysis examining children, neither internalizing nor externalizing disorders were significantly associated with repeat hospitalizations (Table 3). Demographic variables that were significant risk factors for repeat admissions in this age-group were age, male sex, Hispanic ethnicity and age were no longer statistically significant in the adolescent age-group, and the effect size for black race decreased sharply (1.63 [1.18–2.23]).

In post hoc analyses, the effect of psychiatric disorders on the odds for repeat hospitalization did not differ significantly by sex. Additionally, among those who had more than one repeat hospitalization, psychiatric disorders were not a significant predictor of the number of subsequent hospitalizations when explored as a continuous outcome. When we examined having more than one repeat hospitalization as a dichotomous outcome, the only notable difference in the findings was an increase in the effect size observed for internalizing disorders in adolescents (OR 2.21 [95%CI 1.35–3.62]). Finally, limit-
ing the outcome to readmissions for diabetic ketoacidosis (84% of the original readmissions) did not result in significant changes in effect sizes for any covariate, including psychiatric disorders. Some of these analyses may have been limited by the sample size of the subgroups examined.

**CONCLUSIONS** — In this analysis, we found that comorbid internalizing disorders such as depression or anxiety were associated with significantly elevated odds for repeat admissions in diabetic adolescents. There are several possible reasons why internalizing disorders might lead to increases in rehospitalizations. First, internalizing disorders may interfere with the ability of the adolescent to adhere to the recommended treatment plan or lead to intentional/nonintentional self-harm. In adult patients with diabetes, depression is associated with poorer adherence to diet and exercise, more lapses in prescription refills for oral medications (17), and more missed medical appointments (P. Ciechanowski, W.J.K., J. Russo, unpublished observations).

It is unclear why internalizing disorders are associated with increased risk for hospital readmission in adolescents but not in younger children. One possible explanation is that although adolescents are usually in control of their own diabetes management, parents are often in control for younger children. As a result, parental intervention may be preventing internalizing disorders from affecting treatment adherence in the younger age-group. Furthermore, internalizing disorders are also different in nature during adolescence compared with childhood, and this may play a role as well (32,33). For example, psychomotor retardation as a symptom of depression is more common in older adolescents than in younger children (34). The comorbidity of disordered eating with internalizing disorders also increases with age among youth (35,36).

An additional possibility is that because of the lower prevalence of internalizing disorders in the younger age-group, we had inadequate power to detect an association in this age-group. However, the fact that the OR does not even trend toward being positive in this age-group makes this less likely. On the other hand, the negative finding for externalizing disorders was much more likely to be a consequence of inadequate power in that particular group; for both age-groups, the effect size for externalizing disorders closely mirrors that for internalizing disorders. Among adolescents, the OR for internalizing disorders is statistically significant whereas the quite similar estimate for externalizing disorders is not; the wider CIs for the latter appear to be an artifact of the smaller numbers for externalizing disorders, which are approximately half of those for internalizing disorders.

There are several limitations to this analysis. As we were only able to include psychiatric diagnoses that were coded at hospital discharge, our findings probably underestimate the true prevalence of comorbid psychiatric disorders in this population. Patients whose psychiatric disorders are more severe and persistent are also more likely to be diagnosed, so our sample may be more reflective of that population. Furthermore, we were only able to capture repeat hospitalizations that occurred at the same hospital and within the study time frame; we were not able to detect rehospitalizations at other hospitals in the region. And as with most studies, it is possible that unmeasured confounders (such as family dysfunction or substance use) have biased our results.

Despite these limitations, there are several implications of our findings. First, screening for comorbid internalizing disorders in adolescents may allow clinicians to target patients who require more intensive outpatient follow-up after hospital discharge; (5,37) this may be especially important for patients already at high risk for repeat hospitalizations, such as black youth or those with Medicaid as the primary payer. Second, additional research is needed to determine the underlying mechanisms for the observed association. Finally, this population may represent an opportunity for significant cost savings, if improvements in detection and treatment of comorbid internalizing disorders in diabetic youth can be shown to reduce repeat hospitalizations (38–43).

**References**

15. Herpertz S, Wagener R, Albus C, Kocnar M, Wagner R, Best F, Schleppinghoff BS,
Psychiatric comorbidity and readmissions


