HHS Public Access
Author manuscript
J Pediatr. Author manuscript; available in PMC 2022 February 10.

Published in final edited form as:
J Pediatr. 2021 September ; 236: 229–237.e5. doi:10.1016/j.jpeds.2021.05.021.

Emergency Department Pediatric Readiness and Potentially Avoidable Transfers

Monica K. Lieng, PhD[a], James P. Marcin, MD, MPH[a], Parul Dayal, PhD[a], Daniel J. Tancredi, PhD[a], Morgan B. Swanson, BS[b], Sarah C. Haynes, PhD[a], Patrick S. Romano, MD, MPH[a], Ilana S. Sigal, MPH[a], Jennifer L. Rosenthal, MD, MAS[a]

[a]Department of Pediatrics, University of California, Davis Health, Sacramento, California

[b]Department of Epidemiology, University of Iowa College of Public Health, Iowa City, Iowa

Abstract

Objective: To determine the association between potentially avoidable transfers (PATs) and emergency department (ED) pediatric readiness scores and the score's associated components.

Methods: This cross-sectional study linked the 2012 National Pediatric Readiness Project assessment with individual encounter data from California's statewide ED and inpatient databases during the years 2011–2013. A probabilistic linkage, followed by deterministic heuristics, linked pre-transfer and post-transfer encounters. Applying previously published definitions, a transferred child was considered a PAT if they were discharged within one day from the ED or inpatient care and had no specialized procedures. Analyses were stratified by injured and non-injured children. We compared PATs to necessary transfers using mixed-effects logistic regression models with random intercepts for hospital and adjustment for patient and hospital covariates.

Results: After linkage, there were 6675 injured children (27% PATs) and 18 793 non-injured children (14% PATs) who presented to 283 hospitals. In unadjusted analyses, a ten-point increase in pediatric readiness was associated with lower odds of PATs in both injured (OR: 0.93, 95% CI: 0.90–0.96) and non-injured children (OR: 0.90, 95% CI: 0.88–0.93). In adjusted analyses, a similar association was detected in injured patients (aOR: 0.92, 95% CI: 0.86–0.98) and was not detected in non-injured patients (aOR: 0.94, 95% CI 0.88–1.00). Components associated with decreased PATs included having a nurse pediatric emergency care coordinator and a quality improvement plan.

Conclusions: Hospital ED pediatric readiness is associated with lower odds of a PAT. Certain pediatric readiness components are modifiable risk factors that EDs could target to reduce PATs.

Address Correspondence to: Monica K. Lieng, Center for Health and Technology, University of California Davis Health, 4610 X Street Suite 2301, Sacramento, CA 95817, mlieng@ucdavis.edu, 650-479-5060.

Previous Presentations: Accepted to 2020 Pediatric Academic Societies conference for poster presentation; conference canceled due to concerns for COVID-19 pandemic

Conflicts of Interest
The remaining authors have disclosed that they do not have any potential conflicts of interest.

Keywords

Emergency Medical Services [MeSH]; Patient Transfer [MeSH]; Transfer Agreement [MeSH]; health care transition [MeSH]; Facilities and Services Utilization [MeSH]; Quality of Health Care [MeSH]

Introduction

Pediatric patients are transferred between hospitals at disproportionately higher rates than adult patients.[1,2] While interfacility transfers are often necessary, potentially avoidable transfers (PATs) make up 19–39% of pediatric interfacility transfers.[3–7] PATs expose patients to unnecessary costs and risk of psychological distress, care delays,[8] transport-related injuries,[9] redundancies in care, and mortality.[10,11]

The number of pediatric interfacility transfers and PATs may be related to the readiness of the pre-transfer hospital to care for pediatric patients. The majority of emergency departments (ED) receive a low volume of pediatric patients.[12] In addition, many smaller hospitals lack pediatric-specific equipment and pediatric emergency care coordinators.[10] These factors contribute to lack of ED preparedness to care for pediatric conditions. To address this challenge, the National Pediatric Readiness Project (NPRP) assessment was developed to quantify the pediatric readiness of EDs across the United States.[11] The NPRP assessment found that many EDs lack essential elements of pediatric readiness.[10] Furthermore, hospitals with decreased pediatric readiness scores were associated with increased pediatric ED encounter mortality,[13,14] and increased likelihood of transfer in small rural hospitals.[15] Roughly only half in children in the United States could travel to an ED with a readiness score at or above the 90th percentile.[16] Despite increased interest in improving pediatric readiness and increased awareness of PAT, no studies to date have examined the association between pediatric readiness and PAT. Furthermore, such examination should stratify injured and non-injured patients, for prior research suggests that trauma patients may experience different transfer patterns[17,18] and transfer protocols than non-trauma patients.[19–21]

The primary aim of this study was to determine the association between pediatric readiness and PAT. We hypothesized that pediatric transfers from hospitals with greater pediatric readiness scores would have lower odds of being potentially avoidable. The secondary aim of this study was to identify components of pediatric readiness most strongly associated with PATs.

Methods

Data Sources

We linked hospital-level pediatric readiness scores from the NPRP to encounter-level data from California Office of Statewide Health Planning and Development (OSHPD) datasets. Several professional organizations, such as Emergency Medical Services for Children and the American Academy of Pediatrics, formed the NPRP. The NPRP assessment evaluates ED compliance with the 2009 “Guidelines of Care of Children in the Emergency

Department." The assessment was conducted across California from late 2011 through 2012 as a pilot to develop the assessment. There was a 90% response rate of California hospital EDs (*n*=335; Table 1; online). The OSHPD administrative datasets included individual encounter emergency department data and patient discharge data.[22] These are the same administrative data sets that are sent to the Healthcare Cost and Utilization Project (HCUP) longitudinal State Emergency Department Databases and State Inpatient Databases.

Study Population

Our initial study population included patients aged <18 years treated in non-federal, California hospitals from January 1, 2011 to December 31, 2013. We restricted the analysis to patient encounters that occurred within 12 months after each individual hospital's pediatric readiness assessment. We only included pre-transfer ED encounters with an interfacility transfer to one of the following as designated by OSHPD: short-term general hospital, cancer center, or children's hospital.

Linkage

To link pre- and post-transfer encounters, the post-transfer record must have occurred within a one-day window from the initial pre-transfer ED encounter. Although OSHPD data have an encoded social security number for the linkage between ED data and patient discharge data, this value was missing for most pediatric encounters. Individuals without the encoded social security number may differ from those who do; they may be younger children or non-citizens.[23] To recuperate some of those individuals, we utilized probabilistic linkage followed by post-processing deterministic heuristics. Using a threshold of 0.9, the variables for the linkage included exact matches for birthdate, sex, and patient county and string matches for patient zip code. Additional details are described in Supplemental Methods and in Figure 1.

Definition of Pediatric Readiness

The primary exposure variable, pediatric readiness, was a hospital-level variable assessing the pre-transfer ED's readiness to care for pediatric patients. The NPRP assessment of pediatric readiness was measured on a weighted scale from 0 to 100. The six sections of pediatric readiness were 1) administration-pediatric emergency care coordinators; 2) physician, nurse and other ED provider competencies; 3) quality improvement (QI) and performance improvement plans; 4) pediatric patient safety in the ED; 5) policies, procedures and protocols for the ED; and 6) pediatric equipment and supplies.[10,11] To ease interpretation, the pediatric readiness score was divided by 10 in statistical models for the primary aim.

For the secondary aim, components of readiness included the items from the following sections: 1) pediatric emergency care coordinators; 3) QI plans; 5) policies and procedures and 6) pediatric equipment and supplies. These four sections were selected because they were thought, *a priori*, to be modifiable hospital factors that impact PATs the most. Since the equipment and supplies section had 57 items, we used the aggregated section score in modeling. The individual items comprising these sections are provided in Table 2 (online).[10,11]

Definition of a Potentially Avoidable Transfer

The primary outcome variable, PAT, was assigned at the individual encounter level. As shown in Figure 2, a patient was considered to have had a PAT if they were discharged directly from the post-transfer hospital's ED or the post-transfer hospital's inpatient ward within 0 or 1 days without receiving any specialized procedures (e.g. "Insertion of Pressure Sensor Monitoring Device into Coronary Vein"). Specialized procedures were identified using the 2016 HCUP major and minor diagnostic therapeutic procedure definitions using International Classification of Diseases, 9th Revision (ICD-9) codes.[24] Additional specialized procedures were identified using the Current Procedural Terminology codes from the only validated algorithm for measuring PATs to date.[25]

Patient and Hospital Characteristics

Patient-level covariates were obtained from the pre-transfer encounter and included age, gender, race/ethnicity, and insurance type. In addition, injury severity score,[26] illness severity,[27] and pediatric complex chronic conditions[28] were determined using ICD-9 diagnoses codes. For patients with multiple diagnoses, we used the most severe rating among all their diagnoses. Diagnoses were categorized by the HCUP Clinical Classifications Software.[29] Encounter data were linked to census data using ZIP Code Tabulation Areas to obtain estimates of median household income and percent completed high school.[30]

Hospital-level covariates included teaching hospital status, pediatric admitting capabilities (having a license for pediatric beds > 0), trauma center designation, pediatric trauma center designation, and type of hospital financial control. These data were obtained from the 2011 OSHPD Hospital Utilization[31] and 2011 Quarterly Financial datasets and were matched to the NPRP data manually.[32] Additional covariates were derived from the 2011 OSHPD ED encounter data, including ED pediatric volume, percent of encounters paid by Medicaid, and driving distance to the closest trauma hospital.

Statistical Methods

Since trauma patients experience different transfer patterns[17,18] and transfer protocols than non-trauma patients,[19–21] we determined *a priori* that analyses would be stratified on the presence (versus absence) of one or more diagnoses categorized as "injury or poisoning" by the Clinical Classifications Software.[29] Unadjusted comparisons of PAT versus non-PATs included Wilcoxon-Mann-Whitney tests and Pearson's chi-square tests where appropriate. For categories with cell counts less than five, Fisher's exact tests were used.

Confounders were identified in two ways. In a data-driven approach, potential covariates were selected if they were loosely associated with exposure and outcome (p <0.2). Each individual covariate was placed in a model with the exposure of interest. If the beta coefficient or the odds ratio (OR) for pediatric readiness changed more than 10%, then the covariate was considered for multivariable models. Confounders identified by this method included ED volume of pediatric patients (both injured and non-injured patients), trauma center designation (injured only), small and rural hospital status (both), and teaching status (non-injured only). In a theory-based approach, confounders were selected from PAT literature and used to construct a directed acyclic graph representing presumed causal linkages. From these, a minimal set of confounders was selected utilizing the software DAGitty.[33] (Figure 3) Using this method, additional confounders were included in the models including patient demographics (age, gender, insurance, race), measures of injury/illness severity, having a complex chronic condition and pediatric admitting capability. Teaching status and small and rural hospital status were not included in the models because of the theoretical overlap with pediatric admitting capability and trauma center designation.

After fitting mixed-effects models with pre-transfer hospital as a random intercept, marginal probabilities were calculated for a PAT at the means of the covariates. For the secondary aim, models were fit with the same mixed effects approach and confounders from the main analysis. The items were first fit individually with the core model and then simultaneously in a large model. Data linkage and statistical analyses were conducted using R version 3.5.2 and Stata 15.[34,35] Probabilistic linkages were generated using the R package "RecordLinkage"[36] and cartesian-plane distances were calculated using the R package "geosphere."[37] This study was approved by the University of California Davis Institutional Review Board and by the California Committee for the Protection of Human Subjects. This manuscript was prepared using the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) extension of the STROBE guidelines.[38]

Results

Characteristics of Study Sample

After conducting linkage and applying exclusion criteria, we identified 87 921 transfers. Twenty-one percent of the linked transfers had an encoded social security number for both the pre-transfer and post-transfer encounters for linkage purposes. There were 283 pre-transfer hospitals with both a pediatric readiness assessment and transferred patients within 12 months of the assessment. Of the 25 601 transfers from those hospitals, 6765 (26%) were injured patients and 18 836 (74%) were non-injured patients. During a 12-month period, the median [interquartile (IQR)] number of transfers was 87.5 [38.0–156].

For injured patients, there were 14 (5%) hospitals without an injured transfer resulting in a cohort of 269 pre-transfer hospitals. The median [IQR] number of linked injured transfers per hospital was 17 [8.0–35]. One hundred one (38%) hospitals had pediatric admitting capabilities and only 8 (3%) had a pediatric trauma center. The mean (standard deviation [SD]) and median [IQR] pediatric readiness score of these hospitals was 71.2 (17.0) and 69.6 [57.4–86.4], respectively. (Figure 4) A patient that experienced a PAT was more likely to have a lower injury severity score. (Table 3)

For non-injured patients, there were 8 (3%) hospitals without a non-injured transfer resulting in a cohort of 275 pre-transfer hospitals. The median [IQR] number of linked non-injured transfers per hospital was 42 [18–85]. One hundred four (38%) hospitals had pediatric admitting capabilities. The mean (SD) and median [IQR] pediatric readiness score of these hospitals was 71.1 (17.1) and 69.6 [57.2–86.1], respectively. (Figure 4) A patient that experienced a PAT was more likely to have a lower severity of illness. (Table 3)

Pediatric Readiness and Potentially Avoidable Transfers

Among injured patients, 10-point increase in overall pediatric readiness was associated with lower odds of a PAT (OR: 0.93, 95% CI: 0.90–0.96). As shown in Table 4, when adjusted in a mixed model with a random intercept for pre-transfer hospital, the adjusted odds ratio (aOR) went to 0.92 (95% CI: 0.86–0.98). As shown in Table 5 (online), an injured patient being transferred from a hospital with the rounded median pediatric readiness score of 70 would have a 26% (95% CI: 24%−28%) marginal probability of a PAT. If an injured patient was seen at a pre-transfer hospital with a pediatric readiness score of 90, the patient would have a 23% (95% CI: 20% to 26%) chance of having a PAT. This 20-point difference is roughly one standard deviation or the equivalent of obtaining both a physician and a nurse pediatric emergency care coordinator.

For non-injured patients, a 10-point increase in pediatric readiness was also associated with decreased odds of having a PAT (OR: 0.90, 95% CI: 0.88–0.93). This association did not remain after adjustment in the mixed model with a random intercept for hospital (aOR: 0.94, 95% CI 0.88–1.00). A non-injured patient being transferred from a hospital with a pediatric readiness score of 70 and 90 would have a 15% (95% CI: 14% to 16%) and 13% (11% to 15%) chance of having a PAT, respectively.

Pediatric Readiness Components

In unadjusted analyses of injured patients, the presence of a physician coordinator, a nurse coordinator, QI plans and each of the four items within the QI plans section were associated with decreased PATs (all *p*-values <0.001). Within the policies and procedures section, having policies or procedures related to the following were associated with decreased odds of having a PAT: triage, pediatric patient assessment and reassessment, and death of child in the ED (all *p*-values <0.001). The aggregated section score for equipment and supplies was not associated with PATs in injured patients.

When adjusting for the same covariates and random intercepts as the main analysis, only the QI subcomponents remained statistically significant predictors of PATs. As shown in Table 6, after simultaneous adjustment of pediatric readiness components, none of the items were statistically significant. Having a nurse coordinator, triage policy, pediatric assessment and reassessment policy, and policy regarding death of a child in the ED had nonsignificant reductions in PATs. Transfer guidelines had an aOR of 1.17 (95% CI: 0.82–1.67).

In unadjusted analyses of non-injured patients, similar associations were seen. The presence of physician coordinator, a nurse coordinator, QI processes, the four QI plan items, and the same three policies were all associated with reductions in PATs (all p <0.001). Having written transfer guidelines was not associated with changes in PATs (OR: 1.11; 95% CI: 0.95–1.31). When adjusting for the same covariates and random intercepts as the main analysis, having a nurse pediatric emergency care coordinator, QI plan and each of the QI items, and a policy regarding death of a child in the ED had significant reductions in PATs. After simultaneous adjustment, none of the items were statistically significant. However, many of the items associated with reduced PAT odds in injured patients were similarly also associated with reduced PAT odds in non-injured patients. (Table 6)

Discussion

This study investigated the association between ED pediatric readiness and pediatric PATs in California hospitals during the years 2011–2013. In unadjusted analyses, injured and non-injured patients presenting to a hospital with higher pediatric scores resulted in lower odds of a PAT. In adjusted analyses, that same association was detected in injured patients. This study also found that presence of a nurse pediatric emergency care coordinator and QI plans may be associated with decreased odds of PATs.

The decrease in PAT odds in relation to overall pediatric readiness score may be due to either lower absolute numbers of PATs (in the numerator) or higher absolute numbers of (necessary) transfers from the pre-transfer hospital (in the denominator). If the second situation was true, it is possible that the pre-transfer hospital had improved ability in determining necessary transfers. It is also possible that the pre-transfer hospitals were choosing to transfer patients that needed admissions even if they could have been admitted locally. For example, a 2019 study found that uninsured patients are more likely to be discharged or transferred than privately insured patients.[39] Furthermore, this study focused on patients who were transferred. However, pediatric readiness may also be associated with admissions to the home institution instead of transfer elsewhere; future research could explore this association. Additional studies are needed to determine the association between pediatric readiness and discharges, admissions, and transfers at the pre-transfer hospital.

Furthermore, this study identified possible components of pediatric readiness that were associated with decreased risk of PATs. The presence of a nurse pediatric emergency care coordinator may be associated with decreased PATs. A quasi-experimental study found decreased pediatric transfers after a bundled intervention which included hiring a pediatric emergency care coordinator.[40] These coordinators may be instrumental in triaging appropriate patients for transfer. Furthermore, we found that the presence of QI plans was associated with decreased PATs. Notably, the presence of transfer guidelines was not associated with decreased PATs. Previous policy efforts by the Emergency Medical Services for Children have included the generation of interfacility transfer guidelines in EDs as a performance measure[41,42] and the creation of educational resources such as the transfer toolkit.[43] However, this toolkit focuses on the logistics of transfer but not the appropriateness of transfer. If the goal is to reduce PATs, our results provide limited evidence that resources could be allocated to improve triage education or to continue efforts on the pediatric emergency care coordinator performance measure rather than on transfer guidelines. When adjusting for multiple pediatric readiness components simultaneously, most of the odds ratios maintained their magnitude and directionality, but the confidence intervals widened. Additional research is needed with a larger hospital sample size to identify the most important components for reducing PATs.

To the best of our awareness, this is the first study to identify modifiable hospital-level risk factors to possibly reduce PATs. Most previous literature has focused on patient risk factors associated with PATs.[3,4,6,44–48] The few studies that have investigated hospital-level factors have found associations with difficult-to-modify risk factors: pediatric ED volume,[49] non-metropolitan location,[2,50] having a pediatric ED[50] or pediatric ED staff,[49] or having inpatient pediatric services.[7,51] In contrast, the pediatric readiness score components explored in this study are modifiable. For example, designating a pediatric emergency care coordinator may be more achievable than increasing the volume of pediatric emergency cases or hiring a sub-specialist. There is also early work in determining the use of simulation studies and statewide verification systems to improve pediatric readiness overall.[52–54]

Limitations

This study was observational and causal inference is limited; similar to other studies pediatric readiness.[52,55] Several covariates and random intercepts were included in the model; however, residual confounding might still exist. Fundamentally, a PAT is a subjective classification that may differ between different physicians, hospitals, and circumstances. Thus, this study uses a PAT definition that may misclassify PATs as necessary transfers and vice versa. Furthermore, this study was conducted with data that were 8–10 years old. Many pediatric inpatient units have closed since then, and children are now more likely to be transferred than admitted locally.[56,57] Future interventional studies could investigate how improvements in pediatric readiness could lead to a reduction of PATs and other outcomes with newer data. The number needed to treat for injured and non-injured patients, assuming a 20-point improvement in pediatric readiness, would be 33 and 50, respectively. For smaller hospitals, that have few transfers, the cost of improving pediatric ED readiness may outweigh the benefit of reducing PATs. In addition, pediatric readiness was self-assessed and may have large variability. Survey respondents included pediatric liaison nurses, nurse ED managers, nurse ED directors, and physician ED clinical directors. These differing roles may affect the quality of the data reported. Data validation processes or site visits could increase the validity and measurement precision but would require more resources. In addition, the lack of a definitive linkage between pre-transfer and post-transfer encounters limits the generalizability of this study. Non-linked individuals may represent a different patient population than the population we studied.[23] Last, this study does not take in consideration the patient's clinical course and individual preferences of patients and families for transfer.

Conclusion

Our study found that an increase in pediatric readiness score is associated with reduced odds of having a PAT in injured and non-injured patients. Having a nurse pediatric emergency care coordinator and a quality improvement plan are modifiable risk factors that EDs may target to reduce PATs. However, additional studies are necessary to validate the association between pediatric readiness, its components, and PATs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments:

The authors would like to thank the California Office of Statewide Health Planning and Development and the National Pediatric Readiness Project for their support in data acquisition and guidance in understanding each of their respective data sets.

Funding Sources

This study was supported by the Health Resources and Services Administration's (HRSA) Emergency Medical Services for Children Program SPROC TACTICAL grant (award H3AMC24073) to JPM; the National Center for Advancing Translational Sciences (NCATS) and National Institutes of Health (NIH) (grant number UL1 TR001860) to University of California Davis Center for Translational Science; NCATS and NIH (linked award TL1 TR001861) to MKL; NCATS and NIH (linked award KL2 TR001859) to JLR. The content is solely the responsibility of the authors and does not necessarily represent the official views of the HRSA or NIH.

Abbreviations:

PAT	Potentially Avoidable Transfer
ED	Emergency Department
OSHPD	Office of Statewide Health Planning and Development
NPRP	National Pediatric Readiness Project
QI	Quality Improvement
ICD-10-CM	International Classification of Diseases
HCUP	Healthcare Cost and Utilization Project
IQR	Interquartile Range
SD	Standard Deviation
CI	Confidence Interval
OR	Odds Ratio
aOR	Adjusted Odds Ratio

References

1. Nacht J, Macht M, Ginde AA. Interhospital Transfers from U.S. Emergency Departments: Implications for Resource Utilization, Patient Safety, and Regionalization. Gratton MC, editor. Acad Emerg Med 2013;20:888–93. [PubMed: 24033705]
2. Osen HB, Bass RR, Abdullah F, Chang DC. Rapid Discharge After Transfer: Risk Factors, Incidence, and Implications for Trauma Systems. J Trauma Inj Infect Crit Care 2010;69:602–6.
3. Gattu RK, Teshome G, Cai L, Wright C, Lichenstein R. Interhospital Pediatric Patient Transfers —Factors Influencing Rapid Disposition After Transfer. Pediatr Emerg Care 2014;30:26–30. [PubMed: 24365724]
4. Fenton SJ, Lee JH, Stevens AM, Kimbal KC, Zhang C, Presson AP, et al. Preventable transfers in pediatric trauma: A 10-year experience at a level I pediatric trauma center. J Pediatr Surg 2016;51:645–8. [PubMed: 26520697]
5. Mohr NM, Harland KK, Shane DM, Miller SL, Torner JC. Potentially Avoidable Pediatric Interfacility Transfer Is a Costly Burden for Rural Families: A Cohort Study. Newgard CD, editor. Acad Emerg Med 2016;23:885–94. [PubMed: 27018337]
6. Leung A, Bonasso P, Lynch K, Long D, Vaughan R, Wilson A, et al. Pediatric Secondary Overtriage in a Statewide Trauma System. Am Surg 2016;82:763–7. [PubMed: 27670555]
7. Peebles ER, Miller MR, Lynch TP, Tijssen JA. Factors Associated With Discharge Home After Transfer to a Pediatric Emergency Department. Pediatr Emerg Care 2018;34:650–5. [PubMed: 28328691]

8. Ward MJ, Kripalani S, Storrow AB, Liu D, Speroff T, Matheny M, et al. Timeliness of interfacility transfer for ED patients with ST-elevation myocardial infarction. Am J Emerg Med 2015;33:423–9. [PubMed: 25618768]

9. Janiak BD, Rawson JV, Clayton SK. Unnecessary Repeat Radiologic Examinations in the Emergency Department After Interfacility Transfer. J Am Coll Radiol JACR 2015;12:1079–81. [PubMed: 26435121]

10. Gausche-Hill M, Ely M, Schmuhl P, Telford R, Remick KE, Edgerton EA, et al. A national assessment of pediatric readiness of emergency departments. JAMA Pediatr 2015;169:527–34. [PubMed: 25867088]

11. Remick K, Kaji AH, Olson L, Ely M, Schmuhl P, McGrath N, et al. Pediatric Readiness and Facility Verification. Ann Emerg Med 2016;67:320–328.e1. [PubMed: 26320519]

12. Gausche-Hill M, Schmitz C, Lewis RJ. Pediatric Preparedness of US Emergency Departments: A 2003 Survey. Pediatrics 2007;120:1229–37. [PubMed: 18055671]

13. Balmaks R, Whitfill TM, Ziemele B, Blumberga M, Upenieks R, Vegeris I, et al. Pediatric Readiness in the Emergency Department and Its Association With Patient Outcomes in Critical Care: A Prospective Cohort Study. Pediatr Crit Care Med J Soc Crit Care Med World Fed Pediatr Intensive Crit Care Soc 2020;21:e213–20.

14. Ames SG, Davis BS, Marin JR, Fink EL, Olson LM, Gausche-Hill M, et al. Emergency Department Pediatric Readiness and Mortality in Critically Ill Children. Pediatrics 2019;144:e20190568. [PubMed: 31444254]

15. Lieng MK, Marcin JP, Sigal IS, Haynes SC, Dayal P, Tancredi DJ, et al. Association between emergency department pediatric readiness and transfer of noninjured children in small rural hospitals. J Rural Health Off J Am Rural Health Assoc Natl Rural Health Care Assoc 2021;

16. Ray KN, Olson LM, Edgerton EA, Ely M, Gausche-Hill M, Schmuhl P, et al. Access to High Pediatric-Readiness Emergency Care in the United States. J Pediatr 2018;194:225–232.e1. [PubMed: 29336799]

17. Huang Y, Natale JE, Kissee JL, Dayal P, Rosenthal JL, Marcin JP. The Association Between Insurance and Transfer of Noninjured Children From Emergency Departments. Ann Emerg Med 2016;69:108–116.e5. [PubMed: 27553479]

18. Huang Y, Kissee JL, Dayal P, Wang NE, Sigal IS, Marcin JP. Association Between Insurance and Transfer of Injured Children From Emergency Departments. Pediatrics 2017;140:1–9.

19. Rogers FB, Osler TM, Shackford SR, Cohen M, Camp L, Lesage M. Study of the Outcome of Patients Transferred to a Level I Hospital after Stabilization at an Outlying Hospital in a Rural Setting. J Trauma Acute Care Surg 1999;46:328.

20. Acosta CD, Delgado MK, Gisondi MA, Raghunathan A, D’Souza PA, Gilbert G, et al. Characteristics of Pediatric Trauma Transfers to a Level I Trauma Center: Implications for Developing a Regionalized Pediatric Trauma System in California. Acad Emerg Med Off J Soc Acad Emerg Med 2010;17:1364–73.

21. Nathens A, Maier R, Brundage S, Jurkovich G, Grossman D. The Effect of Interfacility Transfer on Outcome in an Urban Trauma System. J Trauma Inj Infect Crit Care 2003;55:444–9.

22. About Our Data - Patient Discharge Data (PDD) and Emergency Data (ED) [Internet] California’s Office of Statewide Health Planning and Development (OSHPD). [cited 2019 May 10]. Available from: https://oshpd.ca.gov/data-and-reports/request-data/tools-resources/

23. Anderson JE, Vanover MA, Saadai P, Stark RA, Stephenson JT, Hirose S. Epidemiology of Hirschsprung disease in California from 1995 to 2013. Pediatr Surg Int 2018;34:1299–303. [PubMed: 30324568]

24. Procedure Classes 2015 [Internet]. Healthcare Cost and Utilization Project (HCUP); [cited 2019 May 29]. Available from: https://www.hcup-us.ahrq.gov/toolssoftware/procedure/procedure.jsp

25. Rosenthal JL, Atolagbe O, Hamline MY, Li S-TT, Toney A, Witkowski J, et al. Developing and Validating a Pediatric Potentially Avoidable Transfer Quality Metric. Am J Med Qual 2019;1062860619854535.

26. Clark DE, Black AW, Skavdahl DH, Hallagan LD. Open-access programs for injury categorization using ICD-9 or ICD-10. Inj Epidemiol 2018;5:11. [PubMed: 29629480]

27. Alessandrini EA, Alpern ER, Chamberlain JM, Shea JA, Holubkov R, Gorelick MH. Developing a Diagnosis-based Severity Classification System for Use in Emergency Medical Services for Children. Acad Emerg Med 2012;19:70–8. [PubMed: 22251193]

28. 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;14:199. [PubMed: 25102958]

29. Clinical Classifications Software (CCS) for ICD-9-CM [Internet]. Healthcare Cost and Utilization Project (HCUP); [cited 2019 Feb 28]. Available from: https://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp

30. Office ACS. 2012 – 2016 ACS 5-Year Data Profiles [Internet]. S1903 Median Income in the Past 12 Months (in 2016 Inflation Adjusted Dollars) Available from: https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2016/

31. California's Office of Statewide Health Planning and Development (OSHPD). 2011 Calendar Year Hospital Utilization [Internet]. California Health and Human Services Agency (CHHS) [cited 2019 May 14]. Available from: https://data.chhs.ca.gov/dataset/pre-2012-hospital-annual-utilization-report-pivot-tables/resource/7b07cf58-db62-4aa3-81c2-731b0b5bad8b

32. Hospital Quarterly Financial and Utilization Report - 2011 Sum of Four Quarters [Internet]. California's Office of Statewide Health Planning and Development (OSHPD) [cited 2018 May 7]. Available from: https://www.oshpd.ca.gov/HID/Hospital-Quarterly.html

33. Textor J, van der Zander B, Gilthorpe MS, Liśkiewicz M, Ellison GT. Robust causal inference using directed acyclic graphs: the R package 'dagitty.' Int J Epidemiol 2016;45:1887–94. [PubMed: 28089956]

34. R Core Team. R: A Language and Environment for Statistical Computing [Internet]. Vienna, Austria: R Foundation for Statistical Computing; 2020. Available from: https://www.R-project.org/

35. Stata Statistical Software: Release 15 College Station, TX: StataCorp LLC; 2017.

36. Borg A, Sariyar M. RecordLinkage: Record Linkage in R [Internet]. 2019 [cited 2019 Feb 2]. Available from: https://CRAN.R-project.org/package=RecordLinkage

37. Hijmans RJ, Williams E, Vennes C. Spherical Trigonometry [R package geosphere version 1.5–7] [Internet]. Available from: https://CRAN.R-project.org/package=geosphere

38. Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, et al. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. PLOS Med 2015;12:e1001885. [PubMed: 26440803]

39. Venkatesh AK, Chou S-C, Li S-X, Choi J, Ross JS, D'Onofrio G, et al. Association Between Insurance Status and Access to Hospital Care in Emergency Department Disposition. JAMA Intern Med 2019;179:686–93. [PubMed: 30933243]

40. Oakley E, Crellin D, Barty N, Braitberg G, Young S. Improving emergency care for children: A model of collaboration between emergency departments. Emerg Med 2004;16:417–24.

41. Emergency Medical Services for Children (EMSC). Performance Measures [Internet]. Emergency Medical Services for Children | Innovation & Improvement Center. [cited 2020 Feb 23]. Available from: https://emscimprovement.center/programs/partnerships/performance-measures/

42. Genovesi AL, Olson LM, Telford R, Fendya D, Schenk E, Morrison-Quinata T, et al. Transitions of Care: The Presence of Written Interfacility Transfer Guidelines and Agreements for Pediatric Patients. Pediatr Emerg Care 2017;

43. Emergency Medical Services for Children (EMSC). Interfacility Transfer Toolkit [Internet] Emergency Medical Services for Children | Innovation & Improvement Center. [cited 2020 Feb 23]. Available from: https://emscimprovement.center/education-and-resources/toolkits/interfacility-transfer-toolbox/

44. Li J, Monuteaux MC, Bachur RG. Interfacility Transfers of Noncritically Ill Children to Academic Pediatric Emergency Departments. PEDIATRICS 2012;130:83–92. [PubMed: 22665410]

45. Sorensen MJ, von Recklinghausen FM, Fulton G, Burchard KW. Secondary Overtriage. JAMA Surg 2013;148:763. [PubMed: 23784088]

46. Tang A, Hashmi A, Pandit V, Joseph B, Kulvatunyou N, Vercruysse G, et al. A critical analysis of secondary overtriage to a Level I trauma center: J Trauma Acute Care Surg 2014;77:969–73. [PubMed: 25423540]

47. Lynch KT, Essig RM, Long DM, Wilson A, Con J. Nationwide secondary overtriage in level 3 and level 4 trauma centers: are these transfers necessary? J Surg Res 2016;204:460–6. [PubMed: 27565083]
48. Snyder CW, Kauffman JD, Pracht EE, Danielson PD, Ciesla DJ, Chandler NM. Risk factors for avoidable transfer to a pediatric trauma center among patients 2 years and older: J Trauma Acute Care Surg 2019;86:92–6. [PubMed: 30312251]
49. Walls TA, Chamberlain JM, Klein BL. Factors Associated With Emergency Department Discharge After Pediatric Interhospital Transport. Pediatr Emerg Care 2015;31:10–4. [PubMed: 25526016]
50. Ray KN, Marin JR, Li J, Davis BS, Kahn JM. Referring Hospital Characteristics Associated With Potentially Avoidable Emergency Department Transfers. Acad Emerg Med 2018;26:205–16. [PubMed: 30019793]
51. Rosenthal JL, Lieng MK, Marcin JP, Romano PS. Profiling Pediatric Potentially Avoidable Transfers Using Procedure and Diagnosis Codes: Pediatr Emerg Care 2019;1.
52. Whitfill TM, Remick KE, Olson LM, Richards R, Brown KM, Auerbach MA, et al. Statewide Pediatric Facility Recognition Programs and Their Association with Pediatric Readiness in Emergency Departments in the United States. J Pediatr 2020;218:210–216.e2. [PubMed: 31757472]
53. Whitfill T, Gawel M, Auerbach M. A Simulation-Based Quality Improvement Initiative Improves Pediatric Readiness in Community Hospitals. Pediatr Emerg Care 2018;34:431–5. [PubMed: 28719479]
54. Abulebda K, Lutfi R, Whitfill T, Abu-Sultaneh S, Leeper KJ, Weinstein E, et al. A Collaborative In Situ Simulation-based Pediatric Readiness Improvement Program for Community Emergency DepartmSents. Acad Emerg Med 2018;25:177–85. [PubMed: 28977717]
55. Michelson KA. It’s Time to Get Serious about Pediatric Readiness. J Pediatr 2020;218:9–10. [PubMed: 31704055]
56. Lorch SA, Myers S, Carr B. The Regionalization of Pediatric Health Care. PEDIATRICS 2010;126:1182–90. [PubMed: 21041285]
57. França UL, McManus ML. Trends in Regionalization of Hospital Care for Common Pediatric Conditions. Pediatrics 2018;141:e20171940. [PubMed: 29263253]

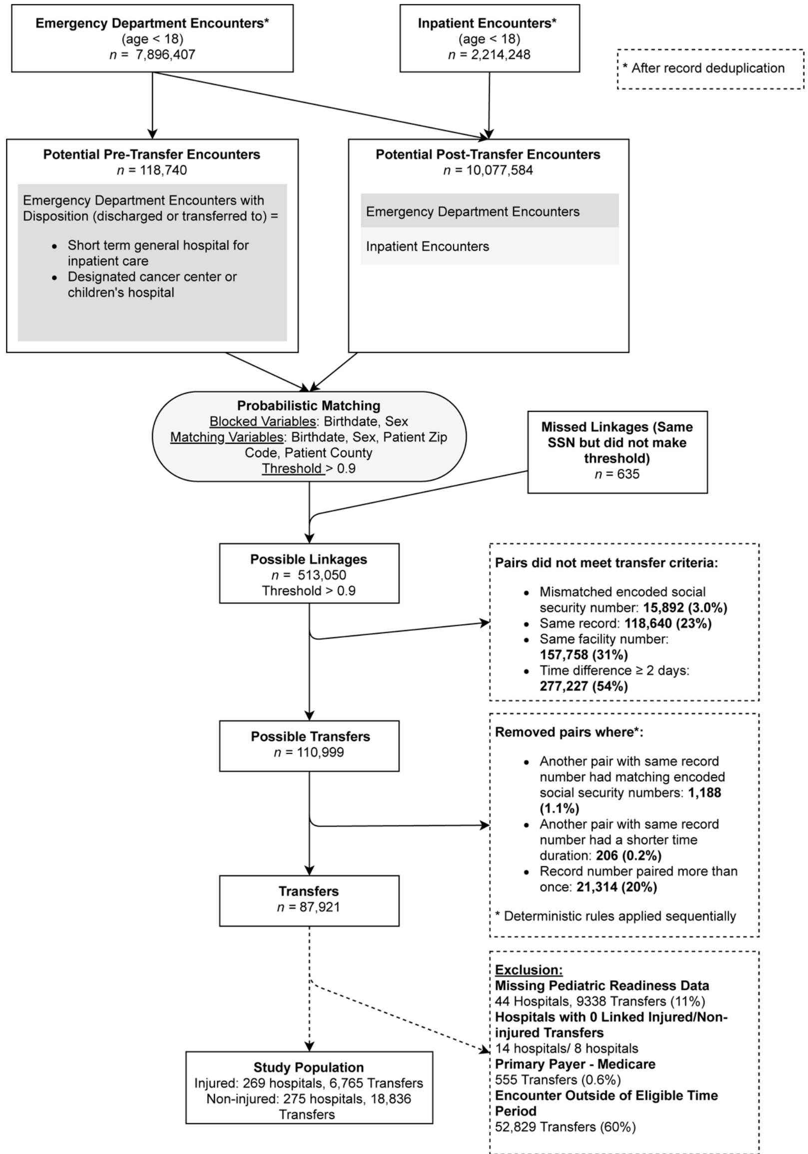


Figure 1.

Linkage strategy and study population

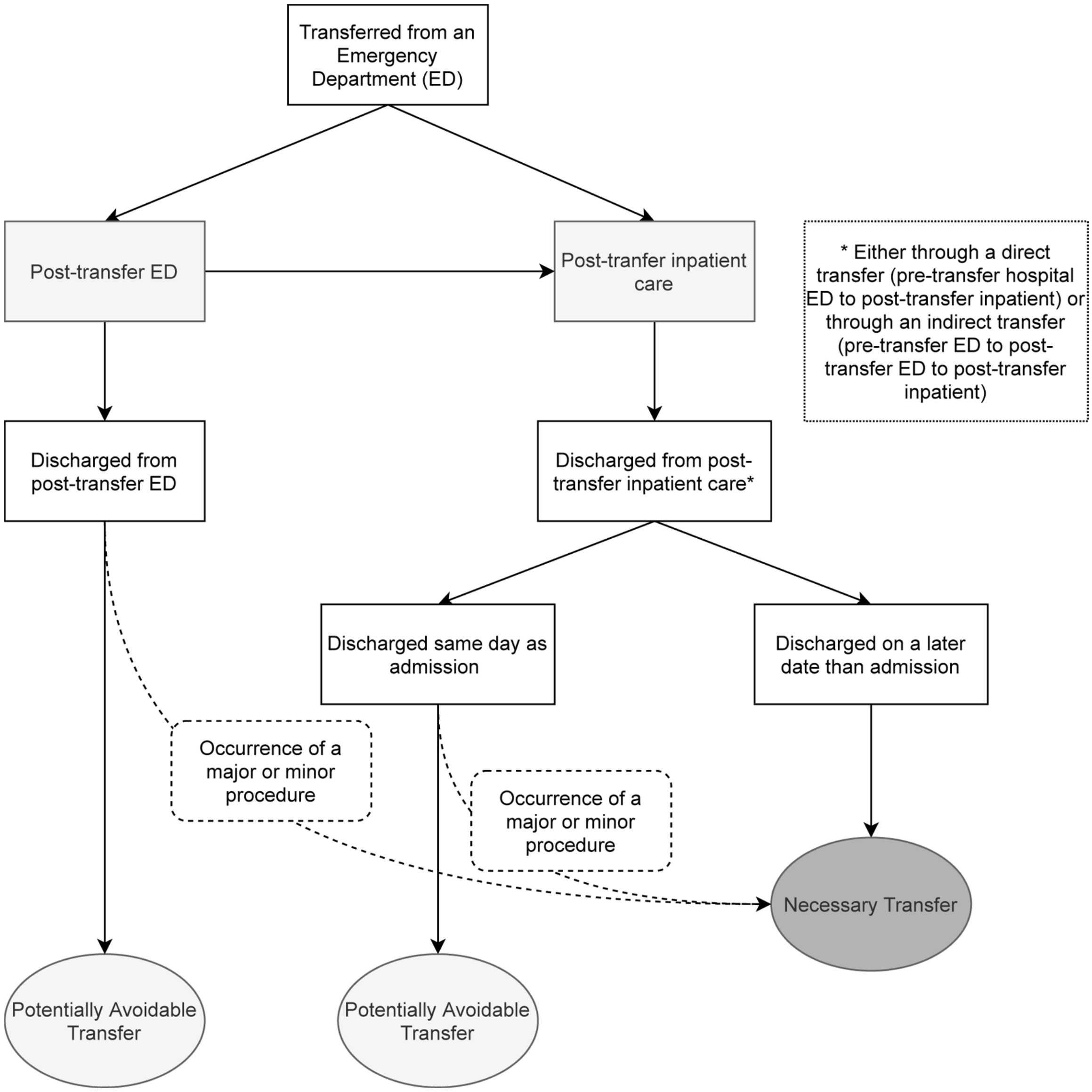
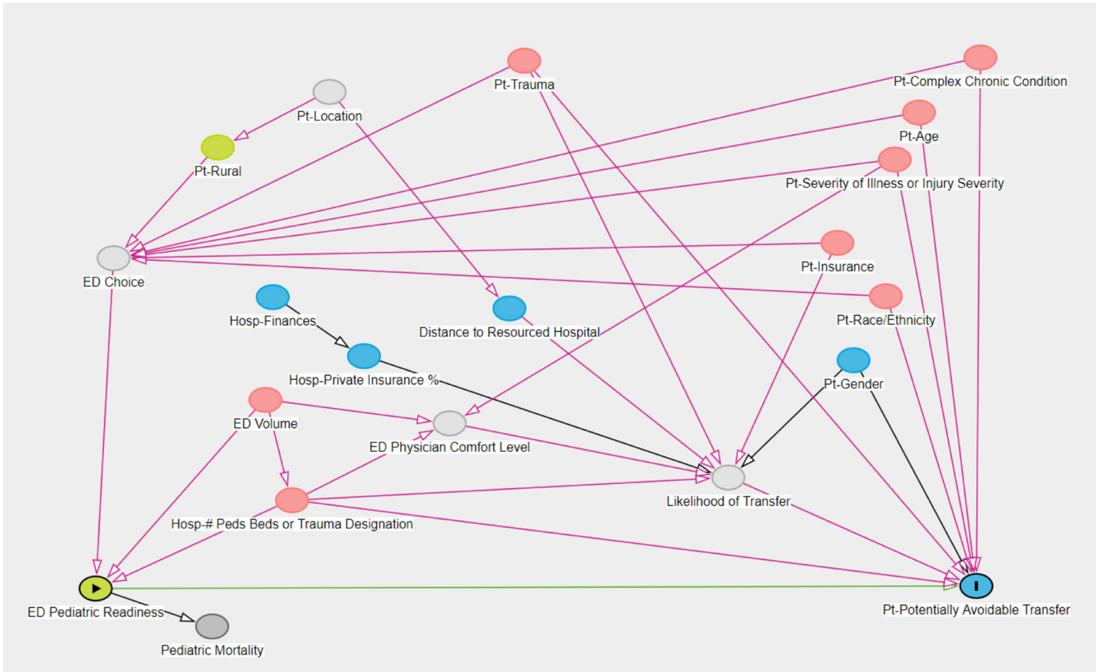


Figure 2.
Definition of potentially avoidable transfers



Pt = Patient
Hosp = Hospital
Peds = Pediatric

Hospital-Pediatric Beds or Trauma Designation is a surrogate for pediatric specialists

Legend
- exposure
- outcome
- ancestor of exposure
- ancestor of outcome
- ancestor of exposure *and* outcome
- adjusted variable
- unobserved (latent)
- other variable
- causal path
- biasing path

Figure 3.
Directed acyclic graph using DAGitty v3.0

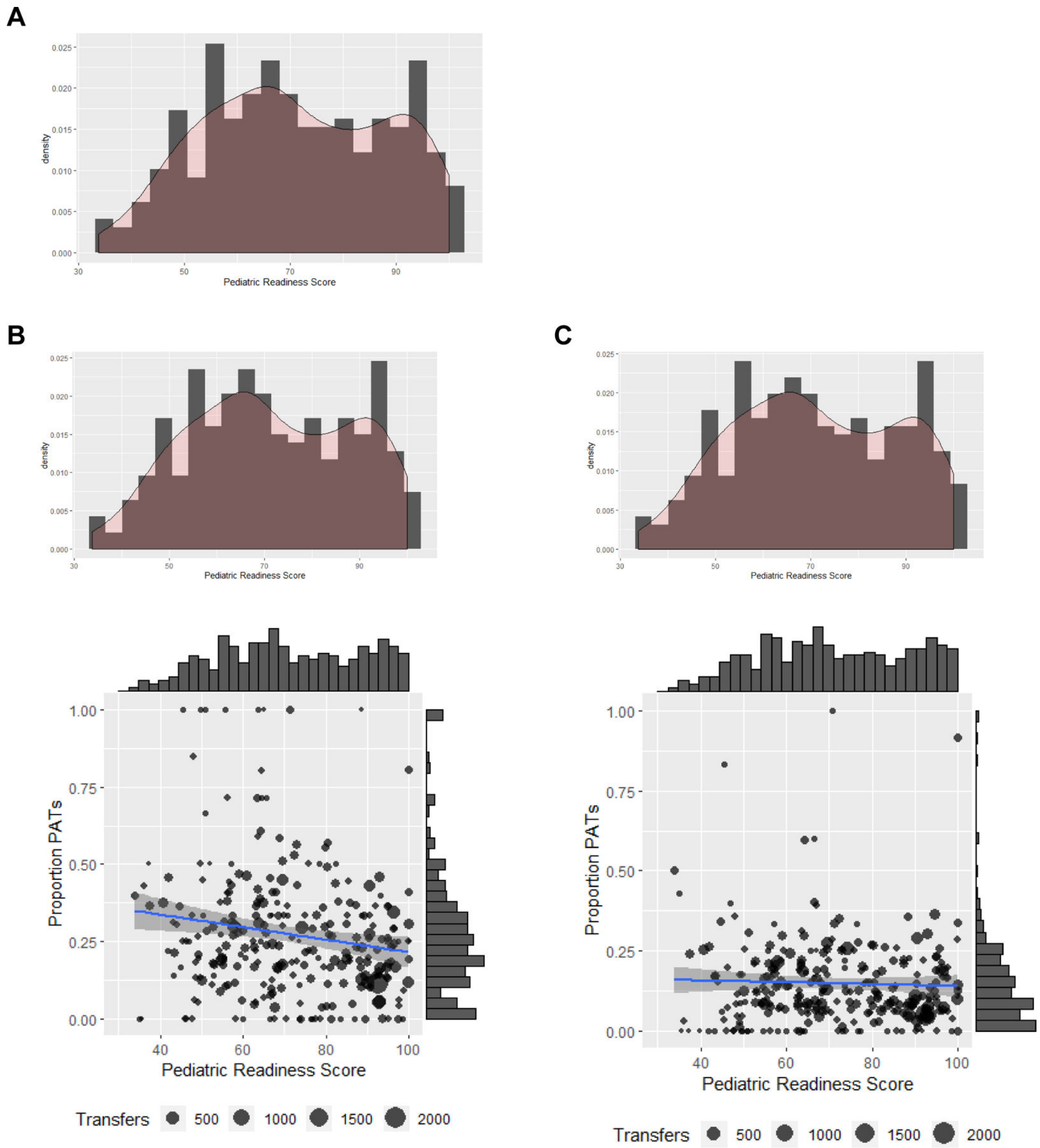


Figure 4.

Distributions of pediatric readiness scores with proportional potentially avoidable transfers (PATs). **A**, All hospitals (*N*=283). **B**, Injured study population (*N*=269). **C**, Non-injured study population (*N*=275)

Table 1.

Pre-transfer hospital characteristics

Variable	Respondents to NRPP[a] assessment			Hospital cohorts[c]	
	Non-responder ***n*** **= 40 (12%)**	**Responded** ***n*** **= 283 (88%)**	***P***[b]	**Injured**[d] ***n*** **= 275 (97%)**	**Non-injured**[e] ***n*** **= 269 (95%)**
Patient Characteristics, *n* (%)					
Finances			0.31		
Non-profit	29 (72%)	273 (96%)		219 (80%)	213 (80%)
Investor	11 (28%)	10 (4%)		54 (20%)	54 (20%)
Teaching Hospital	3 (8%)	24 (9%)	>0.99	24 (9%)	22 (8%)
Small and Rural	7 (18%)	54 (19%)	0.98	51 (19%)	49 (18%)
Pediatric Admitting Capability[f]	12 (30%)	108 (38%)	0.41	104 (38%)	101 (38%)
Pediatric Trauma Center	0 (0%)	10 (4%)	0.62	10 (4%)	8 (3%)
Derived Characteristics from 2011 Individual Encounters, median (IQR)					
Pediatric Volume in the Emergency Department	4 848 (1 748, 11 124)	6 730 (3 125, 11 006)	0.16	6 820 (3 148, 11 042)	6 876 (3 167, 11 046)
Pediatric Readiness					
Mean Score, mean (SD)	-	71.1 (17.1)	-	71.2 (17.0)	71.1 (17.1)
Median, median (IQR)	-	69.6 (57.1, 85.9)		69.6 (57.4, 86.4)	69.6 (57.2, 86.1)

[a]National Pediatric Readiness Project assessment

[b]Categorical variables were compared using chi-square tests and continuous variables were compared using Wilcoxon rank-sum tests. For categories with cell counts less than five, Fisher exact tests were used.

[c]Among the hospitals that responded to the NRPP assessment

[d]Excludes hospitals that saw non-injured patients exclusively from 2011–213

[e]Excludes hospitals that saw injured patients exclusively from 2011–2013

[f]Licensed Pediatric Beds > 0

Table 2.

Items in selected pediatric readiness sections[a]

Name	Weighted Value
Section 1: Pediatric Emergency Care Coordinator	**19**
Physician	9.5
Nurse	9.5
Section 3: Quality Improvement (QI)	**7**
QI/Performance plan	5
Subcomponents in QI plan	
Identification of quality indicators for children	0.5
Collection and analysis of pediatric emergency care data	0.5
Development of a plan for improvement in pediatric emergency care	0.5
Re-evaluation of performance using outcomes-based measures	0.5
Section 5: Policies/Procedures/Protocols	**17**
Triage for ill and injured children	2.12
Pediatric assessment and reassessment	2.12
Immunization assessment	2.12
Death of child in ED	2.12
Pediatric age- or weight-based dosing in medical imaging	2.12
Family centered care	2.12
Hospital disaster plan	2.12
Transfer guidelines	2.12

[a]Sections selected from the National Pediatric Readiness Project assessment as described in Gausche-Hill M, Ely M, Schmuhl P, Telford R, Remick KE, Edgerton EA, et al. A national assessment of pediatric readiness of emergency departments. JAMA Pediatr. 2015;169:527–34.[10]

Table 3.

Patient characteristics by outcome

Variable	Injured Patients *n* = 6765: Necessary Transfer *n* = 4972 (73%)	Injured Patients *n* = 6765: Potentially Avoidable Transfer *n* = 1793 (27%)	*P*[a]	Non-Injured Patients *n* = 18 836: Necessary Transfer *n* = 16 212 (86%)	Non-Injured Patients *n* = 18 836: Potentially Avoidable Transfer *n* = 2624 (14%)	*P*[a]
Patient Characteristics, *n* (%)						
Patient age			<0.001			<0.001
Neonate/Infant (0m-12m)	631 (80%)	163 (21%)		3848 (86%)	579 (13%)	
Toddler (13m-24m)	569 (72%)	225 (28%)		1497 (83%)	304 (17%)	
Early Childhood (2y-5y)	1376 (71%)	565 (29%)		3260 (84%)	619 (16%)	
Middle Childhood (6y-11y)	1031 (70%)	445 (30%)		3619 (87%)	556 (13%)	
Early Adolescence (12y-17y)	1365 (78%)	395 (22%)		3988 (88%)	566 (12%)	
Gender			0.08			0.07
Female	2082 (75%)	707 (25%)		7188 (87%)	1113 (13%)	
Male	2890 (73%)	1086 (27%)		9024 (86%)	1511 (14%)	
Race/Ethnicity			0.23			0.055
White	1686 (72%)	643 (28%)		4534 (85%)	773 (15%)	
Hispanic or Latino	2317 (74%)	818 (26%)		8301 (87%)	1298 (14%)	
Black or African American	355 (72%)	136 (28%)		1337 (85%)	245 (16%)	
Other, mixed or unknown	614 (76%)	196 (24%)		2040 (87%)	308 (13%)	
Primary spoken language			0.64			0.60
English	4256 (73%)	1550 (27%)		13 447 (86%)	2189 (14%)	
Spanish	667 (75%)	228 (26%)		2577 (86%)	410 (14%)	
Other language or unknown	49 (77%)	15 (23%)		188 (88%)	25 (12%)	
Percent High School or Higher Degree[b], median (IQR)	79 (68, 89)	80 (71, 89)	0.03	78 (67, 88)	80 (68, 88)	0.010
Median Household Income[c], median (IQR) (/1000 USD)	56.1 (44.8, 72.7))	56.0 (45.0, 72.2)	0.99	55.9 (45.0, 72.2)	55.1 (45.3, 71.6)	0.28
Encounter Characteristics, *n* (%)						
Complex Chronic Condition			<0.001			0.001
TRUE	128 (88%)	17 (12%)		988 (90%)	116 (11%)	
FALSE	4844 (73%)	1776 (27%)		15 224 (86%)	2508 (14%)	
Severity of Illness			<0.001			<0.001 .
1 or Missing (least severe)	181 (74%)	63 (26%)		851 (83%)	172 (17%)	
2	254 (65%)	140 (36%)		628 (77%)	189 (23%)	
3	2627 (70%)	1121 (30%)		6975 (84%)	1343 (16%)	

Variable	Injured Patients n = 6765			Non-Injured Patients n = 18 836		
	Necessary Transfer n = 4972 (73%)	Potentially Avoidable Transfer n = 1793 (27%)	P[a]	Necessary Transfer n = 16 212 (86%)	Potentially Avoidable Transfer n = 2624 (14%)	P[a]
4	1697 (79%)	451 (21%)		6629 (89%)	811 (11%)	
5 (most severe)	213 (92%)	18 (7.8%)		1129 (91%)	109 (8.8%)	
Injury Severity Score			<0.001			
0 or Missing (least severe)	2319 (80%)	565 (20%)		16 212 (86%)	2624 (14%)	
1–9	2355 (67%)	1172 (33%)		0	0	
10–14	111 (85%)	20 (15%)		0	0	
15+ (most severe)	187 (84%)	36 (16%)		0	0	
Primary Payer			0.39			<0.001
Medicaid	2107 (74%)	732 (26%)		8176 (87%)	1203 (13%)	
Private	2260 (73%)	818 (27%)		6348 (85%)	1094 (15%)	
Uninsured/Self-pay	419 (71%)	172 (29%)		1136 (85%)	204 (15%)	
Other	183 (72%)	70 (28%)		543 (82%)	123 (19%)	
Missing	3 (75%)	1 (25%)		9 (100%)	0 (0%)	
Principle Diagnosis			<0.001			<0.001
Injury and Poisoning	3730 (70%)	1616 (30%)		-	-	
Respiratory	770 (90%)	83 (9.7%)		4133 (88%)	568 (12%)	
Symptoms, Signs and Ill-Defined	80 (81%)	19 (19%)		2441 (78%)	699 (22%)	
Digestive	26 (90%)	3 (10%)		2491 (90%)	274 (9.9%)	
Neurologic	82 (73%)	30 (27%)		1571 (83%)	317 (17%)	
Endocrine/Metabolic	19 (91%)	2 (9.5%)		1059 (92%)	96 (8.3%)	
Other	265 (87%)	40 (13%)		4517 (87%)	669 (13%)	
Distance between pre- and post-transfer hospitals (km)			<0.001			<0.001
0–10 km	1004 (77%)	296 (23%)		4305 (88%)	615 (13%)	
11–50km	2550 (71%)	1040 (29%)		8196 (85%)	1430 (15%)	
51–100km	949 (74%)	334 (26%)		2567 (85%)	445 (15%)	
>100km	468 (80%)	120 (20%)		1139 (90%)	132 (10%)	
Missing	1 (25%)	3 (75%)		5 (71%)	2 (29%)	

[a] *P*-value calculations did not include missing/unknown categories (except for Severity of Illness and Injury Severity Score). Categorical variables were compared using chi-square tests and continuous variables were compared using Wilcoxon rank-sum tests. For categories with cell counts less than five, Fisher exact tests were used. Due to rounding, row percentages may not add up to 100.

[b] Missing = Injured: 71 (1.4%), 28 (1.6%), Non-injured: 214 (1.3%), 40 (1.5%)

[c] Missing = Injured: 71 (1.4%), 28 (1.6%), Non-injured: 216 (1.3%), 40 (1.5%)

Table 4.

Unadjusted and adjusted models of pediatric readiness and potentially avoidable transfer

	Injured Patients *n*=6 758	Non-Injured Patients *n*= 18 823
Unadjusted	**OR (95% CI)**	**OR (95% CI)**
Pediatric Readiness Score (/10)	0.93 (0.90–0.96) ‡	0.90 (0.88–0.93) ‡
Adjusted		
Pediatric Readiness Score (/10)	0.92 (0.86–0.98) †	0.94 (0.88–1.001)
Age		
Neonate/Infant (0m-12m)	1.11 (0.89–1.38)	0.94 (0.82–1.08)
Toddler (13m-24m)	1.71 (1.39–2.10) ‡	1.28 (1.08–1.50) ‡
Early Childhood (2y-5y)	1.49 (1.27–1.75) ‡	1.24 (1.08–1.41) ‡
Middle Childhood (6y-11y)	1.39 (1.17–1.64) ‡	1.01 (0.89–1.15)
Early Adolescence (12y-17y)	1 [Ref]	1 [Ref]
Gender		
Male	1 [Ref]	1 [Ref]
Female	0.96 (0.85–1.08)	0.95 (0.87–1.03)
Race/Ethnicity		
White	1 [Ref]	1 [Ref]
Hispanic/Latino	0.94 (0.82–1.09)	0.96 (0.86–1.08)
Black or African American	1.01 (0.80–1.29)	1.06 (0.89–1.26)
Other or mixed	0.87 (0.71–1.07)	0.90 (0.77–1.05)
Insurance		
Private	1 [Ref]	1 [Ref]
Medicaid	0.96 (0.83–1.10)	0.76 (0.68–0.85) ‡
Uninsured/self-pay	1.09 (0.88–1.35)	0.97 (0.81–1.15)
Other	1.02 (0.73–1.41)	1.13 (0.88–1.45)
Injury Severity Score		
0 or Missing	0.53 (0.47–0.61) ‡	-
1–9	1 [Ref]	-
10–14	0.36 (0.22–0.60) ‡	-
> 15	0.44 (0.30–0.64) ‡	-
Severity of Illness		
1 or Missing	-	1.08 (0.90–1.30)
2	-	1.55 (1.28–1.85) ‡
3	-	1 [Ref]
4	-	0.66 (0.60–0.74)‡
5	-	0.50 (0.40–0.63) ‡

	Injured Patients n=6 758	Non-Injured Patients n= 18 823
Complex Chronic Condition	0.55 (0.32–0.93) †	1.02 (0.82–1.27)
Pre-transfer ED		
… Pediatric Volume[a]	1.17 (1.03–1.33) †	1.24 (1.11–1.39) ‡
… Pediatric Admitting Capability[b]	0.78 (0.62–0.98) †	0.78 (0.62–0.98) ‡
… Pediatric Trauma Center	0.83 (0.41–1.69)	-

† $p < 0.05$,

‡ $p < 0.001$

[a] Standardized by subtracting sample mean and dividing result by sample standard deviation

[b] Licensed Pediatric Beds > 0

Table 5.

Unadjusted and adjusted probability of potentially avoidable transfer (PAT); % probability (95% CI)

Injured Patients *n*=6 758; 269 hospitals				
Pediatric Readiness Score	**Model 1: Unadjusted**	**Model 2: Adjusted with Individual Covariates**[a]	**Model 3: Adjusted with Individual Covariates + Random Intercept**[b]	**Model 4: Adjusted with Individual and Hospital Covariates + Random Intercept**[c]
40	32 (29–34)	31 (29–34)	30 (26–35)	31 (26–36)
50	30 (28–32)	29 (27–31)	29 (25–32)	29 (26–33)
60	29 (27–30)	28 (26–29)	27 (25–30)	28 (25–30)
70	27 (26–28)	26 (25–27)	26 (24–28)	26 (24–28)
80	26 (24–27)	25 (23–26)	24 (22–26)	25 (23–27)
90	24 (23–26)	23 (22–25)	23 (20–25)	23 (20–26)
100	23 (21–25)	22 (20–24)	22 (18–25)	22 (18–25)
Non-injured Patients *n*=18 823; 275 hospitals				
Pediatric Readiness Score	**Model 5: Unadjusted**	**Model 6: Adjusted with Individual Covariates**[d]	**Model 7: Adjusted with Individual Covariates + Random Intercept**[e]	**Model 8: Adjusted with Individual and Hospital Covariates + Random Intercept**[f]
40	19 (17–20)	18 (17–20)	16 (13–19)	17 (14–20)
50	17 (16–18)	17 (16–18)	16 (13–18)	17 (14–19)
60	16 (15–17)	15 (15–16)	15 (13–17)	16 (14–17)
70	15 (14–15)	14 (14–15)	15 (13–16)	15 (14–16)
80	13 (13–13)	12 (12–13)	14 (13–16)	14 (13–15)
90	12 (12–13)	12 (11–12)	14 (12–15)	13 (12–15)
100	11 (10–12)	11 (10–11)	13 (11–15)	13 (11–15)

[a]Adjusted by age, gender, race/ethnicity, insurance, injury severity score, complex chronic condition

[b]Adjusted by covariates in model 2 and a random intercept for hospital

[c]Adjusted by pre-transfer ED pediatric volume, pediatric admitting capability and pediatric trauma center designation and the covariates in model 3

[d]Adjusted by age, gender, race/ethnicity, insurance, severity of illness, complex chronic condition

[e]Adjusted by covariates in model 6 and a random intercept for hospital

[f]Adjusted by pre-transfer ED pediatric volume, pediatric admitting capability and the covariates in model 7

Table 6.

Adjusted[a] associations between the components of pediatric readiness and potentially avoidable transfer

Section	Injured Patients n=6 758		Non-injured Patients n= 18 823	
	Single component in model[a]	Multiple components in model[a]	Single component in model[a]	Multiple components in model[a]
Pediatric Emergency Care Coordinators				
Physician	0.84 (0.67–1.03)	0.95 (0.72–1.26)	0.84 (0.68–1.04)	0.99 (0.75–1.31)
Nurse	0.81 (0.65–1.001)	0.92 (0.69–1.23)	0.80 (0.65–0.99) †	0.87 (0.65–1.16)
Quality Improvement (QI)				
QI/Performance plan	0.83 (0.66–1.03)	0.94 (0.71–1.23)	0.78 (0.63–0.96) †	0.84 (0.64–1.10)
Subcomponents in QI plan[b]				
Identification of quality indicators for children	0.78 (0.62–0.97) †	-	0.78 (0.63–0.97) †	-
Collection and analysis of pediatric emergency care data	0.73 (0.58–0.91) †	-	0.74 (0.59–0.92) †	-
Development of a plan for improvement in pediatric emergency care	0.72 (0.57–0.90) †	-	0.72 (0.58–0.90) †	-
Re-evaluation of performance using outcomes-based measures	0.71 (0.57–0.89) †	-	0.73 (0.58–0.91) †	-
Policies/Procedures/Protocols				
Triage for ill and injured children	0.85 (0.68–1.06)	0.91 (0.71–1.18)	0.90 (0.72–1.13)	0.93 (0.72–1.19)
Pediatric assessment and reassessment	0.78 (0.60–1.004)	0.83 (0.62–1.12)	0.86 (0.67–1.12)	0.88 (0.66–1.18)
Immunization assessment	0.91 (0.74–1.13)	1.01 (0.80–1.28)	1.03 (0.83–1.28)	1.09 (0.86–1.37)
Death of child in ED	0.81 (0.66–1.001)	0.91 (0.71–1.17)	0.81 (0.66–0.99) †	0.83 (0.65–1.06)
Pediatric age- or weight-based dosing in medical imaging	0.89 (0.71–1.11)	0.97 (0.77–1.24)	1.08 (0.87–1.34)	1.11 (0.88–1.41)
Family centered care	1.00 (0.80–1.25)	1.16 (0.91–1.47)	0.96 (0.78–1.19)	0.99 (0.78–1.26)
Hospital disaster plan	0.85 (0.68–1.05)	0.96 (0.75–1.24)	1.02 (0.82–1.26)	1.20 (0.94–1.52)
Transfer guidelines	1.02 (0.72–1.45)	1.17 (0.82–1.67)	1.03 (0.72–1.46)	1.10 (0.77–1.56)
Equipment and Supplies for Children[c]				
1	1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]
2	1.04 (0.76–1.42)	1.10 (0.80–1.51)	1.06 (0.78–1.46)	1.12 (0.81–1.54)
3	0.85 (0.63–1.15)	0.91 (0.67–1.23)	1.08 (0.80–1.45)	1.17 (0.86–1.58)
4	0.82 (0.60–1.13)	0.88 (0.63–1.22)	1.11 (0.81–1.51)	1.19 (0.86–1.64)

† $p < 0.05$

[a]Models include the covariates from the core adjusted model in Table 4 and random intercepts. Coefficients for these other covariates are not shown but include age, gender, race/ethnicity, insurance, injury severity score, complex chronic condition, pre-transfer ED pediatric volume, pediatric admitting capability and pediatric trauma center.

[b]QI plan subcomponents were not included in the final model because of collinearity with the presence/absence of a QI plan.

[c]Aggregate weighted section score divided into quartiles: Quartile 1 (0 to <28.9 pts), Quartile 2 (28.93 to <31.1 pts), Quartile 3 (31.1 to < 32.7 pts), Quartile 4 (32.7 to 33 pts)