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The Burden of Hospital Readmissions among Pediatric Patients with Inflammatory Bowel Disease

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Abstract

Objective—To evaluate the burden and predictors of hospital readmissions among pediatric patients with inflammatory bowel disease using the Nationwide Readmissions Database.

Study design—We performed a retrospective cohort study using 2013 Nationwide Readmissions Database. *International Classification of Diseases, Ninth Revision, Clinical Modification* codes were used to identify patients <18 years with diagnoses of ulcerative colitis (UC) or Crohn disease (CD). Demographic factors and details of hospitalizations were evaluated using survey procedures in SAS v 9.4 (SAS Institute, Cary, North Carolina). Multivariable logistic regression was used to estimate ORs and 95% CIs of readmission.

Results—Among 2733 hospitalizations (63% CD, 37% UC), 611 (22%) patients were readmitted within 90 days of the index hospitalization. Readmission resulted in weighted estimates of 11 440 excess days of hospitalization and total charges of over $107 million. For CD, male sex (aOR 1.36, 95% CI 1.03–1.81) and co-existing anxiety or depression (aOR 1.89, 95% CI 1.06–3.40) were associated with increased readmissions, while patients who underwent surgery had decreased readmissions (aOR 0.40, 95% CI 0.24–0.65). In patients with UC, and index admission of >7 days was associated with increased readmissions (aOR 1.69, 95% CI 1.09–2.62).

Conclusions—Readmission occurs frequently in children with inflammatory bowel disease and is associated with significant cost and resource burdens. Among patients with CD, psychiatric comorbidities such as anxiety and depression are apparent drivers of readmission.

Hospital readmissions are a key metric associated with quality of healthcare in the US, with the potential to place a great burden on both the patient and the healthcare system.[1] Recent

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studies indicate that hospitalizations are increasing for children with inflammatory bowel diseases (IBD) in the US.[2,3] In addition, a Canadian study demonstrated that pediatric patients with IBD are at greater risk for hospital readmission compared with older patients.[4] These trends are cause for concern to both patients and payers, as hospitalization of pediatric patients with IBD has been associated with a significant cost burden[5–7] and hospitalization has been associated with decreased health-related quality of life in other populations of children with chronic diseases.[8]

Despite these concerns, there remains a paucity of literature examining the factors associated with hospital readmissions in children with Crohn disease (CD) and ulcerative colitis (UC). Studies of postsurgical readmissions in children with IBD indicate that surgery performed by a pediatric surgeon[9] and having surgery at a high volume hospital[10] confer a lower risk of postoperative readmission. However, the exact role that healthcare disparities, racial differences in phenotypes, or other confounding factors play in these risks for readmission is uncertain.[11] Single center experiences from American adults with IBD suggest that factors such as severe disease, poorly controlled pain and depression, and admission to a teaching service are associated with a higher likelihood of readmission,[9–11] but it is unknown if these same factors are important in children with IBD.

Our objectives were to use the Nationwide Readmissions Database (NRD) to describe the overall burden of readmission in patients with IBD, including the total charges associated with readmission, and analyze the specific factors associated with hospital readmission within 90 days.

Methods

We conducted a retrospective cohort study using 2013 data from the NRD, a resource of the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases. Designed to be nationally representative in the adult population, the NRD is a publicly available all-payer inpatient database from the US that contains discharge data from 22 geographically dispersed states accounting for 49.3% of all US hospitalizations. Weights were assigned to each admission by HCUP to allow for national readmission analyses. The NRD contains over 100 clinical and nonclinical variables,[12] including outcomes such as hospital length of stay (LOS), readmission, and total charges. The NRD also contains up to 15 diagnostic and procedure codes per admission based on *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) coding. This study was determined exempt from review by the University of North Carolina Institutional Review Board, given the deidentified nature of the data.

We examined discharge data from patients age 17 and younger. Patients were determined to have IBD if they had a primary or secondary ICD-9-CM diagnosis code indicating CD (555.xx) or UC (556.xx) on the index admission. Given that patients with UC undergoing colectomy could have a scheduled readmission for repeat operation such as ileal pouchanal anastomosis within the 90 day follow-up for readmission, we excluded any patient with an ICD-9-CM code for colectomy. Approximately 1% of patients were given discharge codes

for both CD and UC (n = 28), and to minimize misclassification of subgroups of IBD, we excluded those patients.

The primary outcome of interest, hospital readmission within 90 days of the index hospitalization, was determined using a unique identifier specific to the NRD to link discharge data of individual patients. We also evaluated the primary ICD-9- CM diagnosis code on readmission, LOS during all hospitalizations, and the total charges associated with readmission.

Patient demographics included age, sex, and primary insurance/payer for the index hospitalization. We used ICD- 9-CM diagnosis codes to identify additional comorbidities or factors suggested to be independent predictors or confounders of the relationship between IBD and hospital readmission. Given prior suggestions in adult populations that modifiable risk factors such as depression (ICD-9-CM 296.2, 296.3, 298.0, 300.4, 311), chronic pain (338.2, 338.4), and anxiety (300, 300.2) play a significant role in risk for readmission we made the a priori decision to include these covariates in our analyses. We used ICD-9-CM definitions for anxiety and depression that have previously been validated in IBD using administrative data.[13] In addition, the diagnosis coding used to identify admissions with *Clostridium difficile* infection (ICD-9-CM 008.45) has previously been used in HCUP databases.[14] IBD-related surgery was included in the models for CD only. For patients with CD, ICD-9-CM coding was used to identify potential complications of CD including small bowel obstruction and fistulizing disease (ICD-9-CM codes listed in Table I; available at www.jpeds.com).

In the NRD, hospital teaching status is defined as “metropolitan teaching,” “metropolitan nonteaching,” and “rural.” HCUP defines an institution as a teaching hospital if it has an American Medical Association-approved residency program, if the institution is a member of the Council of Teaching Hospitals, or based on the ratio of full-time equivalent interns and residents to hospital beds (0.25 or higher).[12] In other HCUP databases such as the Nationwide Inpatient Sample and the Kids’ Inpatient Database, approximately 98% of patients with IBD admitted to rural hospitals are admitted to nonteaching hospitals,[15] and HCUP indicates that rural teaching hospitals are rare.[12] For our analyses, we collapsed rural and metropolitan nonteaching into 1 category and refer to metropolitan teaching hospitals as “teaching.” We also analyzed hospitals based on annual volume of patients with IBD, using thresholds previously established in the Kids’ Inpatient Database,[7] where those hospitals with an annual volume of IBD discharges of >20 were defined as high volume IBD centers.

Statistical Analyses

All analyses were performed using survey procedures in SAS v 9.4 (SAS Institute, Cary, North Carolina). Data were weighted to reflect estimates of the national population, including the means and proportions presented. The χ^2 test and Student *t* test were used to compare proportions and continuous variables, respectively. We used logistic regression modeling to estimate the unadjusted odds of a readmission within 90 days of the index hospitalization for the covariates of interest. In all logistic regression models, we made the a priori decision to include only patients with Medicaid (33% of all admissions) or private insurance (60% of all admissions) as their primary payer for the admission, given concerns

that there may be significant overlap between the “other” insurance provider group and the Medicaid group. In prespecified sensitivity analyses, we included all patients, regardless of payer status, to assess for any differences in outcomes when patients with other payers were included.

Based on clinical knowledge and previously reported risk factors for readmission among adult populations of patients with IBD, we then evaluated the association between risk factors and readmission within 90 days using multivariable logistic regression. All factors included in the models were chosen due to their clinical relevance and were identified a priori, including payer and hospital specific factors. For all analyses, diagnoses of anxiety or depression were collapsed into one variable. Any covariate with <11 patients was excluded from the multivariable models. ORs and 95% CIs are presented. A 2-tailed *P* value of .05 was chosen as the threshold for statistical significance for all tests.

Results

A total of 2733 (63% CD, 37% UC) patients with IBD were identified in the NRD, of which 611 (22%) required readmission within 90 days of the index hospitalization. Using the NRD weighting, these represented 8632 nationwide admissions and 1845 nationwide readmissions among pediatric patients with IBD in 2013. Hospital readmission resulted in an additional 3788 days of hospitalization for those affected, representing a weighted estimate of 11 440 excess days in the national population of patients with IBD. Among patients with CD, the median LOS for the first readmission was 3.69 days (IQR1.95–6.58) compared with a median LOS of 4.53 days (IQR 2.41–8.84) for patients with UC ($P = .057$). Among patients with CD requiring readmission, 85% had a diagnosis of CD as a primary diagnosis. The other most common primary or secondary diagnoses on readmission among patients with CD were anemia (3.3%), abnormal loss of weight (2%), dehydration (1.5%), and *C difficile* infection (0.6%). Among patients with UC requiring readmission, 89% had UC as a primary diagnosis. The other most common primary or secondary diagnoses on readmission among patients with UC were anemia (13%), abnormal loss of weight (5.1%), *C difficile* infection (2.5%), and dehydration (2.5%). All ICD-9-CM codes for comorbid diagnoses are listed in Table I.

The baseline demographics of the CD and UC populations are depicted in Table II. There was no significant difference in readmission if the diagnosis of CD was listed as the primary or secondary diagnosis (22% vs 17%, $P = .105$). Although the raw percentage of patients with a primary diagnosis of UC requiring readmission was also greater than that of patients with a secondary diagnosis of UC, there was no statistically significant difference in readmission within 90 days (25% vs 17%, $P = .066$).

Among patients with IBD who were readmitted within 90 days, the median total charges for the first readmission were $31 282 (IQR $16 491–$62 496). There was no significant difference when comparing the median total charges for the first readmission in patients with UC to patients with CD ($33 712 vs $30 387, $P = .270$). When aggregated among all pediatric patients with IBD in the NRD, the total charges attributed to the first readmission within 90 days were $35 698 897 with a weighted estimate of $107 820 643 in the national

population of pediatric patients with IBD. Among readmissions of patients with CD, 78% were identified as nonelective readmissions. Sixty-seven percent of patients with UC requiring readmission were reported to have a nonelective readmission.

Factors Associated with Readmission in Crohn's Disease

In univariate analysis of patients with CD, those patients requiring readmission were more likely to be male, have a preexisting psychiatric diagnosis of anxiety or depression (Figure; available at www.jpeds.com) and were less likely to have undergone an IBD related surgery during the index admission (Table III). There was no significant difference in readmission if the diagnosis of CD was listed as the primary or secondary diagnosis (22% vs 17%, $P = .105$). In multivariable analysis, male sex (aOR 1.36, 95% CI 1.03–1.81) and co-existing anxiety or depression (aOR 1.89, 95% CI 1.06–3.40) were associated with a significant increase in odds of readmission within 90 days of index hospitalization (Table IV). In addition, the need for IBD related surgery was associated with decreased odds of readmission within 90 days (aOR 0.40, 95% CI 0.24–0.65). In the prespecified sensitivity analysis including all payer sources, there was no change in the final results.

Factors Associated with Readmission in UC

In univariate analysis, patients with UC requiring readmission were more likely to be admitted to teaching hospitals, more likely to be admitted to high volume IBD centers, and demonstrated longer LOS on the index admission when compared with patients who did not require readmission (Table V). When patients with UC were evaluated in multivariable analysis, only a LOS of >7 days during the index admission was associated with an increased odds of readmission within 90 days (aOR 1.69, 95% CI 1.09–2.62, Table IV). Although not significant, an increased odds of readmission within 90 days was suggested with a comorbid condition of anxiety or depression (aOR 1.57, 95% CI 0.69–3.54), index admission to a teaching hospital (aOR 1.32, 95% CI 0.74–2.37), and index admission to a high volume IBD center (aOR 1.27, 95% CI 0.84–1.69). A sensitivity analysis was also performed including all payer sources, which demonstrated no change in the final results.

Discussion

Based on this US nationwide study of pediatric patients with UC and CD, the burden of readmissions is substantial. Over 20% of patients with IBD required a repeat hospitalization within 90 days of the index admission. These readmissions resulted in a national weighted estimate of over 11 000 excess hospital days and approximately $107 million total charges in the pediatric IBD population. Among patients with CD, male sex and a coexisting diagnosis of anxiety or depression were associated with significantly increased odds of readmission within 90 days. In patients with UC, an increased LOS during the index admission was associated with increased odds of readmission.

The majority of the literature evaluating risk factors for readmission among patients with IBD has evaluated the adult population. Prior single center studies evaluating adults with IBD have associated an increased risk of hospital readmission with factors such as chronic pain and depression.[16] Both anxiety and depression are increased among patients with IBD

compared with other disease states and the general population.[17–19] In addition, anxiety has been associated with worse outcomes among pediatric patients with IBD[20] and increased resource utilization among adult patients with IBD.[21,22] Although the impact of these psychological comorbidities has been evaluated in multiple studies, a majority of patients with UC or CD may not receive adequate psychosocial support in the scheme of their overall treatment for IBD.[23] Among patients with CD in our population, a co-existing diagnosis of anxiety or depression was associated with readmission within 90 days in both the unadjusted analysis and adjusted analyses. Although the association between a co-existing diagnosis of anxiety or depression and readmission was not significant in patients with UC, the magnitude of the effect estimate would seem to suggest that this relationship may also exist among patients with UC. Although this study may have been underpowered to identify a significant relationship, further study of this potential association is indicated in patients with UC, as are efforts to better identify and treat psychological comorbidities among inpatients with IBD.

Among patients with IBD, chronic pain has also been associated with significant effects on quality of life.[24] Less than 11 patients in both populations had a co-existing diagnosis of chronic pain, and, thus, chronic pain was not used in our analyses of patients with UC or CD. In a study of adult inpatients with IBD, a diagnosis of CD was associated with increased use of narcotics despite a lack of association with disease activity on objective evaluation such as radiographic imaging or endoscopy.[25] Taken together, continued examination of the role of pain among pediatric patients with IBD seems essential, as this population was underpowered to evaluate the relationship that chronic pain may play in readmission among pediatric patients with IBD.

In both univariate and multivariable analysis of pediatric patients with CD, the need for IBD-related surgery was a strong negative predictor for readmission within 90 days among pediatric patients. This may indicate that surgery offers either a temporary or definitive successful therapeutic option in patients with CD, as only 8% of patients requiring an IBD related surgery during the index admission were readmitted within 90 days. In a prior evaluation of children with CD and intra- abdominal abscesses, Dotson et al[26] found that 64% of patients with intra-abdominal abscesses treated with medical management or percutaneous drainage ultimately required surgical intervention within one year. Although preservation of intestinal length remains a critical focus in pediatric patients with CD, definitive management with resection in cases of perforation and abscess may be key in allowing a patient to resume school and age appropriate activities more quickly[27] while potentially decreasing the risk for readmission.

Among patients with UC, a longer LOS during the index admission was associated with an increased risk of readmission within 90 days. Although not significant, we also observed that hospitalization at a teaching hospital seemed to be associated with increased odds of readmission. We speculate that both of these may represent indirect markers of disease severity. However, the NRD does not contain sufficient clinical data (laboratory data, medication use, or phenotypic information) to fully explore the relationships between disease severity, hospital characteristics, and readmission rates.

The NRD is designed to be a nationally representative sample of hospitalizations within the US. However, as the majority of hospitalizations are for adult patients, it is unknown whether the NRD is truly representative of the entire population of children with IBD in the US. Nevertheless, the NRD remains the largest, most geographically diverse source of hospitalization and readmission data available in the US. There are other limitations in our study as well. As noted, the NRD does not contain laboratory data or clinical data regarding the severity of an individual patient's disease at the time of hospitalization, and, thus, aside from surrogate indicators such as LOS, our ability to evaluate the relationship between the severity of disease and odds of readmission is limited. Although we evaluated variables such as the presence of a fistula or a small bowel obstruction, the potential remains that these diagnoses may not be coded as accurately as a primary diagnosis of CD.

In addition, the NRD does not contain information on race. This is an important limitation given prior literature demonstrating a shorter time to readmission and a higher probability of readmission among black children with IBD when compared with white children.[11] There is also the potential for misclassification of those factors associated with readmission when using large databases such as the NRD. Because of the high likelihood that active IBD is the primary driver of many index admissions, the potential exists that comorbid conditions such as anxiety, depression, and chronic pain may be less likely to be coded. This could lead to an underestimation of the influence that these comorbid diseases have on readmission, even when using validated algorithms for case- finding. We were also unable to evaluate provider factors that may have contributed to readmission, including the impact that factors such as early discharge from the index hospitalization play in readmission. Although future interest in decreasing readmission will likely focus on multidisciplinary approaches to discharge planning, a continued focus on provider decision making during the index hospitalization will remain critical in efforts to improve outcomes among hospitalized children with IBD.

In conclusion, using a nationwide database, we identified a significant economic burden associated with hospital readmission among pediatric patients with UC and CD. Among patients with CD, psychiatric comorbidities of anxiety or depression and male sex were associated with increased odds of readmission within 90 days. Those patients with UC who experienced longer LOS during their index admission were at increased odds of readmission within 90 days. These findings demonstrate the significant economic burden of readmission in this population and given the paucity of literature evaluating the burden of hospital readmission among children with IBD, may lead to future studies to better identify risk factors associated with readmission.

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Glossary

CD	Crohn disease
HCUP	Healthcare Cost and Utilization Project

IBD	inflammatory bowel disease
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
LOS	length of stay
NRD	Nationwide Readmissions Database
UC	ulcerative colitis

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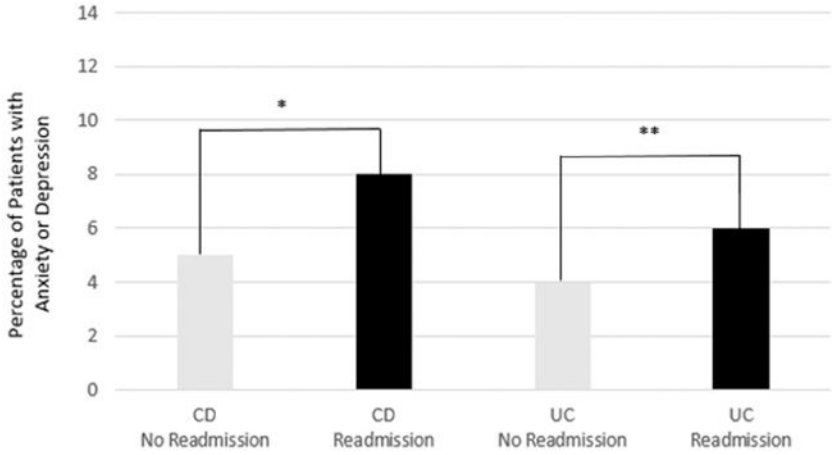

Figure.

Comparison of the percentage of patients with a coexisting diagnosis of anxiety or depression stratified by readmission status and primary diagnosis of CD or UC, **P* = .028, ***P* = .123.

Table I

ICD-9-CM diagnosis codes used in the analysis of 90-day readmissions among patients with CD and UC

Diagnoses	ICD-9-CM Code
C difficile infection	008.45
Small intestinal resection	45.6×
Colectomy	45.7x, 45.8x
Other abdominal operations	54.xx
Dehydration	276.51
Anemia	280.0, 280.9, 281.9, 285.1, 285.29, 285.9
Depression	296.2, 296.3, 298,0 300.4, 311
Anxiety	300, 300.2
Chronic pain	338.2 or 338.4
Fistula	537.4, 569.81, 619.1
CD	555.xx
UC	556.xx
Intestinal obstruction	560.81, 560.89, 560.9
Abnormal weight loss	783.21

Table II

Baseline clinical and demographic characteristics of pediatric patients with IBD in the 2013 NRD

	CD n = 1733		UC n = 1000	
	n	%	n	%
Age (y)				
≤12	451	26	416	42
13–17	1282	74	684	68
Male sex	979	56	497	50
Anxiety or depression	101	6	43	4
Chronic pain	<11	1	<11	1
Teaching hospital on index admission	1549	89	869	87
Hospital volume on index admission				
≤20 IBD admissions per y	459	28	302	31
>20 IBD admissions per y	1274	72	698	69
Payer/insurance				
Medicaid	549	32	375	38
Private insurance	1065	61	575	58
Other	119	7	78	8
C difficile infection	87	5	67	7
Need for IBD-related surgery	225	13	N/A	N/A
LOS for index admission (d)				
≤3	796	46	390	39
4–7	597	34	353	35
>7	340	20	257	26
Presence of a fistula	60	3	N/A	N/A
Small bowel obstruction	226	13	N/A	N/A

Table III

Univariate comparison of characteristics of pediatric patients with CD in the 2013 NRD, including unadjusted odds of readmission

	No readmission n = 1364		Readmission n = 369		Unadjusted OR (95% CI)	*P* value
	n	%	n	%		
Age (y)						.183
≤ 12	371	27	80	22	Reference	
13–17	993	73	289	78	1.22 (0.88–1.70)	
Male sex	756	55	223	60	1.33 (1.01–1.75)	.004
Anxiety or depression	73	5	28	8	1.99 (1.15–3.45)	.028
Index admission to teaching hospital	1208	88	341	92	1.35 (0.85–2.14)	.206
Index admission to high volume IBD center	980	72	294	74	1.12 (0.80–1.55)	.509
Payer/insurance						.087
Medicaid	414	30	135	37	1.28 (0.97–1.69)	
Private insurance	857	63	208	56	Reference	
C difficile infection	61	5	26	7	1.50 (0.87–2.57)	.200
Need for IBD-related surgery	196	14	29	8	0.49 (0.31–0.78)	.003
LOS for index hospitalization (d)						.057
≤3	640	47	156	42	0.83 (0.60–1.13)	
4–7	471	35	126	34	Reference	
>7	253	19	87	24	1.22 (0.84–1.76)	
Presence of a fistula	48	4	12	3	0.84 (0.38–1.88)	.754
Small bowel obstruction	173	13	53	14	1.33 (0.88–2.02)	.067

Table IV

Multivariable analysis, odds of readmission among pediatric patients with CD or UC in the 2013 NRD*

	CD aOR (95% CI)	UC aOR (95% CI)
Age (y)		
≤12	Reference	Reference
13–17	1.32 (0.94–1.85)	0.89 (0.62–1.28)
Male Sex	1.36 (1.03–1.81)	0.81 (0.58–1.14)
Anxiety or depression	1.89 (1.06–3.40)	1.57 (0.69–3.54)
Index admission to teaching hospital	1.36 (0.80–2.32)	1.32 (0.74–2.37)
Index admission to high volume	1.02 (0.70–1.49)	1.27 (0.84–1.92)
IBD center		
Payer/insurance		
Medicaid	1.23 (0.92–1.63)	1.19 (0.84–1.69)
Private insurance	Reference	Reference
Need for IBD-related surgery	0.40 (0.24–0.65)	N/A
LOS for index admission (d)		
≤3	0.79 (0.57–1.08)	1.05 (0.70–1.57)
4–7	Reference	Reference
>7	1.28 (0.87–1.89)	1.69 (1.09–2.62)

*All variables included in the final multivariable analysis are listed above.

Table V

Univariate comparison of characteristics of pediatric patients with UC in the 2013 NRD, including unadjusted odds of readmission

	No readmission n = 758		Readmission n = 242			
	n	%	n	%	Unadjusted OR (95% CI)	*P* value
Age (y)						.652
≤12	239	32	77	32	Reference	
13–17	519	68	165	68	0.86 (0.60–1.24)	
Male sex	381	50	116	48	0.78 (0.56–1.10)	.109
Anxiety or depression	29	4	14	6	1.66 (0.77–3.54)	.123
Index admission to teaching hospital	645	85	224	93	1.73 (1.01–2.95)	.005
Index admission to high volume IBD hospital	502	66	196	76	1.46 (1.01–2.12)	.045
Payer/insurance						.036
Medicaid	256	34	91	38	1.28 (0.91–1.82)	
Private insurance	444	59	131	54	Reference	
C difficile infection	56	7	11	5	0.52 (0.25–1.10)	.088
LOS for index admission (d)						.002
≤3	306	40	84	35	1.02 (0.67–1.53)	
4–7	275	36	78	32	Reference	
>7	177	23	80	33	1.82 (1.18–2.80)	