Readmissions Following Hospitalization for Infection in Children With or Without Medical Complexity

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OBJECTIVE: To describe the prevalence and characteristics of infection-related readmissions in children and to identify opportunities for readmission reduction and estimate associated cost savings.

STUDY DESIGN: Retrospective analysis of 380,067 nationally representative index hospitalizations for children using the 2014 Nationwide Readmissions Database. We compared 30-day, all-cause unplanned readmissions and costs across 22 infection categories. We used the Inpatient Essentials database to measure hospital-level readmission rates and to establish readmission benchmarks for individual infections. We then estimated the number of readmissions avoided and costs saved if hospitals achieved the 10th percentile of hospitals' readmission rates (ie, readmission benchmark). All analyses were stratified by the presence/absence of a complex chronic condition (CCC).

RESULTS: The overall 30-day readmission rate was 4.9%. Readmission rates varied substantially across infections and by presence/absence of a CCC (CCC: range,

0%-21.6%; no CCC: range, 1.5%-8.6%). Approximately 42.6% of readmissions (n = 3,576) for children with a CCC and 54.7% of readmissions (n = 5,507) for children without a CCC could have been potentially avoided if hospitals achieved infection-specific benchmark readmission rates, which could result in an estimated savings of $70.8 million and $44.5 million, respectively. Bronchiolitis, pneumonia, and upper respiratory tract infections were among infections with the greatest number of potentially avoidable readmissions and cost savings for children with and without a CCC.

CONCLUSION: Readmissions following hospitalizations for infection in children vary significantly by infection type. To improve hospital resource use for infections, future preventative measures may prioritize children with complex chronic conditions and those with specific diagnoses (eg, respiratory illnesses). *Journal of Hospital Medicine* 2021;16:134-141. © 2021 Society of Hospital Medicine

H ospitalizations for infections are common in children, with respiratory illnesses, including pneumonia and bronchiolitis, among the most prevalent indications for hospitalization.[1,2] Infections are also among the most frequent indications for all-cause readmissions and for potentially preventable readmissions in children.[3-5] Beyond hospital resource use, infection hospitalizations and readmissions represent a considerable cause of life disruption for patients and their families.[6,7] While emerging evidence supports shortened durations of parenteral antibiotics before transitioning to oral therapy for some infections (eg, pyelonephritis,

osteomyelitis),[8-10] other infections may require extended treatment courses for weeks. The risk of adverse outcomes (eg, complications of medical treatment, readmission risk) and burdens placed on patients and their families may therefore differ across infection types and extend well beyond the immediate hospitalization.

Although infections are common and pediatric providers are expected to have proficiency in managing infections, substantial variation in the management of common pediatric infections exists and is associated with adverse hospitalization outcomes, including increased readmission risk and healthcare costs.[11-18] Potentially avoidable resource use associated with hospital readmission from infection has led to adoption of hospital-level readmission metrics as indicators of the quality of healthcare delivery. For example, the Pediatric Quality Measures Program, established by the Children's Health Insurance Program Reauthorization Act of 2009, has prioritized measurement of readmissions following hospitalization for lower respiratory tract infection.[19] With government agencies increasingly

using readmission metrics to assess quality of healthcare delivery, developing metrics that focus on these resource-intensive conditions is essential.

Because infections are a common and costly indication for hospital resource use and because substantial variation in management has been observed, promoting a broader understanding of infection-specific readmission rates is important for prioritizing readmission-reduction opportunities in children. This study's objectives were the following: (1) to describe the prevalence and characteristics of infection hospitalizations in children and their associated readmissions and (2) to estimate the number of readmissions avoided and costs saved if all hospitals achieved the 10th percentile of the hospitals' risk-adjusted readmission rate (ie, readmission benchmark).

METHODS

Study Design and Data Source
We performed a retrospective cohort analysis using the 2014 Agency for Healthcare Research and Quality (AHRQ) Nationwide Readmissions Database (NRD).[20] The 2014 NRD is an administrative database that contains information on inpatient stays from January 1, 2014, to December 31, 2014, for all payers and allows for weighted national estimates of readmissions for all US individuals. Data within NRD are aggregated from 22 geographically diverse states representing approximately one-half of the US population. NRD contains deidentified patient-level data with unique verified patient identifiers to track individuals within and across hospitals in a state. However, AHRQ guidelines specify that NRD cannot be used for reporting hospital-specific readmission rates. Thus, for the current study, the Inpatient Essentials (Children's Hospital Association), or IE, database was used to measure hospital-level readmission rates and to distinguish benchmark readmission rates for individual infection diagnoses.[21] The IE database is composed of 90 children's hospitals distributed throughout all regions of the United States. The inclusion of free-standing children's hospitals and children's hospitals within adult hospitals allows for comparisons and benchmarking across hospitals on multiple metrics, including readmissions.

Study Population
Children 0 to 17 years of age with a primary diagnosis at the index admission for infection between January 1, 2014, and November 30, 2014, were included. The end date of November 30, 2014, allowed for a full 30-day readmission window for all index admissions. We excluded index admissions that resulted in transfer to another acute care hospital or in-hospital mortality. Additionally, we excluded index admissions of children who had hematologic or immunologic conditions, malignancy, or history of bone marrow and solid-organ transplant, using the classification system for complex chronic conditions (CCCs) from Feudtner et al.[22] Due to the high likelihood of immunosuppression in patients with these conditions, children may have nuanced experiences with illness severity, trajectory, and treatment associated with infection that place them at increased risk for nonpreventable readmission.

Main Exposure
The main exposure was infection type during the index admission. Condition-specific index admissions were identified using AHRQ's Clinical Classifications Software (CCS) categories.[23] CCS is a classification schema that categorizes the greater than 14,000 *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) diagnosis codes and 3,900 *ICD-9-CM* procedure codes into clinically meaningful categories of 295 diagnosis (including mental health codes and E-codes) and 231 procedural groupings. Twenty-two groupings indicative of infection were distinguished and used for the current study. Examples of infections included aspiration pneumonia, pneumonia, bronchiolitis, and sexually transmitted infection. We combined related CCS categories when possible for ease of interpretation and presentation of data (Appendix Table 1).

Main Outcome Measure
The main outcome measure was 30-day hospital readmission. Readmission was defined as all-cause, unplanned admission within 30 days following discharge from a preceding hospitalization. Planned hospital readmissions were identified and excluded using methods from AHRQ's Pediatric All-Condition Readmission Measure.[24] We defined a same-cause return as a return with the same CCS infection category as the index admission. Costs associated with readmissions were estimated from charges using hospital-specific cost-to-charge ratios provided with NRD.

Patient Demographic and Clinical Characteristics
Patient demographic characteristics included age at index admission (<1 year, 1-5 years, 6-9 years, 10-14 years, and 15-18 years), sex, payer (ie, government, private, other), and discharge disposition (ie, routine, home health, other). We assessed all patients for medical complexity, as defined by the presence of at least one CCC, and we reported the categories of CCCs by organ system involved.[22] Otherwise, patients were identified as without medical complexity.

Statistical Analysis
We summarized continuous variables with medians and interquartile ranges and categorical variables with frequencies and percentages. To develop benchmark readmission rates for each infection type, we used generalized linear mixed models with random intercepts for each hospital in the IE database. For each infection type, the benchmark readmission rate was defined as the 10th percentile of hospitals' risk-adjusted readmission rates. The 10th percentile was chosen to identify the best performing 10% of hospitals (ie, hospitals with the lowest readmission rates). Because children with medical complexity account for a large proportion of hospital resource use and are at high risk for readmission,[4,25] we developed benchmarks stratified by presence/absence of a CCC (ie, with complexity vs without complexity). Models were adjusted for severity of illness using the Hospitalization Resource Intensity Score for Kids (H-RISK),[26] a scoring system that assigns relative weights

for each All Patient Refined Diagnosis-Related Group (3M Corporation) and severity of illness level, and each hospital's risk-adjusted readmission rate was determined.

With use of weights to achieve national estimates of index admissions and readmissions, we determined the number of potentially avoidable readmissions by calculating the number of readmissions observed in the NRD that would not occur if all hospitals achieved readmission rates equal to the 10th percentile. Avoidable costs were estimated by multiplying the number of potentially avoidable readmissions by the mean cost of a readmission for infections of that type. Estimates of avoidable readmissions and costs were stratified by medical complexity. In addition to describing estimates at the 10th percentile benchmark, we similarly developed estimates of potentially avoidable readmissions and avoidable costs for the 5th and 25th percentiles, which are presented within Appendix Table 2 (children without complexity) and Appendix Table 3 (children with complexity).

All statistical analyses were performed using SAS version 9.4 (SAS Institute), and *P* values <.001 were considered statistically significant due to the large sample size. The Office of Research Integrity at Children's Mercy Hospital deemed this study exempt from institutional board review.

RESULTS
Characteristics of the Study Population
The study included 380,067 index admissions for infection and an accompanying 18,469 unplanned all-cause readmissions over the 30 days following discharge (readmission rate, 4.9%; Table 1). Children ages 1 to 5 years accounted for the largest percentage (32.9%) of index hospitalizations, followed by infants younger than 1 year (30.3%). The readmission rate by age group was highest for infants younger than 1 year, compared with rates among all other age groups (5.6% among infants < 1 year vs 4.4%-4.7% for other age groups; *P* < .001). In the overall cohort, 16.2% of admissions included patients with a CCC. Children with medical complexity had higher readmission rates than those without medical complexity (no CCC, 3.2%; 1 CCC, 9.2%; 2+ CCCs, 18.9%). A greater percentage of children experiencing a readmission had government insurance (63.0% vs 59.2%; *P* < .001) and received home health nursing (10.1% vs 2.7%; *P* < .001) following the index encounter.

Children Without Complexity
Index Admissions and 30-day Readmissions
Among patients without medical complexity, index admissions occurred most frequently for pneumonia (n = 54,717), bronchiolitis (n = 53,959), and appendicitis (n = 45,036) (Figure 1). The median length of stay (LOS) for index admissions ranged from 1 to 5 days (Table 2), with septic arthritis and osteomyelitis having the longest median LOS at 5 (IQR, 3-7) days.

Thirty-day readmission rates varied substantially by infection at the index admission (range, 1.5% for sexually transmitted infection to 8.6% for peritonitis) (Figure 1). The median LOS for 30-day readmissions varied from 2 to 7 days

(Table 2), while the median number of days to readmission varied substantially by infection type (range, 4 days for bacterial infection [site unspecified] to 24 days for sexually transmitted infections). Among the top five indications for admission for children without complexity, 14.9% to 52.8% of readmissions were for the same cause as the index admission; however, many additional returns were likely related to the index admission (Appendix Table 4). For example, among other return reasons, an additional 992 (61.7%) readmissions following appendicitis hospitalizations were for complications of surgical procedures or medical care, peritonitis, intestinal obstruction, and abdominal pain.

Impact of Achieving Readmission Benchmarks
Among children without complexity, readmission benchmarks (ie, the 10th percentile of readmission rates across hospitals) ranged from 0% to 26.7% (Figure 2). An estimated 54.7% of readmissions (n = 5,507) could potentially be reduced if hospitals achieved infection-specific benchmark readmission rates, which could result in an estimated $44.5 million in savings. Pneumonia, bronchiolitis, gastroenteritis, and upper respiratory tract infections were among conditions with the greatest potential reductions in readmissions and costs if a 10th percentile benchmark was achieved.

Children With Medical Complexity
Index Admissions and 30-day Readmissions
Among patients with complexity, index admissions occurred most frequently for pneumonia (n = 14,344), bronchiolitis (n = 8,618), and upper respiratory tract infection (n = 6,407) (Figure 1). The median LOS for index admissions ranged from 1 to 9 days (Table 2), with septicemia and CNS infections having the longest median LOS at 9 days.

Thirty-day readmission rates varied substantially by the type of infection at the index admission (range, 0% for sexually transmitted infection to 21.6% for aspiration pneumonia) (Figure 1). The median LOS for 30-day readmissions varied from 2 to 14 days (Table 2), and the median number of days to readmission varied substantially by infection type (range, 6 days for tonsillitis to 23 days for other infection). Among the top five indications for admission for medically complex children, 8% to 40.4% of readmissions were for the same cause as the index admission (Appendix Table 4). As with the children without complexity, additional returns were likely related to the index admission.

Impact of Achieving Readmission Benchmarks
Among children with medical complexity, readmission benchmarks ranged from 0% to 30.3% (Figure 2). An estimated 42.6% of readmissions (n = 3,576) could potentially be reduced if hospitals achieved infection-specific benchmark readmission rates, which could result in an estimated $70.8 million in savings. Pneumonia, bronchiolitis, septicemia, and upper respiratory tract infections were among conditions with the greatest potential reductions in readmissions and costs if the benchmarks were achieved.

TABLE 1. **Characteristics of the Study Population**[a]

	Total No. (%)	30-Day, all-cause unplanned readmission	
		Not readmitted No. (%)	Readmitted No. (%)
Overall discharges	380,067	361,598	18,469
Age at admission, y			
<1	115,124 (30.3)	108,681 (30.1)	6,444 (34.9)
1-5	124,913 (32.9)	119,258 (33.0)	5,656 (30.6)
6-9	49,358 (13.0)	47,205 (13.1)	2,153 (11.7)
10-14	51,592 (13.6)	49,187 (13.6)	2,405 (13.0)
15-17	39,080 (10.3)	37,268 (10.3)	1,812 (9.8)
Gender			
Male	206,932 (54.4)	196,769 (54.4)	10,163 (55.0)
Payer			
Government	225,616 (59.4)	213,980 (59.2)	11,636 (63.0)
Private	133,127 (35.0)	127,151 (35.2)	5,977 (32.4)
Other	21,324 (5.6)	20,467 (5.7)	857 (4.6)
Number of CCCs			
0	318,510 (83.8)	308,439 (85.3)	10,071 (54.5)
1	33,350 (8.8)	30,289 (8.4)	3,061 (16.6)
2+	28,207 (7.4)	22,870 (6.3)	5,338 (28.9)
Type of CCCs			
Technology assistance	26,962 (7.1)	21,664 (6.0)	5,298 (28.7)
Gastrointestinal	23,267 (6.1)	18,586 (5.1)	4,681 (25.3)
Neuromuscular	20,688 (5.4)	17,075 (4.7)	3,613 (19.6)
Respiratory	12,792 (3.4)	10,294 (2.8)	2,497 (13.5)
Congenital/genetic	16,518 (4.3)	14,240 (3.9)	2,278 (12.3)
Cardiovascular	13,750 (3.6)	11,827 (3.3)	1,924 (10.4)
Renal	8,595 (2.3)	7,278 (2.0)	1,318 (7.1)
Metabolic	7,007 (1.8)	6,070 (1.7)	937 (5.1)
Neonatal	5,020 (1.3)	4,229 (1.2)	791 (4.3)
Discharge disposition			
Routine	366,196 (96.4)	349,927 (96.8)	16,269 (88.1)
Home health	11,517 (3.0)	9,658 (2.7)	1,859 (10.1)
Other	2,354 (0.6)	2,013 (0.6)	341 (1.8)

[a]All comparisons were statistically significant at $P < .001$ except gender ($P = .104$).

Abbreviation: CCC, complex chronic condition.

DISCUSSION

The current study uncovered new findings regarding unplanned readmissions following index infection hospitalizations for children. In particular, readmission rates and time to readmission varied substantially by infection subtype. The study also identified priority infections and unique considerations for children with CCCs, all of which may help maximize the value of readmission metrics aimed at advancing hospital quality and reducing costs for infection hospitalizations in children. If all hospitals achieved the readmission rates of the best performing hospitals, 42.6% to 54.7% fewer readmissions could be realized with associated cost savings.

Nationally, studies have reported 30-day, all-cause unplanned readmission rates of 6.2% to 10.3%.[5,27] In our current study we observed an overall readmission rate of 4.9% across all infectious conditions; however, readmission rates varied substantially by condition, with upper and lower respiratory tract infections, septicemia, and gastroenteritis among infections with the greatest number of potentially avoidable readmissions based on achievement of readmission benchmarks. Currently, pediatric-specific all-cause and lower respiratory tract infection readmission metrics have been developed with the aim of improving quality of care and reducing healthcare expenditures.[28] Future readmission studies and metrics may
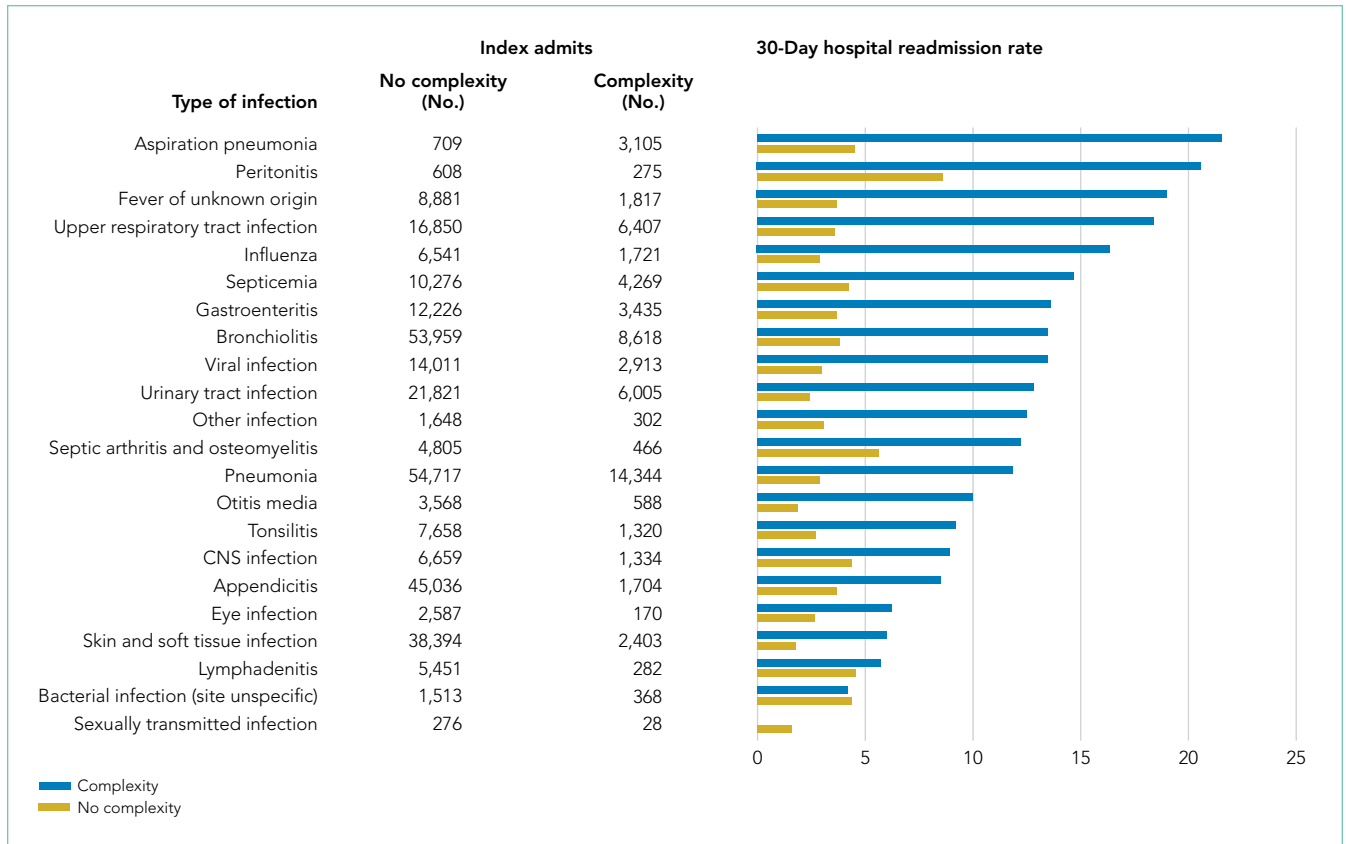
FIG 1. Thirty-Day, All-Cause Unplanned Readmission Rates by Type of Infection at Index Admission. Data presented are stratified by medical complexity. "Other infection" includes tuberculosis, fungal, and parasitic diseases.

Abbreviation: CNS, central nervous system.

prioritize conditions such as septicemia, gastroenteritis, and other respiratory tract infections. Our current study demonstrated that many readmissions following infection hospitalizations were associated with the same CCS category or within a related CCS category (eg, complications of surgical procedures or medical care, appendicitis, peritonitis, intestinal obstruction, and abdominal pain constituted the top five indications for readmission for appendicitis, whereas respiratory illnesses constituted the top five indications for readmissions for pneumonia). While this current study cannot clarify this relationship further, and the "avoidability" of unplanned readmissions is debated,[29-31] our findings suggest that future investigations might focus on identifying whether condition-specific interventions during the index admission could mitigate some readmissions.

While the LOS of the index admission and the readmission were similar for most infection subtypes, we observed substantial variability in the temporal risk for readmission by infection subtype. Our observations complement studies exploring the timing of readmissions for other pediatric conditions.[32-34] In particular, our findings further highlight that the composition and interaction of factors influencing infection readmissions may vary by condition. Infections represent a diverse group of conditions, with treatment courses that vary in need for parenteral antibiotics, ability to tailor treatment based on organism

and susceptibilities, and length of treatment. While treatment for some infections may be accomplished, or nearly accomplished, prior to discharge, other infections (eg, osteomyelitis) may require prolonged treatment, shifting the burden of management and monitoring to patients and their families, which along with the timeliness and adequacy of outpatient follow-up, may modify an individual's readmission risk. Consequently, a "one-size fits all" approach to discharge counseling may not be successful across all conditions. Our study lays the groundwork for how these temporal relationships may be used by clinicians to counsel families regarding the likely readmission timeframe, based on infection, and to establish follow-up appointments ahead of the infection-specific "readmission window," which may allow outpatient providers to intervene when readmission risk is greatest.

Consistent with prior literature, children with medical complexity in our study had increased frequency of 30-day, all-cause unplanned readmissions and LOS, compared with peers who did not have complexity.[5] Readmission rates following hospitalizations for aspiration pneumonia were comparable to those reported by Thompson et al in their study examining rates of pneumonia in children with neurologic impairment.[35] In our current study, nearly 96% of readmissions following aspiration pneumonia hospitalizations were for children with medical complexity, and more than 58% of these readmissions

TABLE 2. **Length of Stay and Time to Readmission by Type of Infection at Index Admission**

	Children without complexity			Children with complexity		
Type of infection	**Index admission LOS, d Median (IQR)**	**Readmission LOS, d Median (IQR)**	**Time to readmission, d Median (IQR)**	**Index admission LOS, d Median (IQR)**	**Readmission LOS, d Median (IQR)**	**Time to readmission, d Median (IQR)**
Bacterial infection (site unspecified)	2 (2-4)	3 (3-6)	4 (2-8)	6 (4-10)	14 (3-16)	9 (9-13)
Tonsillitis	1 (1-2)	2 (1-3)	5 (2-7)	1 (1-2)	3 (1-12)	6 (4-14)
Upper respiratory tract infection	1 (1-2)	2 (2-4)	6 (2-15)	3 (2-5)	4 (2-8)	13 (6-22)
Eye infection	3 (2-4)	2 (1-4)	6 (2-24)	3 (2-4)	10 (4-17)	15 (15-21)
Gastroenteritis	2 (1-3)	3 (2-5)	6 (3-13)	3 (2-5)	4 (2-8)	10 (4-17)
Other infection[a]	3 (2-5)	3 (2-3)	7 (3-19)	6 (3-12)	6 (2-9)	23 (7-26)
Lymphadenitis	2 (2-4)	3 (2-4)	7 (4-12)	2 (2-4)	3 (3-3)	16 (11-23)
Appendicitis	2 (1-4)	3 (2-5)	7 (4-12)	3 (1-6)	3 (1-5)	8 (3-20)
Fever of unknown origin	2 (2-3)	2 (2-4)	7 (4-14)	2 (2-3)	4 (2-7)	15 (8-25)
Viral infection	2 (1-3)	3 (2-4)	8 (3-18)	3 (2-4)	4 (2-8)	12 (5-17)
Central nervous system infection	3 (2-5)	2 (2-4)	8 (3-19)	9 (4-22)	4 (2-9)	10 (5-16)
Septicemia	4 (2-7)	3 (2-5)	9 (5-22)	9 (4-17)	3 (2-7)	13 (5-20)
Aspiration pneumonia	2 (2-4)	7 (2-20)	10 (10-11)	5 (3-10)	5 (3-8)	13 (7-23)
Septic arthritis and osteomyelitis	5 (3-7)	3 (2-5)	10 (4-17)	5 (3-8)	10 (4-14)	20 (13-21)
Otitis media	2 (1-3)	3 (1-4)	11 (3-16)	2 (1-3)	2 (2-4)	13 (8-19)
Skin and soft tissue infection	2 (1-3)	3 (2-4)	11 (4-19)	3 (2-4)	3 (2-6)	13 (5-18)
Bronchiolitis	2 (2-4)	2 (1-4)	13 (3-20)	4 (2-7)	4 (2-8)	14 (6-21)
Pneumonia	2 (2-3)	2 (2-4)	13 (5-21)	4 (2-8)	4 (2-9)	13 (6-22)
Influenza	2 (1-3)	3 (2-5)	14 (5-25)	3 (2-6)	3 (2-10)	12 (6-19)
Urinary tract infection	2 (2-3)	3 (2-4)	15 (8-23)	3 (2-4)	3 (2-5)	16 (9-22)
Peritonitis	4 (3-6)	3 (1-5)	16 (9-20)	7 (4-15)	3 (3-6)	14 (8-25)
Sexually transmitted infection	2 (2-4)	2 (2-5)	24 (14-24)	3 (2-11)	NA	NA

[a]"Other infection" includes tuberculosis, fungal, and parasitic diseases.
Abbreviations: IQR, interquartile range; LOS, length of stay; NA, not available.

were for aspiration pneumonia or respiratory illness. Future investigations should seek to explore factors contributing to readmissions in children with medical complexity and to evaluate whether interventions such as postdischarge coaching or discharge bundles could assist with reductions in healthcare resource use.[36,37]

Despite a lack of clear association between readmissions and quality of care for children,[38] readmissions rates continue to be used as a quality measure for hospitalized patients. Within our present study, we found that achieving benchmark readmission rates for infection hospitalizations could lead to substantial reductions in readmissions; however, these reductions were seen across this relatively similar group of infection diagnoses, and hospitals may face greater challenges when at-

tempting to achieve a 10th percentile readmission benchmark across a more expansive set of diagnoses. Despite these challenges, understanding the intricacies of readmissions may lead to improved readmission metrics and the systematic identification of avoidable readmissions, the goal of which is to enhance the quality of healthcare for hospitalized children.

Our findings should be interpreted in the context of several limitations. We defined our readmission benchmark at the 10th percentile using the IE database. Because an estimated 70% of hospitalizations for children occur within general hospitals,[39] we believe that our use of the IE database allowed for increased generalizability, though the broadening of our findings to nonacademic hospital settings may be less reliable. While we describe the 10th percentile readmission benchmark
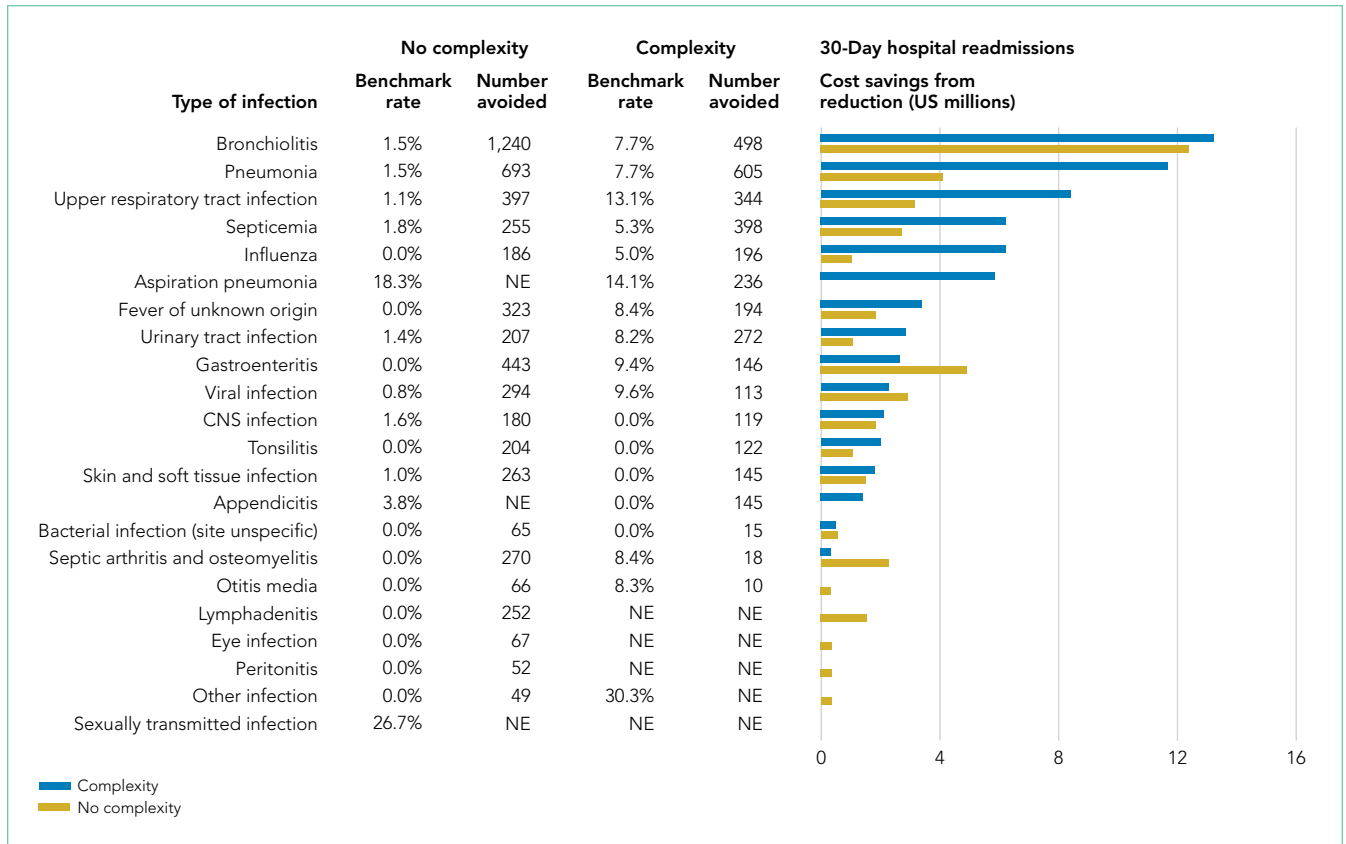
Type of infection	No complexity		Complexity		30-Day hospital readmissions
	Benchmark rate	Number avoided	Benchmark rate	Number avoided	Cost savings from reduction (US millions)
Bronchiolitis	1.5%	1,240	7.7%	498	
Pneumonia	1.5%	693	7.7%	605	
Upper respiratory tract infection	1.1%	397	13.1%	344	
Septicemia	1.8%	255	5.3%	398	
Influenza	0.0%	186	5.0%	196	
Aspiration pneumonia	18.3%	NE	14.1%	236	
Fever of unknown origin	0.0%	323	8.4%	194	
Urinary tract infection	1.4%	207	8.2%	272	
Gastroenteritis	0.0%	443	9.4%	146	
Viral infection	0.8%	294	9.6%	113	
CNS infection	1.6%	180	0.0%	119	
Tonsilitis	0.0%	204	0.0%	122	
Skin and soft tissue infection	1.0%	263	0.0%	145	
Appendicitis	3.8%	NE	0.0%	145	
Bacterial infection (site unspecific)	0.0%	65	0.0%	15	
Septic arthritis and osteomyelitis	0.0%	270	8.4%	18	
Otitis media	0.0%	66	8.3%	10	
Lymphadenitis	0.0%	252	NE	NE	
Eye infection	0.0%	67	NE	NE	
Peritonitis	0.0%	52	NE	NE	
Other infection	0.0%	49	30.3%	NE	
Sexually transmitted infection	26.7%	NE	NE	NE	

Legend: ■ Complexity   ■ No complexity

X-axis: 0, 4, 8, 12, 16

FIG 2. Number of 30-Day, All-Cause Unplanned Readmissions Avoided and Costs Saved if All Hospitals Achieved the 10th Percentile Readmission Benchmark. Data presented are stratified by medical complexity. "Other infection" includes tuberculosis, fungal, and parasitic diseases.

Abbreviations: CNS, central nervous system; NE, nonestimable.

here, alternative benchmarks would result in different estimates of avoidable readmissions and associated readmission costs (Appendix Tables 2 and 3). The IE and NRD databases do not distinguish intensive care use. We tried to address this limitation through model adjustments using H-RISK, which is particularly helpful for adjusting for NICU admissions through use of the 27 All Patient Refined Diagnosis-Related Groups for neonatal conditions. Additionally, the NRD uses state-level data to derive national estimates and is not equipped to measure readmissions to hospitals in a different state, distinguish patient deaths occurring after discharge, or to examine the specific indication for readmission (ie, unable to assess if the readmission is related to a complication of the treatment plan, progression of the illness course, or for an unrelated reason). While sociodemographic and socioeconomic factors may affect readmissions, the NRD does not contain information on patients' race/ethnicity, family/social attributes, or postdischarge follow-up health services, which are known to influence the need for readmission.

Despite these limitations, this study highlights future areas for research and potential opportunities for reducing readmission following infection hospitalizations. First, identifying hospital- and systems-based factors that contribute to readmission reductions at the best-performing hospitals may identify opportunities for hospitals with the highest readmission rates

to achieve the rates of the best-performing hospitals. Second, conditions such as upper and lower respiratory tract infections, along with septicemia and gastroenteritis, may serve as prime targets for future investigation based on the estimated number of avoidable readmissions and potential cost savings associated with these conditions. Finally, future investigations that explore discharge counseling and follow-up tailored to the infection-specific temporal risk and patient complexity may identify opportunities for further readmission reductions.

CONCLUSION

Our study provides a broad look at readmissions following infection hospitalizations and highlights substantial variation in readmissions based on infection type. To improve hospital resource use for infections, future preventive measures could prioritize children with complex chronic conditions and those with specific diagnoses (eg, upper and lower respiratory tract infections).

Disclaimer: This information or content and conclusions are those of the authors and should not be construed as the official position or policy of, nor should any endorsements be inferred by, NIH or the US government.

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