Published in final edited form as:

Pediatrics. 2016 August ; 138(2): . doi:10.1542/peds.2015-4182.

Potentially Preventable 30-Day Hospital Readmissions at a Children's Hospital

Sara L. Toomey, MD, MPhil, MPH, MSc^{a,b}, Alon Peltz, MD, MBA^{a,c}, Samuel Loren, AB^a, Michaela Tracy, BA^a, Kathryn Williams, MS^d, Linda Pengeroth, RN^a, Allison Ste Marie, MD^{a,b}, Sarah Onorato, BA^a, and Mark A. Schuster, MD, PhD^{a,b}

^aDivision of General Pediatrics, Department of Medicine, Boston, Massachusetts

^bDepartment of Pediatrics, Harvard Medical School, Boston, Massachusetts

^cRobert Wood Johnson Foundation Clinical Scholars Program, Yale University School of Medicine, New Haven, Connecticut

^dClinical Research Center, Boston Children's Hospital, Boston, Massachusetts

Abstract

BACKGROUND AND OBJECTIVES—Hospital readmission rates are increasingly used to assess quality. Little is known, however, about potential preventability of readmissions among children. Our objective was to evaluate potential preventability of 30-day readmissions using medical record review and interviews.

METHODS—A cross-sectional study in 305 children (<18 years old) readmitted within 30 days to a freestanding children's hospital between December 2012 and February 2013. Interviews ($N=1459$) were conducted with parents/guardians, patients (if ≥13 years old), inpatient clinicians, and primary care providers. Reviewers evaluated medical records, interview summaries, and transcripts, and then rated potential preventability. Multivariate regression analysis was used to identify factors associated with potentially preventable readmission. Adjusted event curves were generated to model days to readmission.

RESULTS—Of readmissions, 29.5% were potentially preventable. Potentially preventable readmissions occurred sooner after discharge than non-potentially preventable readmissions (5 vs 9 median days; $P<.001$). The odds of a readmission being potentially preventable were greatest when the index admission and readmission were causally related (adjusted odds ratio [AOR]: 2.6; 95% confidence interval [CI]: 1.0–6.8) and when hospital (AOR: 16.3; 95% CI: 5.9–44.8) or patient (AOR: 7.1; 95% CI: 2.5–20.5) factors were identified. Interviews provided new information about the readmission in 31.2% of cases.

Address correspondence to Sara L. Toomey, MD, MPhil, MPH, MSc, Division of General Pediatrics, Department of Medicine, Boston Children's Hospital, 300 Longwood Ave, Boston, MA 02115. sara.toomey@childrens.harvard.edu.

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

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

COMPANION PAPER: A companion to this article can be found online at www.pediatrics.org/cgi/doi/10.1542/peds.2016-1643.

CONCLUSIONS—Nearly 30% of 30-day readmissions to a children’s hospital may be potentially preventable. Hospital and patient factors are associated with potential preventability and may provide targets for quality improvement efforts. Interviews contribute important information and should be considered when evaluating readmissions.

Hospital readmissions are disruptive to patients and families and costly to our health care system. Given that studies in adults suggest that preventable readmissions can result from the care received during the index (ie, initial) admission, inadequate discharge planning or postdischarge follow-up, or poor coordination among providers, adult readmission rates are widely used as a quality measure for public reporting and pay-for-performance.^{1, 2} Increasingly, pediatric hospital readmission rates are also being used as a quality measure.^{3, 4} The Centers for Medicare and Medicaid Services (CMS) and many state Medicaid agencies have levied financial penalties for hospitals with high 30-day readmission rates. Although the CMS does not apply financial penalties for pediatric readmissions, a growing number of states are applying penalties for pediatric readmissions.^{5–11}

A common criticism of using readmission rates as a health care quality measure is that many readmissions are not causally related to the hospital care provided during the index admission; rather, they may represent worsening of underlying chronic disease.^{12, 13} In addition, some argue that hospitals should not be held accountable for readmissions because factors that contribute to readmissions often are not hospital factors (eg, postoperative complication) but instead are outpatient (eg, nurse unable to visit home) or patient (eg, not taking prescribed medications) factors and thus beyond the hospital’s direct control.^{14, 15}

Currently, 3 main strategies for ascertaining the potential preventability of hospital readmissions include the following: claims-based algorithms, medical record review, and structured interviews. Claims-based algorithms are perceived to be limited in identifying reasons for readmission.^{16, 17} Medical record review and structured interviews may offer more information. Although interviews provide opportunities to obtain even more detailed information, it is unclear whether interviews enhance information obtained from medical records or are duplicative. Because interviews are time intensive and costly, it is important to understand their value.

It remains unclear how many readmissions in children may be preventable and whether factors contributing to preventable readmissions can be identified. Furthermore, no previous study in children has compared medical record review and structured interviews in assessing readmissions. Thus, our study aimed to determine the potential preventability of unplanned 30-day hospital readmissions, to identify factors that contribute to readmissions, and to assess whether structured interviews add substantial valuable information beyond medical record review.

METHODS

Study Design and Participants

We conducted a cross-sectional study of unplanned 30-day hospital readmissions at a freestanding children’s hospital. Patients <18 years old who were readmitted between

December 10, 2012, and February 22, 2013 (ie, discharged from the same hospital in the 30 days before the readmission), were potentially eligible for the study. Exclusion criteria included the following: planned readmissions (eg, scheduled surgeries or chemotherapy), psychiatric readmissions, and readmissions for end-of-life care. Patients were only included once during the study period. For 2 common conditions (fever and neutropenia in oncology patients, bleeding after tonsillectomy/adenoidectomy), only a random subsample (1 of every 3 readmissions) was included. Of the 928 patients readmitted during the study period, 378 were potentially eligible on the basis of study exclusion criteria. Thirty-nine patients with 1 of the 2 frequently occurring conditions were randomized out. Parents declined participation or could not be contacted for 9 patients. An additional 25 patients were excluded for other reasons (eg, possible child abuse). In total, the study included 305 patients.

Data Collection

Research nurses and research assistants conducted 1192 semistructured interviews with parents or caregivers, henceforth referred to as “parents” ($n=305$), adolescent patients ($n=42$), inpatient nurses ($n=297$) and attending physicians at time of readmission ($n=304$), social workers ($n=91$) and case managers ($n=104$) who were involved in the index admission, and subspecialists who comanage children with medical complexity ($n=49$). Parent and adolescent interviews were conducted by using a semistructured interview script, recorded, and transcribed. The inpatient provider interviews were conducted by using a structured interview form. We conducted training sessions and a 9-day pilot before the collection of actual study data to refine the study logistics and survey instrument. Study data were collected and managed by using REDCap, a secure, Web-based application.¹⁸

A pediatrician conducted telephone interviews with primary care providers (PCPs; $n=267$) with the use of a structured interview form. Thirteen PCPs were unreachable or declined participation. PCP interviews were excluded for international patients ($n=13$), patients without a designated PCP ($n=8$), and incomplete PCP interviews ($n=4$).

Four pediatric physician reviewers (3 inpatient/outpatient providers and 1 outpatient provider) who did not conduct interviews independently conducted structured medical record reviews for all readmissions. Reviewers received standardized training in which they were presented with guidelines for assessing preventability and related factors by using Institute for Healthcare Improvement background frameworks.¹⁹ After completing medical record review, the physician reviewers assessed the readmission, examined transcripts and interview summaries, and determined whether the interviews changed their assessment of the readmission. Subsequently, a consensus review process was conducted that included the physician reviewer(s) and an academic general pediatrician with >1 decade of postgraduate experience. Because of the complexity of assessing preventability, we used a consensus review process similar to that used in other readmission-preventability studies.^{13, 20, 21} Each case had 1 primary reviewer, with no fewer than 3 pediatricians participating in the consensus review. In circumstances in which the readmission involved significant subspecialty care (eg, congenital heart disease postoperative management), relevant subspecialists were consulted.

Main Outcomes

The primary outcome measure was potential preventability of the readmission using a 4-point Likert scale (very likely to have been preventable, somewhat likely to have been preventable, somewhat unlikely to have been preventable, and very unlikely to have been preventable). Additional dichotomous outcomes included the following: causal relationship between index admission and readmission; index admission and readmission related by chronic illness; and presence of hospital, PCP, or patient factors contributing to the readmission. We characterized the contributing factors by using the overarching categories from the Institute for Healthcare Improvement's STAAR (STate Action on Avoidable Rehospitalizations) Readmissions Diagnostic Worksheet: "typical failures associated with patient assessment," "typical failures found in patient and family caregiver education," "typical failures in handover communication," and "typical failures following discharge from the hospital."²² We created 3 additional categories: postoperative complication/hospital-acquired condition, contributing social factors/parental anxiety, and other. Secondary outcome measures covered whether the addition of the interviews to the medical record review changed the reviewers' assessment of preventability (eg, from somewhat likely to have been preventable to somewhat unlikely to have been preventable) or enabled identification of new contributing factors for readmission (eg, new hospital contributing factor identified).

Covariates of Interest

Child demographic covariates included age in years (<1, 1–4, 5–8, 9–12, and 13–17 years), sex, race/ethnicity (Asian, black/non-Hispanic, Hispanic, white/non-Hispanic, and other), and preferred language (English or non-English). To identify children with chronic disease, we used the Agency for Healthcare Research and Quality (AHRQ) Chronic Condition Indicator (CCI), a classification system based on International Classification of Diseases, Ninth Revision, codes.²³ In addition, we counted the number of CCIs present for each patient (0, 1, 2, or 3).

Data Analysis

The 4-point scale for preventability was collapsed into a binary variable: potentially preventable (somewhat/very likely to have been preventable) and potentially nonpreventable (somewhat/very unlikely to have been preventable). First, we examined whether preventability was associated with patient characteristics. We then examined whether potentially preventable readmissions were associated with the following: (1) the readmission being causally related to the index admission, (2) the readmission being related to the index admission by underlying chronic disease, and (3) the presence of identifiable contributing factors. We examined the association between preventability rating and the presence of different chronic conditions (measured by CCI category). We also assessed whether patients with chronic conditions were more likely to have certain contributing factors in their readmissions. Bivariate associations were tested by using Fisher's exact tests or Wilcoxon rank-sum tests as appropriate; multivariate associations were tested by using multivariate logistic regression models adjusting for additional covariates.

The overall crude 30-day readmission rate for the hospital was calculated for the study period by using the AHRQ-CMS Pediatric All-Condition Readmission Measure SAS program.⁴ We compared the mean days to readmission by using the Wilcoxon rank-sum test for the following conditions: (1) potentially preventable and not preventable, (2) causally related and not causally related, (3) due to underlying chronic disease and not due to underlying chronic disease, and (4) contributing factor and no contributing factor identified. As an illustration of time to readmission, we generated adjusted event curves on the basis of Cox proportional hazard models to adjust for age, sex, language, and CCI count; and the model coefficient Wald tests were used to compare the event curves between groups.

We assessed the change in perception of potential preventability and the addition of contributing factors with the inclusion of the semistructured interviews. Statistical analysis was conducted by using SAS version 9.3 (SAS Institute, Cary, NC) and Stata version 13 (StataCorp, College Station, TX). The Boston Children's Hospital Institutional Review Board determined that this study was exempt.

RESULTS

The overall readmission rate for the hospital during the study period was 6.5%. Of the readmissions included in the study, 29.5% were determined to be potentially preventable: 11.8% very likely, 17.7% somewhat likely, 16.1% somewhat unlikely, and 54.4% very unlikely. In bivariate analysis, potentially preventable readmissions and non-potentially preventable readmissions did not vary significantly on the basis of patient age, sex, language, or race/ethnicity (Table 1). Although potentially preventable and non-potentially preventable readmissions did not vary significantly by number of chronic conditions, for 2 of the 18 chronic condition categories, neoplasms (2.2% vs 9.8%; $P=.03$) and diseases of blood/blood-forming organs (1.1% vs 8.8%; $P=.01$), readmissions were more likely to be considered non-potentially preventable. In contrast, readmissions for congenital anomalies were more likely to be considered potentially preventable (40.0% vs 22.3%; $P=.002$).

Of all readmissions, 48.9% were deemed to be causally related to the index admission and 63.8% were deemed to be due to a chronic disease. Potentially preventable readmissions were more often causally related to the index admission (74.1% vs 38.6%; $P<.001$); however, no association between chronic disease and preventability was observed ($P=.59$).

At least 1 contributing factor was identified more often for potentially preventable than for non-potentially preventable readmissions (86.7% vs 20.4%; $P<.001$). Potentially preventable readmissions more often had hospital (77.1% vs 16.7%; $P<.001$), PCP (14.5% vs 0.5%; $P<.001$), and patient (39.2% vs 9.2%; $P<.001$) contributing factors identified. Among all readmissions, 36.2% were associated with hospital factors, 4.6% with PCP factors, and 18.1% with patient factors. Hospital factors were most often related to "patient assessment" (37.4%) and postoperative complications/hospital-acquired conditions (28.0%); PCP factors were most often related to "patient assessment" (58.3%) and "handover communication" (25.0%); and patient factors were most often related to "following discharge from the hospital" (60.4%) (Table 2).

In multivariate analyses adjusting for age, sex, language, and CCI count, potentially preventable readmissions, when compared with non-potentially preventable readmissions, had increased odds of being causally related to the index admission (adjusted odds ratio [AOR]: 2.6; 95% confidence interval [CI]: 1.02–6.75). Potentially preventable readmissions also had increased odds of identification of a hospital (AOR: 16.3; 95% CI: 5.94–44.81) or patient (AOR: 7.1; 95% CI: 2.45–20.48) factor (Table 3).

The mean days to readmission (Fig 1) was shorter for potentially preventable readmissions than for non-potentially preventable readmissions (4 vs 9 median days; Wilcoxon test, $P < .001$). Similar findings were observed for readmissions that were causally related to the index admission (4 vs 14 median days; Wilcoxon test, $P < .001$) and for readmissions for which a contributing factor was identified in comparison with readmissions where one was not (5 vs 10 median days; Wilcoxon test, $P < .001$). The time to readmission was significantly longer for readmissions that were related to underlying chronic disease (9 vs 5 median days; Wald test, $P < .001$). These comparisons of the curves between preventable and nonpreventable and the other factors were also significant (Wald test, $P < .01$).

New information was learned from the interview regarding the readmission in 31.2% of all cases. For instance, a complicated patient was readmitted with respiratory distress 1 week after discharge. We learned from the physician that the family declined to have their child go to a rehabilitation center after the index admission. In another example, a patient readmitted with gastrostomy-tube cellulitis was initially discharged without a visiting nurse. However, we learned from the parent that they were frequently checking the gastrostomy-tube site and that the cellulitis developed rapidly and would not have been picked up earlier had a visiting nurse been coming to the home. In another case, we learned from the parent that because of delays in her child's procedure, she missed her medications and pulmonary toileting, which ultimately led to increased respiratory distress the day after the procedure and resulted in a readmission. New information was learned about the potential preventability of the readmission in 20.3% of cases, the reasons for readmission in 12.8% of cases, and additional contributing factors in 15.1% of cases. In 11.8% of all cases, new information learned from the interviews changed the final assessment of potential preventability of the readmission. In cases in which the reviewers' opinion regarding the potential preventability changed after the interview review, 47.2% of cases were revised from potentially nonpreventable to potentially preventable and 8.3% from potentially preventable to nonpreventable. For the remaining cases, the assessment shifted without changing the direction of the preventability rating (eg, a change from somewhat to very likely to have been preventable). New information learned from the interviews was predominantly gained from parents (21.6%), attending physicians (14.8%), PCPs (11.1%), and inpatient nurses (7.2%). The information learned was mainly about the hospital (19.0%), parents (15.1%), patients (7.9%), and PCPs (4.6%).

DISCUSSION

We found that 29.5% of all-cause, unplanned, 30-day readmissions to a tertiary care children's hospital were potentially preventable. Potentially preventable readmissions were more likely to be causally related to the index admission and have an associated contributing

factor identified than were readmissions that were non–potentially preventable. Hospital and patient factors were strongly associated with potentially preventable readmission. Although many children with underlying chronic disease are readmitted, preventability was not associated with the presence of an underlying chronic disease.

Our findings are largely consistent with the few studies that assessed the preventability of readmissions in the pediatric setting. One study on unplanned pediatric readmissions found that the most common reasons cited for them were disease progression and procedural complications.²⁴ The rate of potentially preventable readmissions has varied across pediatric studies. For instance, 1 study that performed medical record reviews of 200 patients readmitted to a tertiary care children's hospital within 15 days of discharge found that 20% of readmissions were considered likely to be preventable.¹³ In another study, 42.6% of readmissions or revisits to the emergency department within 90 days of discharge after an appendectomy admission were deemed potentially avoidable.²⁵

In comparison with other methods for calculating potentially preventable readmissions in pediatric settings, our rate of potentially preventable readmissions is lower than previously reported rates that used claims-based software algorithms but higher than those that used medical record review.^{26, 27} Discordance between automated and manual review of readmissions has been previously noted.²⁸ Claims-based algorithms may overestimate the preventability by not fully accounting for patient characteristics (eg, severity of chronic condition) and planned readmissions.^{29, 30} Medical record review, on the other hand, may provide added clinical detail but may be limited in ascertaining the contribution of sociodemographic characteristics that may not be documented in the medical record (eg, unmet social needs, medication adherence) or may occur outside of the hospital (eg, missed appointments, transportation barriers), thereby leading to underestimation of the likelihood of preventability.^{13, 25, 31–34} Interviews in combination with medical record review may provide a more global understanding of these circumstances leading up to, and after, a child's hospitalization. Due to the complexity of assessing preventability, we chose to use a multistep approach that culminated in a consensus review.

In contrast to other studies that have shown an association between clinical characteristics and readmissions in other settings, our study did not observe an association between certain patient clinical characteristics and potentially preventable readmissions.^{13, 24–26, 31, 32, 34–38} This difference may be related to the high overall prevalence of chronic illness in our sample. Chronically ill children may be more vulnerable to potentially preventable readmissions due to medical fragility and increased care needs after discharge (eg, specialty appointments, multiple medications); however, their parents may be more comfortable navigating the health care system. Further research is needed to examine the role of chronic illness in potentially preventable readmissions.

Potentially preventable readmissions occurred sooner after hospital discharge than did non–potentially preventable readmissions. We observed a strong association between hospital factors and potential preventability and also found that readmissions with hospital contributing factors were more likely to occur sooner after hospital discharge than

readmissions without. Our findings suggest that readmissions occurring closer to the index admission are more likely to be preventable.

A majority of potentially preventable readmissions had an identified hospital contributing factor. Previous studies have identified hospital and clinician factors as a large portion of potentially preventable readmissions.^{39, 40} Hospital factors may serve as targets for quality improvement initiatives. In particular, we found that hospital factors were often related to patient assessment, such as failure to recognize worsening clinical status. Hospital factors were also often related to patient and family education and handover communication. Addressing these areas through improved discharge preparation and planning might help hospitals decrease preventable readmissions.

Our study has limitations. The retrospective interviews are subject to response bias. In addition, we conducted the study with children hospitalized at a tertiary care children's hospital, so this may limit the generalizability to non-children's hospitals. Because it was a single hospital, we were unable to examine characteristics of the treating hospital such as nurse staffing ratios, which have been shown to be associated with pediatric readmission rates.⁴¹

CONCLUSIONS

Our results suggest that nearly 30% of readmissions were likely to have been prevented with better care delivery and that interviews provided new information about readmissions in nearly one-third of all cases. Although they are not the majority of readmissions, potentially preventable readmissions are prevalent enough to warrant monitoring readmission rates and to provide targets for quality improvement. Interviews led to a change in the assessment of the potential preventability and provided important information regarding the reasons for and contributing factors to readmissions in a substantial proportion of cases. On the basis of this study, targets for reducing readmissions might include addressing hospital factors, such as the need for improved caregiver education, meeting social needs, and increasing rates of postdischarge follow-up. More broadly, parent and provider interviews offer important information regarding potential preventability and contributing factors for preventability.

Acknowledgments

We thank Dr Swee Hui Ang, MD, MPH, Dr Samantha Bannister, MD, MPH, Ms Annemarie Fayemi, MS, RN, CPNP-PC, Ms Diane McInerney, Ms Christine Finn, RN, Dr Kathleen Levin, MD, Ms Colleen Madden, RN, Mr Debanjan Pain, AB, and Ms Michelle Wang, AB, for their help with data collection and analysis.

Dr Toomey conceptualized and designed the study, obtained funding, oversaw data collection, and drafted the initial manuscript; Dr Peltz contributed to conceptualizing and designing the study, participated in data collection, and reviewed and revised the manuscript; Mr Loren and Ms Tracy coordinated data collection, carried out analyses, and reviewed and revised the manuscript; Ms Williams and Ms Onorato carried out analyses and reviewed and revised the manuscript; Ms Pengerth coordinated data collection and reviewed and revised the manuscript; Dr Ste Marie participated in data collection and reviewed and revised the manuscript; Dr Schuster conceptualized and designed the study, obtained funding, reviewed and revised the manuscript, and provided overall supervision; and all authors approved the final manuscript as submitted.

FUNDING: Support for this work was provided by the US Department of Health and Human Services Agency for Healthcare Research and Quality and Centers for Medicare and Medicaid Services, CHIPRA (Children's Health Insurance Program Reauthorization Act of 2009) Pediatric Quality Measures Program Centers of Excellence under

grant U18 HS 020513. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Agency for Healthcare Research and Quality.

ABBREVIATIONS

AOR	adjusted odds ratio
CCI	Chronic Condition Indicator
CI	confidence interval
CMS	Centers for Medicare and Medicaid Services
PCP	primary care provider

References

1. Goldfield NI, McCullough EC, Hughes JS, et al. Identifying potentially preventable readmissions. *Health Care Financ Rev.* 2008; 30(1):75–91. [PubMed: 19040175]
2. Hansen LO, Young RS, Hinami K, Leung A, Williams MV. Interventions to reduce 30-day rehospitalization: a systematic review. *Ann Intern Med.* 2011; 155(8):520–528. [PubMed: 22007045]
3. Centers for Medicare and Medicaid Services. Readmissions reduction program. Published April 26 2013. Available at: www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program.html. Accessed May 20, 2013
4. Agency for Healthcare Research and Quality Centers for Medicare and Medicaid Services. Pediatric All-Condition Readmission Measure. Available at: www.ahrq.gov/sites/default/files/wysiwyg/policymakers/chipra/factsheets/chipra_14-p008-1-ef.pdf. Accessed August 17, 2015
5. Patient Protection and Affordable Care Act. Vol Stat. 2010; 119:318–319. Available at: www.gpo.gov/fdsys/pkg/PLAW-111publ148.pdf Accessed September 8, 2015.
6. Medicare Payment Advisory Commission. Report to Congress: Medicare and the Health Care Delivery System. Washington, DC: 2013. Available at: www.medpac.gov/documents/Jun13_EntireReport.pdf Accessed January 31, 2014
7. Illinois Department of Healthcare and Family Services. State fiscal year (SFY) 2014 Potentially Preventable Readmissions (PPR) Reports. Published October 4, 2014. Available at: www.hfs.illinois.gov/html/100413n1.html Accessed January 13, 2016
8. Potentially preventable readmissions in the Texas Medicaid population, state fiscal year 2012. Texas Health and Human Services Commission. 2013. p. 11-25. Available at: www.hhsc.state.tx.us/reports/2013/PPR-Report.pdf Accessed August 17, 2015
9. NY State Potentially Preventable Readmissions. 2011. Available at: https://www.health.ny.gov/regulations/recently_adopted/docs/2011-02-23_potentially_preventable_readmissions.pdf Accessed January 13, 2016
10. Oklahoma Health Care Authority. Hospital Potentially Preventable Readmissions (PPR) Program. 2015. Available at: <http://www.okhca.org/providers.aspx?id=16078&terms=Hospital%20Potentially%20Preventable%20Readmissions%20PPR>. Accessed January 13, 2016
11. Colorado Department of Health Care Policy and Financing. Creating a culture of change. 2014. Available at: <https://www.colorado.gov/pacific/sites/default/files/Accountable%20Care%20Collaborative%202014%20Annual%20Report.pdf> Accessed January 13, 2016
12. Lavenberg JG, Leas B, Umscheid CA, Williams K, Goldmann DR, Kripalani S. Assessing preventability in the quest to reduce hospital readmissions. *J Hosp Med.* 2014; 9(9):598–603. [PubMed: 24961204]
13. Hain PD, Gay JC, Berutti TW, Whitney GM, Wang W, Saville BR. Preventability of early readmissions at a children's hospital. *Pediatrics.* 2013; 131(1) Available at: www.pediatrics.org/cgi/content/full/131/1/e171.

14. Lorch SA, Baiocchi M, Silber JH, Even-Shoshan O, Escobar GJ, Small DS. The role of outpatient facilities in explaining variations in risk-adjusted readmission rates between hospitals. *Health Serv Res.* 2010; 45(1):24–41. [PubMed: 19780853]
15. Kirby SE, Dennis SM, Jayasinghe UW, Harris MF. Patient related factors in frequent readmissions: the influence of condition, access to services and patient choice. *BMC Health Serv Res.* 2010; 10(216)
16. Sacks GD, Dawes AJ, Russell MM, et al. Evaluation of hospital readmissions in surgical patients: do administrative data tell the real story? *JAMA Surg.* 2014; 149(8):759–764. [PubMed: 24920156]
17. Hechenbleikner EM, Makary MA, Samarov DV, et al. Hospital readmission by method of data collection. *J Am Coll Surg.* 2013; 216(6):1150–1158. [PubMed: 23583617]
18. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform.* 2009; 42(2):377–381. [PubMed: 18929686]
19. Institute for Healthcare Improvement. STate Action on Avoidable Rehospitalizations (STAAR) Initiative. Available at: www.ihl.org/offerings/Initiatives/STAAR/Pages/default.aspx Accessed October 23, 2013
20. Meisenberg BR, Hahn E, Binner M, et al. ReCAP: insights into the potential preventability of oncology readmissions. *J Oncol Pract.* 2016; 12(2):153–154. [PubMed: 26787758]
21. Greenberg JK, Washington CW, Guniganti R, Dacey RG, Derdeyn CP, Zipfel GJ. Causes of 30-day readmission after aneurysmal subarachnoid hemorrhage. *J Neurosurg.* 2016; 124(3):743–749. [PubMed: 26361278]
22. Institute for Healthcare Improvement. IHI STAAR Readmissions Diagnostic Worksheet. Available at: <http://www.ihl.org/resources/pages/tools/readmissionsdiagnosticworksheet.aspx>. Accessed June 20, 2016
23. Healthcare Cost and Utilization Project (HCUP). Chronic Condition Indicator (CCI) for ICD-9-CM. Available at: <https://www.hcup-us.ahrq.gov/August 17, 2015>
24. Williams EI, Fitton F. Factors affecting early unplanned readmission of elderly patients to hospital. *BMJ.* 1988; 297(6651):784–787. [PubMed: 3142550]
25. Lautz TB, Reynolds M. Context and significance of emergency department visits and readmissions after pediatric appendectomy. *J Pediatr Surg.* 2011; 46(10):1918–1922. [PubMed: 22008328]
26. Gay JC, Agrawal R, Auger KA, et al. Rates and impact of potentially preventable readmissions at children's hospitals. *J Pediatr.* 2015; 166(3):613–619.e5. [PubMed: 25477164]
27. Tejedor-Sojo J, Singleton LM, McCormick K, Wrubel D, Chern JJ. Preventability of pediatric 30-day readmissions following ventricular shunt surgery. *J Pediatr.* 2015; 167(6):1327–1333.e1. [PubMed: 26454576]
28. Jackson AH, Fireman E, Feigenbaum P, Neuwirth E, Kipnis P, Bellows J. Manual and automated methods for identifying potentially preventable readmissions: a comparison in a large healthcare system. *BMC Med Inform Decis Mak.* 2014; 14(1):28. [PubMed: 24708889]
29. Hallerbach M, Francoeur A, Pomerantz SC, et al. Patterns and predictors of early hospital readmission in patients with congestive heart failure. *Am J Med Qual.* 2008; 23(1):18–23. [PubMed: 18187587]
30. Amin BY, Tu T-H, Schairer WW, et al. Pitfalls of calculating hospital readmission rates based on nonvalidated administrative data sets: presented at the 2012 Joint Spine Section Meeting: clinical article. *J Neurosurg Spine.* 2013; 18(2):134–138. [PubMed: 23186376]
31. Chern JJ, Bookland M, Tejedor-Sojo J, et al. Return to system within 30 days of discharge following pediatric shunt surgery. *J Neurosurg Pediatr.* 2014; 13(5):525–531. [PubMed: 24628507]
32. Berry JG, Ziniel SI, Freeman L, et al. Hospital readmission and parent perceptions of their child's hospital discharge. *Int J Qual Health Care.* 2013; 25(5):573–581. [PubMed: 23962990]
33. Gay JC, Hain PD, Grantham JA, Saville BR. Epidemiology of 15-day readmissions to a children's hospital. *Pediatrics.* 2011; 127(6) Available at: www.pediatrics.org/cgi/content/full/127/6/e1505.
34. Flores G, Abreu M, Tomany-Korman S, Meurer J. Keeping children with asthma out of hospitals: parents' and physicians' perspectives on how pediatric asthma hospitalizations can be prevented. *Pediatrics.* 2005; 116(4):957–965. [PubMed: 16199708]

35. Li LT, Mills WL, White DL, et al. Causes and prevalence of unplanned readmissions after colorectal surgery: a systematic review and meta-analysis. *J Am Geriatr Soc.* 2013; 61(7):1175–1181. [PubMed: 23730901]
36. Clarke A. Are readmissions avoidable? *BMJ.* 1990; 301(6761):1136–1138. [PubMed: 2252925]
37. Grim RD, McElwain D, Hartmann R, Hudak M, Young S. Evaluating causes for unplanned hospital readmissions of palliative care patients. *Am J Hosp Palliat Care.* 2010; 27(8):526–531. [PubMed: 20713425]
38. Zmistowski B, Restrepo C, Hess J, Adibi D, Cangoz S, Parvizi J. Unplanned readmission after total joint arthroplasty: rates, reasons, and risk factors. *J Bone Joint Surg Am.* 2013; 95(20):1869–1876. [PubMed: 24132361]
39. Oddone EZ, Weinberger M, Horner M, et al. Classifying general medicine readmissions. Are they preventable? Veterans Affairs Cooperative Studies in Health Services Group on Primary Care and Hospital Readmissions. *J Gen Intern Med.* 1996; 11(10):597–607. [PubMed: 8945691]
40. Feigenbaum P, Neuwirth E, Trowbridge L, et al. Factors contributing to all-cause 30-day readmissions: a structured case series across 18 hospitals. *Med Care.* 2012; 50(7):599–605. [PubMed: 22354212]
41. Tubbs-Cooley HL, Cimiotti JP, Silber JH, Sloane DM, Aiken LH. An observational study of nurse staffing ratios and hospital readmission among children admitted for common conditions. *BMJ Qual Saf.* 2013; 22(9):735–742.

WHAT'S KNOWN ON THIS SUBJECT

Hospital readmission rates are increasingly used as measures of hospital quality. Limited information is available on whether pediatric readmissions are potentially preventable; however, no studies in children have incorporated medical record review and interviews in assessing potential preventability of readmissions.

WHAT THIS STUDY ADDS

Nearly 30% of 30-day readmissions to a children's hospital were potentially preventable. Hospital and patient factors were often identified for these readmissions. Parent and provider interviews, in combination with medical record reviews, provided important information about potential preventability of readmissions.

FIGURE 1.

Adjusted event curves for days to readmission for the following comparisons: (1) potentially preventable versus not potentially preventable, (2) causally related versus not causally related, (3) related by underlying chronic disease versus not related by chronic disease, and (4) any contributing factor identified versus no contributing factor identified. All values were adjusted for age, sex, language, and CCI count. $P < .01$ for all curves.

TABLE 1

Characteristics of Patients and Readmissions for Potentially Preventable and Non–Potentially Preventable Readmissions

	<i>n</i>	Potentially Preventable Readmissions (<i>n</i> =90), %	Non–Potentially Preventable Readmissions (<i>n</i> =215), %
Age			
<1 year	80	31.1	24.2
1–4 years	82	23.3	28.3
5–8 years	42	11.1	14.9
9–12 years	41	16.7	12.1
13–17 years	60	17.8	20.5
Sex			
Male	165	56.7	53.0
Female	140	43.3	47.2
Language			
English	255	80.0	85.1
Non-English	50	20.0	14.9
Race/ethnicity			
Asian	8	3.5	2.4
Black	28	9.4	9.7
Latino	38	10.6	14.0
White	182	61.2	63.8
Other	36	15.3	11.1
Number of chronic conditions			
0	54	15.6	18.6
1	113	38.9	36.3
2	93	28.9	31.1
3	45	16.7	14.0
CCI category ^{a†}			
CCI 2: Neoplasms	23	2.2	9.8*
CCI 3: Endocrine, nutritional, and metabolic diseases and immunity disorders	38	11.1	13.0
CCI 4: Diseases of blood/blood-forming organs	20	1.1	8.8*
CCI 5: Mental disorders	31	10.0	10.2
CCI 6: Diseases of nervous system/sense organs	63	23.3	19.5
CCI 7: Diseases of circulatory system	24	7.8	7.9
CCI 8: Diseases of respiratory system	60	18.9	20.0
CCI 9: Diseases of digestive system	46	18.9	13.5
CCI 14: Congenital anomalies	84	40.0	22.3**
CCI 18: Factors influencing health status/contact with health services	33	7.8	12.1
Index admission and readmission causally related	136	74.1	38.6***
Index admission and readmission disease related	185	66.7	62.6

^aEach CCI category was tested individually.

*
 $P < .05$.

**
 $P < .01$.

 $P < .001$.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

TABLE 2
Association of Potential Preventability and Contributing Factors and Categorization of Contributing Factors

Contributing factors	Potentially Preventable Readmissions (<i>n</i> =90), %	Non-Potentially Preventable Readmissions (<i>n</i> =215), %	Hospital Factors (<i>n</i> =107), %	PCP Factors (<i>n</i> =12), %	Patient Factors (<i>n</i> =48), %
At least 1 of 3 contributing factors	86.7	20.4 ***	—	—	—
Hospital contributing factors	77.1	16.7 ***	—	—	—
PCP contributing factors	14.5	0.5 ***	—	—	—
Patient contributing factors	39.2	9.2 ***	—	—	—
Categorization of contributing factors ^a					
1: Patient assessment	—	—	37.4	58.3	10.4
2: Patient/caregiver education	—	—	10.3	0.0	2.1
3: Handover communication	—	—	10.3	16.7	2.1
4: After discharge from the hospital	—	—	7.5	25.0	60.4
6: Postoperative complication/hospital-acquired condition	—	—	28.0	0.0	0.0
7: Contributing social factors or parental anxiety	—	—	0.9	0.0	25.0
8: Other	—	—	5.6	0.0	0.0

^aCategories are adapted from the Institute for Healthcare Improvement's STAAR (State Action on Avoidable Rehospitalizations) Readmission Diagnostic Worksheet. 22 Categories are not mutually exclusive.

*** $P < .001$.

TABLE 3**Multivariate Analysis of Odds of Potentially Preventable Readmissions**

Variables	AOR	95% CI	P
Index admission and readmission causally related (yes versus no)	2.6	1.02–6.75	.045
Hospital contributing factors (yes versus no)	16.3	5.94–44.81	< .001
Patient contributing factors (yes versus no)	7.1	2.45–20.48	< .001
Sex (male versus female)	2.8	1.18–6.71	.02
Age			
<1 vs 5–8 years ^a	8.2	1.96–34.61	.004
1–4 vs 5–8 years	2.1	0.513–8.57	.303
9–12 vs 5–8 years	4.8	1.03–21.98	.045
13–17 vs 5–8 years	5.8	1.34–24.84	.019
English (yes versus no)	1.01	0.29–3.5	.991
CCI count (1 vs 0)	0.68	0.219–2.08	.493

^aThe age reference of 5–8 years old was used to produce all age odds ratios >1.