

Mental Health Conditions and Medical and Surgical Hospital Utilization

Stephanie K. Doupnik, MD,^{a,b} John Lawlor, MHS,^{c,d} Bonnie T. Zima, MD, MPH,^e Tumaini R. Coker, MD, MBA,^f Naomi S. Bardach, MD, MAS,^g Matt Hall, PhD,^{c,d} Jay G. Berry, MD, MPH^h

abstract

OBJECTIVE: Mental health conditions are prevalent among children hospitalized for medical conditions and surgical procedures, but little is known about their influence on hospital resource use. The objectives of this study were to examine how hospitalization characteristics vary by presence of a comorbid mental health condition and estimate the association of a comorbid mental health condition with hospital length of stay (LOS) and costs.

METHODS: Using the 2012 Kids' Inpatient Database, we conducted a retrospective, nationally representative, cross-sectional study of 670 161 hospitalizations for 10 common medical and 10 common surgical conditions among 3- to 20-year-old patients. Associations between mental health conditions and hospital LOS were examined using adjusted generalized linear models. Costs of additional hospital days associated with mental health conditions were estimated using hospital cost-to-charge ratios.

RESULTS: A comorbid mental health condition was present in 13.2% of hospitalizations. A comorbid mental health condition was associated with a LOS increase of 8.8% (from 2.5 to 2.7 days, $P < .001$) for medical hospitalizations and a 16.9% increase (from 3.6 to 4.2 days, $P < .001$) for surgical hospitalizations. For hospitalizations in this sample, comorbid mental health conditions were associated with an additional 31 729 (95% confidence interval: 29 085 to 33 492) hospital days and \$90 million (95% confidence interval: \$81 to \$101 million) in hospital costs.

CONCLUSIONS: Medical and surgical hospitalizations with comorbid mental health conditions were associated with longer hospital stay and higher hospital costs. Knowledge about the influence of mental health conditions on pediatric hospital utilization can inform clinical innovation and case-mix adjustment.



^aDivision of General Pediatrics, Center for Pediatric Clinical Effectiveness, and PolicyLab, The Children's Hospital of Philadelphia, Philadelphia, Pennsylvania; ^bThe Leonard Davis Institute of Health Economics, The University of Pennsylvania, Philadelphia, Pennsylvania; ^cChildren's Hospital Association, Washington, District of Columbia; ^dChildren's Hospital Association, Overland Park, Kansas; ^eUCLA Semel Institute for Neuroscience and Human Behavior, University of California at Los Angeles, Los Angeles, California; ^fDepartment of Pediatrics, UCLA Geffen School of Medicine, University of California at Los Angeles, Los Angeles, California; ^gDepartment of Pediatrics, Philip R. Lee Institute for Health Policy Studies, UCSF School of Medicine, University of California at San Francisco, San Francisco, California; and ^hDivision of General Pediatrics, Boston Children's Hospital, Harvard Medical School, Boston, Massachusetts

Dr Doupnik participated in the design of the study and interpretation of the data and drafted the initial manuscript; Mr Lawlor participated in design of the study and interpretation of the data, performed the data analysis, and revised the manuscript for key intellectual content; Drs Zima, Coker, Bardach, and Berry participated in the design of the study, interpretation of the data, and revised the manuscript for key intellectual content; Dr Hall participated in the design of the study, provided statistical consultation and oversight, participated in interpretation of the data, and revised the manuscript for key intellectual content; and all authors approved the final manuscript as submitted.

WHAT'S KNOWN ON THIS SUBJECT: For a few select complex medical conditions, comorbid mental health conditions are associated with higher hospital resource use.

WHAT THIS STUDY ADDS: Among hospitalizations for the 10 most common medical and 10 most common surgical conditions in 2012, 13.2% had a comorbid mental health condition. Comorbid mental health conditions were associated with an additional 31 729 hospital days and \$90 million in costs.

To cite: Doupnik SK, Lawlor J, Zima BT, et al. Mental Health Conditions and Medical and Surgical Hospital Utilization. *Pediatrics*. 2016;138(6):e20162416

Over the past decade, the prevalence of mental health diagnoses has been rising among pediatric patients seeking acute medical care.¹⁻³ Nearly 1 in 10 US pediatric hospitalizations is for a primary mental health diagnosis, resulting in \$3.5 billion in annual health care system costs.⁴ Mental health conditions are also common in children hospitalized for medical or surgical conditions; at least 1 in 10 US pediatric medical or surgical hospitalizations involve a patient with a mental health condition.⁴ Despite mounting recognition that mental health conditions are common and costly among hospitalized pediatric patients, hospital systems report challenges ensuring adequate resources for patients with mental health conditions.⁵⁻⁷

Current research investigating hospital resource utilization in children with mental health comorbidities has been limited to select conditions. For certain complex medical conditions, such as cystic fibrosis, diabetes, and sickle cell disease, children with physical illness and a comorbid mental health condition have higher hospital utilization than children with no mental health condition.⁸⁻¹¹ In addition, children with attention-deficit/hyperactivity disorder (ADHD)¹²⁻¹⁵ depression¹⁶ or autism^{17,18} have higher rates of hospitalizations and health care costs compared with children without these mental health conditions. Nevertheless, little is known about the epidemiology of co-occurring mental health conditions in pediatric medical and surgical hospitalizations and how comorbid mental health conditions may affect hospital resource utilization.

An in-depth understanding of the prevalence of mental health conditions and their impact on resource utilization can help inform practice and policy in 2 main ways. First, knowledge about

the epidemiology of mental health conditions and their influence on resource utilization in hospitalized children can help inform the allocation of hospital-based mental health resources. Second, understanding the influence of mental health conditions on hospital resource utilization can inform case-mix adjustment methods. Including mental health conditions in case-mix adjustment methods can help ensure that hospitals are not unfairly penalized for different utilization patterns in children with mental health conditions or provision of beneficial hospital-based mental health services.

To address the knowledge gap about the influence of mental health conditions on resource utilization in hospitalized children, we identified pediatric hospitalizations for 10 common medical conditions and 10 common surgical procedures using a large nationally representative sample. For these hospitalizations, we examined how child sociodemographic, clinical, and hospital characteristics vary by presence of ≥ 1 comorbid mental health condition and estimated the association of having at least 1 comorbid mental health condition with hospital length of stay (LOS) and costs.

METHODS

Study Design and Data Source

We conducted a retrospective, cross-sectional study of pediatric medical and surgical hospitalizations in 2012, using the most recent Kids' Inpatient Database (KID). The KID is made available triennially by the Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project (HCUP). The database contains administrative data for a nationally representative sample of pediatric hospitalizations of patients 0 to 20 years old from 4179 acute-care hospitals in 44 states. The

KID includes hospital information, patient demographic information, and *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) discharge diagnoses and procedures, with 1 primary diagnosis and up to 24 additional fields for comorbid diagnoses.

Sample

To create the study sample, we categorized hospitalizations for common medical conditions and surgical procedures, using All Patient Refined Diagnosis-Related Groups (APR-DRGs, 3M Health Information Systems, Salt Lake City, UT). APR-DRGs use all of the ICD-9-CM codes registered for a hospital discharge to assign 1 reason that best explains the need for hospitalization. We selected the 10 medical conditions and 10 surgical procedures with the largest absolute number of hospitalizations with a documented comorbid mental health condition. This sample was chosen to ensure inclusion of hospitalizations where both the primary indication for hospitalization and mental health comorbidity were common. For those 20 conditions, we included all hospitalizations, both those with and without a mental health condition. The study sample was restricted to hospitalizations of children 3 to 20 years of age to create a sample that was within the pediatric purview¹⁹ and did not include infants less likely to need behavioral health services. Transfers and discharges to post-acute care were excluded.

Mental health conditions were classified into diagnosis categories using ICD-9-CM codes, according to a scheme previously used to identify pediatric mental health conditions in hospital discharge data.²⁻⁴ Mental health condition categories included the following: anxiety disorders, ADHD, autism, bipolar disorder, depression, psychoses, reaction disorders (eg, adjustment reaction,

stress reaction), and substance abuse. Some hospitalizations had more than one associated mental health diagnosis because 24 data fields were available for comorbid hospital discharge ICD-9-CM codes.

Covariates

A priori, we selected demographic, clinical, and hospital covariates associated with hospital resource utilization^{20,21} or risk of having a diagnosed mental health condition for inclusion in analyses.⁴ Demographic covariates included patient age, sex, race/ethnicity, payer category, and ZIP code income quartile. Hospital covariates included children's hospital status, hospital location, and hospital teaching status. Clinical covariates included a count of the total number of complex chronic condition diagnoses and indicators for the presence of a complex chronic condition diagnosis in each of 12 organ systems.²²

Analysis

To provide national estimates of hospital resource use, we weighted all analyses using survey weights provided by HCUP and reported results for the weighted study population. We calculated summary statistics for all covariates and compared their distribution for hospitalizations involving comorbid mental health conditions to those without. We estimated the association of a comorbid mental health condition with LOS using generalized linear models with exponential distributions. We modeled LOS within each medical and surgical APR-DRG as well as for the 10 medical APR-DRGs combined and the 10 surgical APR-DRGs combined. All models were adjusted for demographic, clinical, and hospital characteristics described previously. We estimated the financial cost of additional hospital days associated with mental health conditions using mean hospital

charges per day for each APR-DRG adjusted for region-specific hospital cost-to-charge ratios provided by HCUP. To explore whether the influence of mental health conditions varied by patient age, we conducted a sensitivity analysis stratified by age group, modeling LOS separately for 3- to 12-year-old children and for 13- to 20-year-old adolescents.

All statistical analyses were completed by using SAS version 9.4 (SAS Institute, Cary, NC). All tests were 2-sided, and a *P* value <.05 was considered statistically significant. The Children's Hospital of Philadelphia Institutional Review Board deemed this study exempt from review.

RESULTS

Sample Characteristics

The final sample included 670 161 hospitalizations (486 795 medical and 183 365 surgical), representing 48.5% of all US hospital discharges of children aged 3 to 20 years. Among these hospitalizations, 13.2% had at least 1 comorbid mental health condition. Among all hospitalizations in the 2012 KID, at least 1 comorbid mental health condition was present in 15% of hospitalizations. Details of the distribution of comorbid mental health conditions by medical and surgical diagnoses are summarized in Table 1.

Child sociodemographic characteristics, child clinical characteristics, and hospital type are summarized in Table 2. Hospitalizations involving a documented comorbid mental health condition were more likely to involve patients who were older, male, white, and with a complex chronic condition, and they were less likely to occur at a children's hospital (*P* < .001 for all; Table 2).

Contribution of Comorbid Mental Health Conditions to Hospital Resource Use

In 2012, among pediatric hospitalizations for medical or surgical indications, comorbid mental health conditions were associated with longer hospital stay in 9 of 10 medical conditions and 9 of 10 surgical conditions. Longer LOS resulted in an aggregate 31 729 hospital days (95% confidence interval [CI]: 29 085 to 33 492) more than the expected number of inpatient days for hospitalizations with similar clinical and demographic characteristics. The additional hospital days associated with comorbid mental health conditions resulted in an additional \$90 million (95% CI: \$81 million to \$101 million) in hospital costs. Figure 1 summarizes the relationships among volume of hospitalizations, LOS, and hospital charges for the 9 medical and 9 surgical hospital conditions where a mental health condition was associated with longer hospital stay.

The prevalence of individual comorbid mental health conditions and their relationship with LOS for medical and surgical hospitalizations are summarized in Table 3. In multivariable analysis, hospitalizations with multiple mental health conditions had the strongest association with increased hospital resource utilization, contributing an additional 6714 medical hospital days and 3270 surgical hospital days. When ≥2 mental health conditions were present, LOS was 14% longer (95% CI: 13% to 15%) in medical hospitalizations and 30% longer (95% CI: 27 to 33) in surgical hospitalizations.

For medical hospitalizations, depression and anxiety disorders were both common and associated with increased LOS and cost. For medical hospitalizations with comorbid depression, LOS was

TABLE 1 Prevalence of MHCs in Medical and Surgical Diagnosis Groups

APR-DRG	N	N With MHC (%)	Age Median (IQR)	% With MHC		Three Most Common MHCs		
				3–12 y	13–20 y	1	2	3
Medical								
Hospitalizations	486 795	66 629 (13.7)	8 (4–15)	6.9	27.9	ADHD	SA	Anxiety
Asthma	107 157	7 097 (6.6)	6 (3–10)	3.9	23.7	ADHD	SA	Anxiety
Cellulitis	46 486	6 434 (13.8)	11 (4–16)	5.5	25.5	SA	ADHD	Anxiety
Chemotherapy	42 120	4 596 (10.9)	11 (6–16)	7.1	16.3	Anxiety	Depression	ADHD
Constipation	26 922	5 671 (21.1)	10 (6–16)	13.6	33.2	Anxiety	ADHD	SA
Diabetes	47 879	11 790 (24.6)	15 (11–18)	8.9	33.2	SA	Depression	ADHD
Gastroenteritis	38 063	4 082 (10.7)	7 (3–14)	5.1	24.4	SA	ADHD	Anxiety
Headache	12 277	3 451 (28.1)	15 (12–17)	20.0	31.4	Anxiety	Depression	ADHD
Pneumonia	79 025	4 592 (5.8)	5 (3–9)	3.1	21.3	ADHD	SA	Autism
Seizure	57 923	15 022 (25.9)	8 (4–15)	18.5	41.0	ADHD	Autism	Anxiety
UTI	28 943	3 896 (13.5)	12 (5–18)	4.7	23.0	SA	Anxiety	ADHD
Surgical								
Hospitalizations	183 366	21 507 (11.7)	14 (9–17)	5.6	16.2	SA	ADHD	Anxiety
Appendectomy	85 331	6 845 (8.0)	13 (9–17)	4.3	11.6	SA	ADHD	Anxiety
Arm procedures	19 490	1 469 (7.5)	8 (5–14)	3.4	16.9	SA	ADHD	Anxiety
Bowel procedures	7 091	1 272 (17.9)	16 (10–18)	11.2	21.4	SA	Anxiety	ADHD
Craniotomy	14 392	1 569 (15.6)	18 (16–19)	12.6	19.3	ADHD	Anxiety	Autism
Cholecystectomy	10 066	2 714 (18.9)	12 (6–16)	6.3	20.0	SA	Anxiety	Depression
Facial bone procedures	7 380	1 238 (16.8)	17 (15–19)	6.5	19.0	SA	ADHD	Anxiety
Hip procedures	8 575	1 426 (16.6)	13 (9–17)	7.6	24.7	SA	ADHD	Anxiety
Knee procedures	17 769	2 573 (14.5)	15 (12–18)	7.1	17.2	SA	ADHD	Anxiety
Multiple trauma	3 564	1 129 (31.7)	17 (15–19)	16.4	34.8	SA	ADHD	Anxiety
Spinal fusion	9 708	1 271 (13.1)	14 (12–16)	8.8	14.8	ADHD	Anxiety	Autism

Anxiety, anxiety disorders; IQR, interquartile range; MHC, mental health condition; SA, substance abuse; UTI, Urinary tract infection.

TABLE 2 Comparison of Patients With and Without a Comorbid MHC in 10 Medical and 10 Surgical Diagnosis Groups (APR-DRGs)

	Medical APR-DRGs				Surgical APR-DRGs			
	Overall	No MHC	With MHC	P	Overall	No MHC	With MHC	P
Number of hospitalizations	486 795	420 165	66 639	NA	183 366	161 858	21 506	NA
Age, y (mean)	9.4	8.6	14.3	<.001	13.1	12.7	15.9	<.001
Gender (% male)	51.7	51.4	53.2	<.001	56.3	55.6	61.7	<.001
Race/ethnicity (%)				<.001				<.001
White	49.4	47.2	63.6		53.7	52.0	66.9	
Black	20.7	21.3	16.9		10.4	10.1	12.3	
Hispanic	21.3	22.6	13.1		27.1	28.8	14.4	
Other	8.5	8.9	6.4		8.8	9.2	6.4	
Payer (%)				<.001				<.001
Public	49.3	49.7	46.8		37.5	37.6	37.1	
Private	41.8	41.9	41.3		51.2	51.6	48.4	
Other (self-pay, charity care)	8.9	8.4	11.9		11.3	10.8	14.5	
Patient's ZIP code median annual income (%)				<.001				<.001
<\$39 000	33.7	34.2	30.7		28.0	27.8	29.5	
\$39 000-\$47 999	24.0	23.9	24.4		23.8	23.7	25.0	
\$48 000-\$63 999	22.4	22.2	23.5		24.2	24.3	23.1	
≥\$64 000	20.0	19.8	21.4		24.0	24.2	22.3	
Any complex chronic condition (%)	29.6	28.2	38.3	<.001	18.8	17.9	24.9	<.001
Number of chronic conditions (mean)	0.40	0.38	0.49	<.001	0.24	0.23	0.32	<.001
Number of discharge diagnoses (mean)	4.1	3.5	6.1	<.001	3.1	2.7	5.6	<.001
Children's hospital admission (%)	24.9	25.3	22.0	<.001	20.7	21.7	13.1	<.001
Hospital category (%)				<.001				<.001
Rural	9.3	9.4	8.6		7.6	7.4	8.7	
Urban nonteaching	20.4	20.3	20.9		25.5	25.7	24.2	
Urban teaching	70.3	70.3	70.5		66.9	66.9	67.1	

MHC, mental health condition; NA, not applicable.

9% longer (95% CI: 7% to 12%), and with a comorbid anxiety disorder, LOS was 13% longer (95% CI: 11% to 15%). For surgical hospitalizations, substance abuse and anxiety disorders were both common and associated with increased LOS and cost. For surgical hospitalizations with comorbid

substance abuse, LOS was 10% longer (95% CI: 7% to 12%), and with a comorbid anxiety disorder, LOS was 21% longer (95% CI: 17% to 25%). Psychoses and reaction disorders were associated with substantial increases in LOS of 20% to 41%, though the conditions affected a relatively small number

of patients (Psychosis $n = 1159$; Reaction Disorders $n = 3291$).

Medical Hospitalizations

Among medical hospitalizations, 13.7% ($n = 88\,136$) were affected by at least 1 comorbid mental health condition. The most common comorbid mental health conditions were ADHD ($n = 19\,092$; 3.9%), substance abuse ($n = 18\,546$; 3.8%), and anxiety disorders ($n = 14\,116$; 2.9%). Mental health conditions were most prevalent in hospitalizations for headache (28.1%; $n = 3541$). Comorbid mental health conditions were present in 27.9% ($n = 43\,960$) of medical hospitalizations of adolescents and in 6.9% ($n = 22\,669$) of medical hospitalizations of 3- to 12-year-old children. Among medical hospitalizations, 19.4% ($n = 12\,946$) with any comorbid mental health condition had 2 unique mental health conditions, and 7.6% ($n = 5084$) had ≥ 3 .

Among medical hospitalizations, adjusted LOS was significantly longer ($P < .001$) for hospitalizations involving any mental health condition in 9 of the 10 medical conditions in the study sample, (ie, all included medical conditions except asthma; Fig 2). Mental health conditions were associated with an 8.8% (95% CI: 8.0% to 10.0%) longer hospital stay

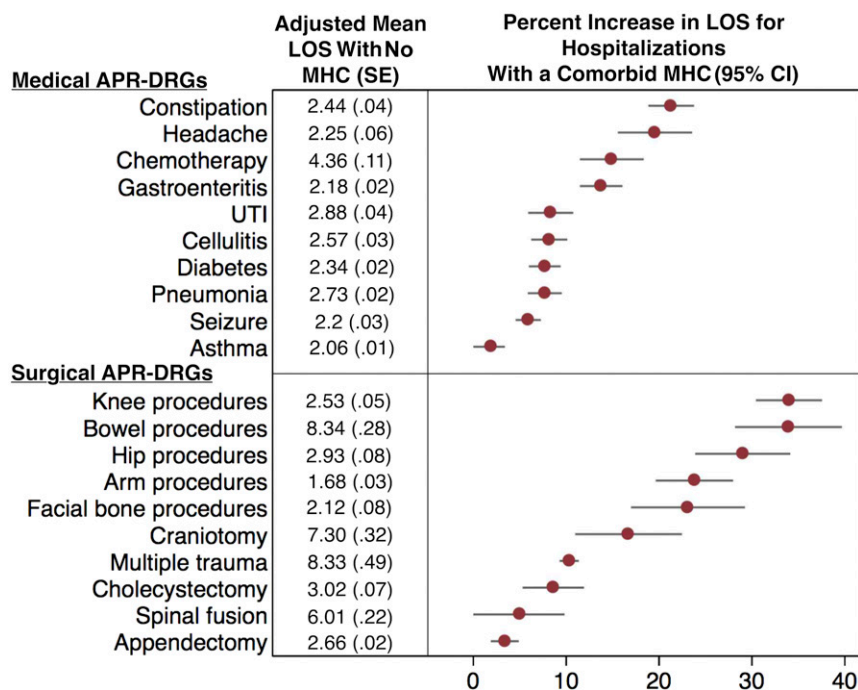


FIGURE 1 National US pediatric hospital costs and LOS associated with comorbid mental health conditions by primary hospital diagnoses. Marker size is proportional to the number of hospitalizations in each APR-DRG with a comorbid mental health condition. Models adjusted for age, sex, race, payer, ZIP code income quartile, number of chronic condition diagnoses, complex chronic condition diagnoses, children's hospital status, hospital location and teaching status, and APR-DRG. UTI, urinary tract infection.

TABLE 3 Prevalence of MHC and Relationship With Hospital LOS

MHC	Medical APR-DRGs				Surgical APR-DRGs	
	Affected by MHC ^a		% Difference in LOS ^b , (95% CI)	Affected by MHC ^a		% Difference in LOS ^b , (95% CI)
	<i>n</i>	%		<i>n</i>	%	
ADHD	19 092	3.9	-3% (-4 to -1%)	6 527	3.6	-1% (-4% to 1%)
Anxiety	14 116	2.9	13% (11% to 15%)	3 630	2.0	21% (17% to 25%)
Autism	9 797	2.0	3% (1% to 5%)	1 657	0.9	5% (0% to 11%)
Bipolar disorder	5 581	1.1	4% (1% to 7%)	1 191	0.6	10% (3% to 16%)
Depression	10 871	2.2	9% (7% to 12%)	2 203	1.2	16% (11% to 21%)
Psychosis	954	0.2	20% (12% to 28%)	205	0.1	41% (23% to 61%)
Reaction disorder	2 744	0.6	39% (33% to 44%)	547	0.3	26 (8% to 47%)
Substance abuse	18 546	3.8	-4% (-5 to -3%)	9 468	5.2	10 (7% to 12%)
Multiple MHCs	18 031	3.7	14% (13% to 15%)	4 098	2.2	30 (27% to 33%)

MHC, mental health condition.

^a A hospitalization may be represented more than once if >1 MHC was documented.

^b Models adjusted for age, sex, race, payer, ZIP code income quartile, number of complex condition diagnoses, complex chronic condition diagnoses, children's hospital status, hospital location and teaching status, and APR-DRG.

in medical hospitalizations (mean [SE] LOS: 2.50 [0.01] days vs 2.72 [0.01] days, $P < .001$). Of the medical hospitalizations studied, comorbid mental health conditions had the greatest impact on LOS and cost for chemotherapy admissions (LOS increase 14.9%, 95% CI: 11.2% to 19.0%; Fig 2).

Surgical Hospitalizations

Among surgical hospitalizations, 11.7% had at least 1 comorbid mental health condition. The most common comorbid mental health conditions were substance abuse ($n = 9468$; 5.2%), ADHD ($n = 6527$; 3.6%), and anxiety disorders ($n = 3630$; 2.0%). The highest prevalence of comorbid mental health conditions was observed in hospitalizations for multiple trauma (31.7%; $n = 1129$). Comorbid mental health conditions were present in 16.2% ($n = 43\,960$) of surgical hospitalizations of adolescents compared with 5.6% ($n = 4381$) of surgical hospitalizations of 3- to 12-year-old children. Among surgical hospitalizations, 14.4% ($n = 3103$) with any comorbid mental health condition had 2 unique mental health conditions, and 4.6% ($n = 994$) had ≥ 3 .

Among surgical hospitalizations, adjusted LOS was longer for hospitalizations involving any mental health condition in 9 of the 10 surgical conditions in the study sample, all included surgical conditions except spinal fusion (Fig 2). Mental health conditions were associated with 16.9% (95% CI: 15.1% to 18.8%) longer hospital stay in surgical hospitalizations [mean [SE] LOS 3.56 [0.02] days vs 4.16 [0.04] days, $P < .001$]. Of the surgical hospitalizations studied, comorbid mental health conditions had the greatest impact on both LOS and cost for bowel procedures (Fig 1).

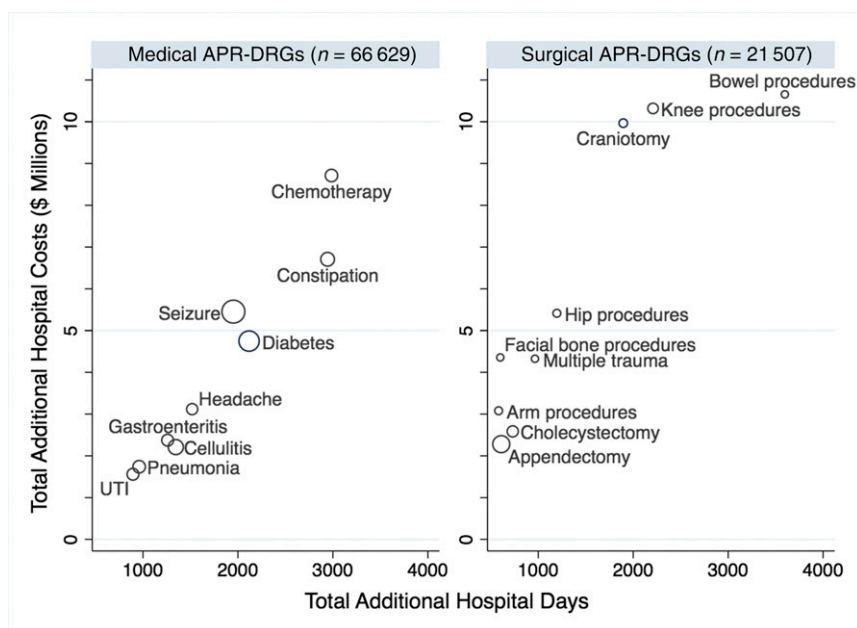


FIGURE 2

Influence of a comorbid MHC on LOS in common pediatric medical and surgical hospitalizations. Models adjusted for age, sex, race, payer, ZIP code income quartile, number of chronic condition diagnoses, complex chronic condition diagnoses, children's hospital status, hospital category. MHC, mental health condition; UTI, urinary tract infection.

Influence of Age

A sensitivity analysis stratified by age group showed that hospital stay was longer if a patient had a documented comorbid mental health condition for the majority of medical and surgical conditions in both 3- to 12-year-old children and 13- to 20-year-old adolescents. Adolescents had more than twice as many additional hospital days associated with comorbid mental health conditions compared with 3- to 12-year-old children (20 358 days vs 8517 days, respectively). The main driver of this finding was higher prevalence of mental health conditions among adolescents. Among hospitalizations for 3- to 12-year-old children, LOS was prolonged in 8 of 10 medical conditions ($P = .01$ to $P < .001$); LOS was not prolonged in asthma or cellulitis. For these younger children, LOS was prolonged in 6 of 10 surgical conditions ($P = .01$ to $P < .001$). Mental health conditions were not associated with prolonged LOS

for younger children hospitalized for appendectomy, craniotomy, facial bone procedures, or spinal fusion. Among hospitalizations for 13- to 20-year-old adolescents, LOS was prolonged in all 10 medical conditions ($P = .03$ to $P < .001$) and in 8 of 10 surgical conditions ($P = .02$ to $P < .001$). For adolescents, mental health conditions were not associated with prolonged LOS in spinal fusion and multiple trauma.

DISCUSSION

Findings from the current study suggest that comorbid mental health conditions were present in ~ 1 in 7 US hospitalizations of 3- to 20-year-old children and adolescents in 2012. The presence of a comorbid mental health condition was associated with a longer LOS and higher costs for common medical and surgical conditions. In aggregate, mental health conditions were associated

with an additional 31 729 hospital days and \$90 million in hospital costs in 2012. The present findings identify 3 issues pertinent to the future of mental health care for hospitalized pediatric patients.

First, our findings suggest that adolescents are a priority population for the development of a standard approach to hospital-based mental health care during medical and surgical hospitalizations. The current study found that hospitalized adolescents experience three- to fourfold higher rates of mental health comorbidity than younger children, and the majority of additional hospital days and costs associated with comorbid mental health conditions were incurred by adolescents. Because many adolescents have undiagnosed mental health conditions,²³⁻²⁵ the population of hospitalized adolescents who could benefit from mental health support is likely larger than the population identified in the current study. Current practice recommendations for adolescent mental health care address outpatient settings,^{19,26-28} and a paucity of evidence guides mental health care for hospitalized adolescents. However, 2 models can inform an approach to mental health care for hospitalized adolescents. Pediatric hospital trauma care provides a model for substance abuse screening and interventions,²⁹⁻³² and suicide prevention efforts have developed an evidence base to support screening hospitalized adolescents for suicidal ideation.³³⁻³⁵ These models can also serve as a guide for future investigation of patient's perspectives on mental health interventions during physical illness.³³

Second, findings from this study identify depression, anxiety disorders, and substance abuse as priority conditions for quality

improvement interventions to potentially reduce hospital resource use. Depression, anxiety, and substance abuse were the 3 types of mental health conditions associated with the greatest additional resource use, which is consistent with a growing body of evidence showing that these conditions are associated with worse hospital outcomes.^{8-11,30,36} Possible explanations for greater hospital resource use include longer LOS due to lower ability to cope with pain and other symptoms of acute illness,³⁷⁻⁴⁰ lower adherence to treatment plans,⁴¹⁻⁴³ and more care coordination needs^{44,45} than patients without these conditions. Investment in hospital-based mental health clinicians with skills in addressing these conditions could benefit both patients and health systems if targeted interventions were found to reduce LOS. Nevertheless, given the current shortage of hospital-based mental health clinicians,^{5,6} findings from this study also support future research to examine hospital capacity to care for children with psychiatric disorders to inform resource allocation and workforce development.

Third, accounting for the presence of comorbid mental health conditions in hospital case-mix adjustment methods may help promote the provision of hospital-based mental health services. Case-mix adjustment can ensure that hospitals are not unfairly penalized for providing beneficial hospital-based mental health services that may increase LOS. The present finding that hospitalized pediatric patients with mental health conditions have higher hospital resource utilization supports the concept that, like the physical health comorbidities commonly included in case-mix adjustment methods,^{22,46,47} mental health

comorbidities complicate hospital care. That said, much remains to be learned about mechanisms driving differences in outcomes between patients with and without mental health comorbidity, and future research is necessary to understand whether additional resource utilization is beneficial to patients. For example, are additional hospital days in patients with mental health conditions a marker of higher-quality care due to interventions such as mental health specialty consultation? Or are they a marker of lower-quality care, such as delays in diagnosis or avoidable medical complications? Until factors driving utilization patterns are better understood, case-mix adjustment methods for mental health conditions may prevent hospitals from being penalized for offering mental health care to medical and surgical inpatients.

The current study has several limitations. First, rates of documentation and administrative coding of comorbid mental health conditions during an inpatient stay may vary depending on characteristics of a patient's physical illness, mental health condition, and the treating clinician and health system.⁴⁸ Furthermore, administrative data cannot be used to identify patients with undiagnosed mental health conditions. Although diagnoses documented during the hospitalization may have imperfect sensitivity for identifying mental health conditions, they are likely specific because a mental health condition is unlikely to be coded if no mental health condition was diagnosed or reported in the patient's history. Thus, limitations inherent to administrative data may underestimate the influence of mental health conditions

on utilization. Second, in this observational study, unmeasured confounding factors not measured in hospital discharge data, such as parental mental health status or severity of physical health condition, could account for the relationship between child mental health conditions and hospital LOS.

CONCLUSIONS

Documented comorbid mental health conditions are present in 1 in 7 pediatric medical and surgical hospitalizations. Having

a documented comorbid mental health condition at the time of hospitalization is associated with longer hospital stay and higher hospital costs. Priority areas for future work in pediatric hospital-based mental health care include developing a standard approach to mental health issues in hospitalized adolescents, building hospital clinical teams skilled in addressing depression, anxiety, and substance abuse and ensuring that case-mix adjustment methods account for the influence of mental health conditions on resource utilization.

ABBREVIATIONS

ADHD: attention-deficit/hyperactivity disorder

APR-DRGs: All Patient Refined Diagnosis-Related Groups

CI: confidence interval

HCUP: Healthcare Cost and Utilization Project

ICD-9-CM: *International Classification of Diseases, Ninth Revision, Clinical Modification*

KID: Kids' Inpatient Database

LOS: length of stay

DOI: 10.1542/peds.2016-2416

Accepted for publication Sep 6, 2016

Address correspondence to Stephanie Doupnik, MD, Division of General Pediatrics, Children's Hospital of Philadelphia, 3401 Civic Center Blvd, CHOP North, Room 1451, Philadelphia, PA 19104. E-mail: doupniks@chop.edu

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

Copyright © 2016 by the American Academy of Pediatrics

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

FUNDING: Dr Doupnik was supported by a Ruth L. Kirschstein National Research Service Award institutional training grant (T32-HP010026-11), funded by the National Institutes of Health. Dr Zima was supported by the National Institute of Mental Health (grant P30MH082760) and Behavioral Health Centers of Excellence for California (grant SB852). Drs Coker and Bardach were supported by the National Institute of Child Health and Human Development (grants K23-HD06267 and K23HD065836). Dr Berry was supported by the Agency for Healthcare Research and Quality (grant R21 HS023092-01). Funded by the National Institutes of Health (NIH).

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

REFERENCES

1. Merikangas KR, Nakamura EF, Kessler RC. Epidemiology of mental disorders in children and adolescents. *Dialogues Clin Neurosci*. 2009;11(1):7–20
2. Torio CM, Encinosa W, Berdahl T, McCormick MC, Simpson LA. Annual report on health care for children and youth in the United States: national estimates of cost, utilization and expenditures for children with mental health conditions. *Acad Pediatr*. 2015;15(1):19–35
3. Zima BT, Rodean J, Hall M, Bardach NS, Coker TR, Berry JG. Ten year national trends in pediatric hospitalizations by psychiatric complexity. Paper presented at the *62nd Annual Meeting of the American Academy of Child and Adolescent Psychiatry*, October 26, 2015; San Antonio, TX
4. Bardach NS, Coker TR, Zima BT, et al. Common and costly hospitalizations for pediatric mental health disorders. *Pediatrics*. 2014;133(4):602–609
5. Shaw RJ, Wamboldt M, Bursch B, Stuber M. Practice patterns in pediatric consultation-liaison psychiatry: a national survey. *Psychosomatics*. 2006;47(1):43–49
6. Bierenbaum ML, Katsikas S, Furr A, Carter BD. Factors associated with non-reimbursable activity on an inpatient pediatric consultation-liaison service. *J Clin Psychol Med Settings*. 2013;20(4):464–472
7. Claudius I, Donofrio JJ, Lam CN, Santillanes G. Impact of boarding pediatric psychiatric patients on a medical ward. *Hosp Pediatr*. 2014;4(3):125–132
8. Myrvik MP, Burks LM, Hoffman RG, Dasgupta M, Panepinto JA. Mental health disorders influence admission rates for pain in children with sickle cell disease. *Pediatr Blood Cancer*. 2013;60(7):1211–1214
9. Myrvik MP, Campbell AD, Davis MM, Butcher JL. Impact of psychiatric diagnoses on hospital length of stay in children with sickle cell anemia. *Pediatr Blood Cancer*. 2012;58(2):239–243
10. Garrison MM, Katon WJ, Richardson LP. The impact of psychiatric comorbidities on readmissions for diabetes in youth. *Diabetes Care*. 2005;28(9):2150–2154
11. Snell C, Fernandes S, Bujoreanu IS, Garcia G. Depression, illness severity, and healthcare utilization

- in cystic fibrosis. *Pediatr Pulmonol*. 2014;49(12):1177–1181
12. Swensen A, Birnbaum HG, Ben Hamadi R, Greenberg P, Cremieux P-Y, Secnik K. Incidence and costs of accidents among attention-deficit/hyperactivity disorder patients. *J Adolesc Health*. 2004;35(4):346.e1–346.e9
 13. Meyers J, Classi P, Wietecha L, Candrilli S. Economic burden and comorbidities of attention-deficit/hyperactivity disorder among pediatric patients hospitalized in the United States. *Child Adolesc Psychiatry Ment Health*. 2010;4:31
 14. Guevara J, Lozano P, Wickizer T, Mell L, Gephart H. Utilization and cost of health care services for children with attention-deficit/hyperactivity disorder. *Pediatrics*. 2001;108(1):71–78
 15. Chan E, Zhan C, Homer CJ. Health care use and costs for children with attention-deficit/hyperactivity disorder: national estimates from the medical expenditure panel survey. *Arch Pediatr Adolesc Med*. 2002;156(5):504–511
 16. Richardson LP, Russo JE, Lozano P, McCauley E, Katon W. The effect of comorbid anxiety and depressive disorders on health care utilization and costs among adolescents with asthma. *Gen Hosp Psychiatry*. 2008;30(5):398–406
 17. Lokhandwala T, Khanna R, West-Strum D. Hospitalization burden among individuals with autism. *J Autism Dev Disord*. 2012;42(1):95–104
 18. Croen LA, Najjar DV, Ray GT, Lotspeich L, Bernal P. A comparison of health care utilization and costs of children with and without autism spectrum disorders in a large group-model health plan. *Pediatrics*. 2006;118(4). Available at: www.pediatrics.org/cgi/content/full/118/4/e1203
 19. Hagan J, Shaw J, Duncan P. *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents*. 3rd ed. Elk Grove Village, IL: The American Academy of Pediatrics; 2008
 20. Gallaher MM, Christakis DA, Connell FA. Health care use by children diagnosed as having developmental delay. *Arch Pediatr Adolesc Med*. 2002;156(3):246–251
 21. Feudtner C, Hays RM, Haynes G, Geyer JR, Neff JM, Koepsell TD. Deaths attributed to pediatric complex chronic conditions: national trends and implications for supportive care services. *Pediatrics*. 2001;107(6). Available at: www.pediatrics.org/cgi/content/full/107/6/E99
 22. Feudtner C, Feinstein JA, Zhong W, Hall M, Dai D. Pediatric complex chronic conditions classification system version 2: updated for ICD-10 and complex medical technology dependence and transplantation. *BMC Pediatr*. 2014;14(1):199
 23. Costello EJ, Angold A, Burns BJ, et al. The Great Smoky Mountains Study of Youth. Goals, design, methods, and the prevalence of DSM-III-R disorders. *Arch Gen Psychiatry*. 1996;53(12):1129–1136
 24. Merikangas KR, He JP, Burstein M, et al. Lifetime prevalence of mental disorders in U.S. adolescents: results from the National Comorbidity Survey Replication—Adolescent Supplement (NCS-A). *J Am Acad Child Adolesc Psychiatry*. 2010;49(10):980–989
 25. Costello EJ, He JP, Sampson NA, Kessler RC, Merikangas KR. Services for adolescents with psychiatric disorders: 12-month data from the National Comorbidity Survey-Adolescent. *Psychiatr Serv*. 2014;65(3):359–366
 26. O'Connor E, Gaynes BN, Burda BU, Soh C, Whitlock EP. Screening for and treatment of suicide risk relevant to primary care: a systematic review for the U.S. Preventive Services Task Force. *Ann Intern Med*. 2013;158(10):741–754
 27. Siu AL; US Preventive Services Task Force. Screening for Depression in Children and Adolescents: US Preventive Services Task Force Recommendation Statement. *Pediatrics*. 2016;137(3):e20154467
 28. Community Preventive Services Task Force. Recommendation from the community preventive services task force for use of collaborative care for the management of depressive disorders. *Am J Prev Med*. 2012;42(5):521–524
 29. Johnson KN, Raetz A, Harte M, et al. Pediatric trauma patient alcohol screening: a 3 year review of screening at a Level I pediatric trauma center using the CRAFFT tool. *J Pediatr Surg*. 2014;49(2):330–332
 30. Kelleher DC, Renaud EJ, Ehrlich PF, Burd RS; Pediatric Trauma Society Guidelines Committee. Guidelines for alcohol screening in adolescent trauma patients: a report from the Pediatric Trauma Society Guidelines Committee. *J Trauma Acute Care Surg*. 2013;74(2):671–682
 31. Nicolson NG, Lank PM, Crandall ML. Emergency department alcohol and drug screening for Illinois pediatric trauma patients, 1999 to 2009. *Am J Surg*. 2014;208(4):531–535
 32. Mello MJ, Bromberg J, Baird J, et al. Translation of alcohol screening and brief intervention guidelines to pediatric trauma centers. *J Trauma Acute Care Surg*. 2013;75(4 suppl 3):S301–S307
 33. Ross AM, White E, Powell D, Nelson S, Horowitz L, Wharff E. To ask or not to ask? Opinions of pediatric medical inpatients about suicide risk screening in the hospital. *J Pediatr*. 2016;170:295–300
 34. Horowitz LM, Bridge JA, Pao M, Boudreaux ED. Screening youth for suicide risk in medical settings: time to ask questions. *Am J Prev Med*. 2014;47(3 suppl 2):S170–S175
 35. Bridge JA, Horowitz LM, Fontanella CA, Grupp-Phelan J, Campo JV. Prioritizing research to reduce youth suicide and suicidal behavior. *Am J Prev Med*. 2014;47(3 suppl 2):S229–S234
 36. Doupnik SK, Mitra N, Feudtner C, Marcus SC. The influence of comorbid mood and anxiety disorders on outcomes of pediatric patients hospitalized for pneumonia. *Hosp Pediatr*. 2016;6(3):135–142
 37. Compas BE, Jaser SS, Dunn MJ, Rodriguez EM. Coping with chronic illness in childhood and adolescence. *Annu Rev Clin Psychol*. 2012;8(1):455–480
 38. Marsac ML, Funk JB, Nelson L. Coping styles, psychological functioning and quality of life in children with asthma. *Child Care Health Dev*. 2007;33(4):360–367
 39. Whiteside LK, Russo J, Wang J, Ranney ML, Neam V, Zatzick DF. Predictors of sustained prescription opioid use after

- admission for trauma in adolescents. *J Adolesc Health*. 2016;58(1): 92–97
40. Sansone RA, Watts DA, Wiederman MW. Pain, pain catastrophizing, and past mental healthcare utilization. *J Psychosom Res*. 2014;76(2): 169–171
 41. Barton C, Clarke D, Sulaiman N, Abramson M. Coping as a mediator of psychosocial impediments to optimal management and control of asthma. *Respir Med*. 2003;97(7):747–761
 42. Bernstein CM, Stockwell MS, Gallagher MP, Rosenthal SL, Soren K. Mental health issues in adolescents and young adults with type 1 diabetes: prevalence and impact on glycemic control. *Clin Pediatr (Phila)*. 2013;52(1):10–15
 43. Jaser SS, White LE. Coping and resilience in adolescents with type 1 diabetes. *Child Care Health Dev*. 2011;37(3):335–342
 44. Brown NM, Green JC, Desai MM, Weitzman CC, Rosenthal MS. Need and unmet need for care coordination among children with mental health conditions. *Pediatrics*. 2014;133(3). Available at: www.pediatrics.org/cgi/content/full/133/3/e530
 45. Borowsky IW. Expose, heed, and coordinate care: priorities for mental health promotion and suicide prevention. *Pediatrics*. 2010;125(5):1064–1065
 46. Simon TD, Cawthon ML, Stanford S, et al; Center of Excellence on Quality of Care Measures for Children with Complex Needs (COE4CCN) Medical Complexity Working Group. Pediatric medical complexity algorithm: a new method to stratify children by medical complexity. *Pediatrics*. 2014;133(6). Available at: www.pediatrics.org/cgi/content/full/133/6/e1647
 47. Silber JH, Rosenbaum PR, Ross RN, et al. Template matching for auditing hospital cost and quality. *Health Serv Res*. 2014;49(5):1446–1474
 48. Rushton JL, Felt BT, Roberts MW. Coding of pediatric behavioral and mental disorders. *Pediatrics*. 2002;110(1 pt 1):e8–e8

Mental Health Conditions and Medical and Surgical Hospital Utilization
Stephanie K. Doupnik, John Lawlor, Bonnie T. Zima, Tumaini R. Coker, Naomi S.
Bardach, Matt Hall and Jay G. Berry

Pediatrics 2016;138;

DOI: 10.1542/peds.2016-2416 originally published online November 11, 2016;

Updated Information & Services

including high resolution figures, can be found at:
<http://pediatrics.aappublications.org/content/138/6/e20162416>

References

This article cites 46 articles, 12 of which you can access for free at:
<http://pediatrics.aappublications.org/content/138/6/e20162416#BIBL>

Subspecialty Collections

This article, along with others on similar topics, appears in the following collection(s):
Hospital Medicine
http://www.aappublications.org/cgi/collection/hospital_medicine_sub
Psychiatry/Psychology
http://www.aappublications.org/cgi/collection/psychiatry_psychology_sub

Permissions & Licensing

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:
<http://www.aappublications.org/site/misc/Permissions.xhtml>

Reprints

Information about ordering reprints can be found online:
<http://www.aappublications.org/site/misc/reprints.xhtml>

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®



PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Mental Health Conditions and Medical and Surgical Hospital Utilization

Stephanie K. Doupnik, John Lawlor, Bonnie T. Zima, Tumaini R. Coker, Naomi S. Bardach, Matt Hall and Jay G. Berry

Pediatrics 2016;138;

DOI: 10.1542/peds.2016-2416 originally published online November 11, 2016;

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/138/6/e20162416>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 345 Park Avenue, Itasca, Illinois, 60143. Copyright © 2016 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®

