Unplanned ICU Transfers from Inpatient Units: Examining the Prevalence and Preventability of Adverse Events Associated with ICU Transfer in Pediatrics

Alison H. Miles¹ Michael C. Spaeder² David C. Stockwell²

¹ Division of Pediatric Anesthesiology and Critical Care Medicine, Johns Hopkins Hospital, Baltimore, Maryland, United States

² Division of Critical Care Medicine, Children's National Health System, Washington, District of Columbia, United States

Address for correspondence: Alison H. Miles, DO, Division of Pediatric Anesthesiology and Critical Care Medicine, Johns Hopkins Hospital, 1800 Orleans Street Bloomberg Children's Center Suite 6321, Baltimore, MD 21287, United States (e-mail: amiles8@jhmi.edu).

J Pediatr Intensive Care 2016;5:21–27.

Abstract

Background Adverse events have been associated with unplanned intensive care unit (ICU) transfers in adults.

Objective To examine trends in unplanned ICU transfers in pediatrics resulting from adverse events.

Design, Setting, Patients Retrospective observational study of pediatric and cardiac ICU transfers from acute care units during a 2-year period in a tertiary care children's hospital.

Methods Transfers were identified via electronic health record query and investigated for adverse events. Predefined adverse events included ICU transfers within 12 hours of admission to an acute care unit, readmissions to an ICU within 24 hours, and cardiopulmonary arrest on an acute care unit. Other adverse events examined were not predefined. Adverse events were evaluated for preventability and categorized by type, diagnosis, time of day and weekday versus weekend occurrence, and level of associated patient harm.

Results There were 1,008 ICU transfers during the study period; 67% were unplanned. Of the unplanned transfers, 32% were attributed to adverse events, 35% of which were preventable. Unplanned transfers associated with a high rate of preventable adverse events included readmission to an ICU within 24 hours (58%, $p = 0.002$) and ICU transfer within 12 hours of acute care admission (34%).

Conclusions We observed a high rate of preventable adverse events associated with unplanned pediatric ICU transfers, many of which were due to inappropriate triage. Readmission to an ICU within 24 hours of transfer to an acute care unit was significantly associated with preventability.

Keywords

- electronic health record
- pediatrics
- adverse events

Introduction

National surveys have shown that 14 to 28% of adult intensive care unit (ICU) patients are admitted to ICUs as unplanned transfers.^{1,2} Importantly, patients unexpectedly admitted to an ICU within the first 24 hours of hospitalization have

increased mortality.³ Patients unexpectedly transferred to an ICU from an inpatient unit rather than from the operating room or emergency department have increased mortality independent of illness severity, comorbidities, age, gender, and preadmission laboratory results.^{4–7} Additionally, when adult patients who experienced ICU readmissions during a

received

June 24, 2015

accepted after revision

October 17, 2015

published online

November 21, 2015

Copyright © 2016 by Georg Thieme
Verlag KG, Stuttgart · New York

DOI <http://dx.doi.org/10.1055/s-0035-1568150>.
ISSN 2146-4618.

hospital course are compared with adult ICU patients who do not require ICU readmission, despite adjusting for severity of illness patients requiring readmission to a medical ICU from a general medicine unit have in-hospital mortality which may be fivefold greater and length of stay twice as long.⁸

Recently, Marquet et al enhanced understanding about unplanned ICU admissions and their impact on care by investigating unplanned intensive care admissions, defined as “all patients unexpectedly admitted to the ICU from a lower level of care in the hospital,”⁹ a recognized validated clinical quality indicator in surgical and anesthesia care.^{10,11} Adverse events were found in over half of all unplanned transfers and 46% of those adverse events were “highly preventable”¹² Bapojé et al evaluated 152 patients unexpectedly transferred to a medical ICU and found that errors in care accounted for 19% of these transfers and most resulted from inappropriate admission triage.⁴ The frequency and preventability of adverse event-related ICU transfers in pediatrics has not been described.

Voluntary reporting and manual medical record review are traditional methods of identifying adverse events in the inpatient setting, but have been shown to underestimate the prevalence of adverse events.^{13,14} The trigger method has been shown to be more effective at identifying adverse events than other detection methods. Triggers are “occurrences, prompts, or flags found on review of the medical record that ‘trigger’ further investigation to determine the presence or absence of an adverse event”^{15,16}. “Transfer to a higher level of care” is one trigger used in the Institute for Healthcare Improvement-Global Trigger Tool to discover adverse events¹⁷ with a positive predictive value estimated at 18.6%.¹⁸ Pediatric-specific triggers have also been developed to identify adverse events in hospitalized children.^{19–23} The same “transfer to a higher level of care” trigger has been reported to have a positive predictive value of 19.6% when evaluating adverse events in pediatrics,²⁴ similar to the adult experience. Automating the trigger identification process from the electronic health record (EHR) has been shown to be both cost effective and efficient.^{25–30}

The goals of this work are to evaluate the adverse event incidence, preventability, type, and resultant level of patient harm associated with pediatric unplanned ICU transfers at our institution.

Materials and Methods

This study was evaluated and approved by the institutional review board at Children’s National Health System. Children’s National is an urban, academic, freestanding, tertiary care children’s hospital in Washington, DC. There are 303 total inpatient beds, 44 pediatric ICU beds, and 26 cardiac ICU beds with over 3,000 annual ICU admissions combined.

We conducted a retrospective review of all transfers from an acute care unit to a higher level of care (pediatric and cardiac ICUs) between March 2008 and April 2010. Transfers to the neonatal ICU were excluded. We used a three-step process of screening, medical record review, and consensus judgment consistent with the protocol of the Harvard Medical Practice Study I.³¹

In the first stage of the process, the “transfers to a higher level of care,” electronic trigger identified all transfers from an acute care bed to an ICU bed with the Admissions-Discharge-Transfer system (STAR, McKesson, San Francisco, California, United States) through the EHR (Millennium, Cerner Corporation, Kansas City, Missouri, United States). Reports were generated daily.

In the second stage, a trained nurse analyst categorized each identified transfer as planned or unplanned. Unplanned patient transfers were defined as transfers to an ICU from an inpatient setting due to a need for escalation of care rather than planned postoperative admissions or admissions for procedures. The nurse analyst then examined each to determine: (1) the clinical details leading to the ICU transfer; (2) whether an adverse event had occurred; (3) the level of patient harm associated with the adverse event; and (4) preventability, defined as whether there had been deviation from the local standard of care. Harm and severity ratings were based on the guidelines from the National Coordinating Council for Medication Error Reporting and Prevention.³²

An adverse event was defined as an injury or worsening in status that led to patient harm (temporary or permanent) caused either by medical management or by missed opportunity for intervention rather than by disease progression. Certain predefined adverse event categories were also identified. These measures have been supported by the National Quality Forum expert panel recommendations and the Children’s Hospital Association (CHA) Whole System Measures for quality in care in pediatric medicine, which included cardiopulmonary arrest on an acute care unit, admission to an ICU in less than 12 hours of acute care unit admission, and readmission to an ICU within 24 hours after transfer to an acute care unit.^{33,34} These events were deemed notable given their association with increased length of stay, health care costs, and mortality.

In the third stage of the study, all unplanned transfers deemed adverse events were reviewed at meetings of the Automated Adverse Event Detection Steering Committee within a month of occurrence. This committee is a multidisciplinary working group that monitors adverse event detection and ensures consensus in definitions for adverse events, preventability, and harm to each case.

Additional data to establish the time, date, patient diagnoses, and primary reason for ICU transfer were collected. Transfers were stratified by day shift (7 AM to 7 PM) versus night shift (7 PM to 7 AM) as well as by weekday versus weekend given differences in physician staffing. To evaluate for trends in disease processes or diagnoses, adverse event-related transfers were grouped by affected organ system in a manner consistent with the AAP Policy Statement on reasons for ICU admission and then divided by diagnosis.³⁵

To evaluate the incidence of preventable adverse events over time, the quarterly incidence of preventable adverse events per 1,000 patient days was calculated.

Statistical Analysis

Continuous variables were compared using Wilcoxon rank-sum testing; categorical variables were compared using

chi-square or Fisher exact testing as appropriate. Event rates over time were analyzed using linear trend testing. Type I error was set at 0.05. All calculations were performed using Stata/IC 12.1 (Stata Corporation, College Station, Texas, United States).

Results

There were 665 unplanned ICU transfers during the period of study, 212 (32%) of which were associated with an adverse event (35% preventable, 65% unpreventable) (►Fig. 1). The median age of patients was 3.7 years (interquartile range: 8 months to 13 years). Patient and transfer characteristics are listed in ►Table 1.

Stratifying unplanned ICU transfers by presence or absence of an adverse event, we observed no differences in patient age (46 vs. 43 months; $p = 0.95$), gender (54 vs. 54% male; $p = 0.88$), or race (46 vs. 44% African American, 17 vs. 20% Caucasian, and 18 vs. 21% Hispanic; $p = 0.70$).

ICU transfers occurring at night were more likely to be associated with an adverse event (37 vs. 27%; $p = 0.006$). There was no difference in the rates of adverse events between ICU transfers occurring on weekdays and those occurring on weekends.

Among unplanned transfers associated with an adverse event, the most common reason for transfer was worsening respiratory status (50%). There were no differences in the primary reason for ICU transfer, patient age, gender, or race between transfers associated with preventable adverse events and those associated with nonpreventable adverse events. There was no association between time of day (day shift vs. night shift) or day of week (weekday vs. weekend/holiday) between preventable and nonpreventable events.

We compared the characteristics of adverse events that led to unplanned ICU transfer based on the preventability of the event (►Table 2). Transfers associated with ICU readmission within 24 hours of transfer to an acute care unit were more likely to be associated with a preventable adverse event

Table 1 Patient demographics and transfer characteristics in unplanned ICU transfers

Characteristic	Number (%)
Female gender	307 (46%)
Age group	
< 6 mo	138 (21%)
6–23 mo	129 (19%)
2–4 y	94 (14%)
5–12 y	138 (21%)
13–17 y	83 (12.5%)
> 17 y	83 (12.5%)
Race/ethnicity	
White	125 (19%)
Black	297 (45%)
Hispanic	133 (20%)
Other	66 (10%)
Unknown	44 (6%)
Nighttime ICU transfer	318 (48%)
Weekend ICU transfer	189 (28%)
Transfer associated with adverse event	212 (32%)
Nonpreventable adverse event	137 (21%)
Preventable adverse event	75 (11%)

Abbreviation: ICU, intensive care unit.

(59 vs. 40%; $p = 0.002$). We investigated temporal trends in the incidence of preventable events during our period of study (►Fig. 2). While not significant by linear trend testing for the entire period of study, we did note a decrease over the last 2 years of the study period (Q3 2008 to Q2 2010; $p = 0.03$).

Fig. 1 Characteristics of transfers to a higher level of care.

Table 2 Characteristics of adverse events resulting in unplanned ICU transfer stratified by preventability

Event characteristic	Preventable events (n = 75)	Nonpreventable events (n = 137)	p-Value
ICU transfer <12 h of acute care admission	43 (34%)	83 (66%)	NS
ICU readmission <24 h of transfer to acute care floor	18 (60%)	12 (40%)	0.002
Cardiopulmonary arrest event on acute care floor	9 (23%)	30 (77%)	NS
Unexpected postoperative complication	1 (6%)	15 (94%)	NS
Medication or blood product reaction	5 (42%)	7 (58%)	NS
Night	44 (36%)	78 (64%)	NS
Weekend/holiday	22 (36%)	40 (65%)	NS

Abbreviations: ICU, intensive care unit; NS, nonsignificant.

During the period of study, our facility encouraged not only health care providers, but also parents or family members, to request a rapid response team or similar ICU-level evaluation of patients on the acute care unit if they felt it was necessary. There were no family activations resulting in a transfer to the ICU during the study period.

The most common adverse event was ICU transfer within 12 hours of hospital admission, which accounted for 59% of adverse event–related unplanned transfers. On review, 34% of these events were preventable, often identified as having preadmission vital sign, physical exam, or laboratory findings that should have prompted initial ICU admission or were known at admission to require more intensive monitoring or intervention than the acute care units could provide despite the patients' apparent clinical stability.

Sixty percent of readmissions to an ICU within less than 24 hours of transfer to an acute care unit were preventable. Eighty-eight percent of these were transferred to the acute care unit with vital sign or exam findings warranting continued ICU admission and the remaining 12% had therapies discontinued on arrival to acute care leading to destabilization. Cardiopulmonary arrest on an acute care unit was associated with 39 unplanned transfers (6%), approximately one-quarter of which were deemed preventable.

Fig. 2 Preventable adverse events over time.

Overall, of 212 unplanned transfers associated with adverse events, 74% fell into the categories of ICU admission within less than 12 hours of admission to an acute care unit or ICU readmission within 24 hours. Of 75 preventable events, 81% were in either of these two categories.

Assigning each preventable adverse event a harm and severity rating, 53% were associated with Category E (an error that may have contributed to or resulted in temporary harm to the patient and required intervention) and 46% were associated with Category F (an error that may have contributed to or resulted in temporary harm and required initial or prolonged hospitalization). One percent was associated with Category H (an error that required intervention to sustain life).

Discussion

We employed an automatic trigger-based mechanism to identify unplanned ICU transfers at our institution. We found that nearly one-third of all unplanned ICU transfers were associated with adverse events and 35% of these events were preventable. Our observed rate was similar to previous published reports, yet somewhat lower than adult data.^{12,21,36}

Adult data have shown that most preventable adverse events are related to inappropriate admission triage.⁴ Recently, there has been attention to the lack of consistent standard ranges for inpatient pediatric vital signs and perhaps this ambiguity has contributed to triaging inconsistencies.³⁷ The majority of adverse event–related unplanned ICU transfers in our study occurred within 12 to 24 hours of a triage decision, which raises questions about triage processes despite the fact that we found 61% of these events to be nonpreventable.

Overall, the most common reason for unplanned transfer associated with an adverse event was worsening respiratory status. Though it is not surprising that a portion of children admitted with respiratory disease became sicker and required ICU admission, our institution used standard vital sign parameters for inpatient unit admission as well as asthma scoring during the period of study. Patients who were classified as experiencing a preventable adverse event leading to ICU admission were found to have characteristics that fell outside of these standards of care.

The most common diagnoses leading to ICU transfer within 12 hours of admission to an acute care floor were sepsis, pneumonia, asthma, and status epilepticus, and may represent populations that would benefit from development of specific ICU admission criteria. It would also be interesting to understand how long the time frame was between the decision to admit these patients to an acute care unit and the time at which they were actually admitted; however, those data were not available.

Furthermore, interventions aimed at the 39% of patients who were mis-triaged are warranted. Again, this group could potentially benefit from development of acute care unit versus ICU admission criteria as well as better understanding about which patients have increased risk for further deterioration. Disease-specific protocols might help identify patients on a trajectory to needing ICU care.

Nearly 60% of readmissions to an ICU within 24 hours of transfer to an acute care unit were found to be preventable. As a result, we established a policy requiring an ICU physician to reexamine each patient within the hour prior to transfer out of the ICU. Goals of this intervention include confirmation of the patient's lack of need for continued ICU care or monitoring as well as discussion of the patient's suitability for transfer with the bedside nurse. Additionally, we began to review each of these readmissions at our monthly Morbidity and Mortality conference including a discussion as to whether ICU census was thought to have played a part in the decision to transfer the patient to acute care.

Other authors have noted an increased incidence of complication rates, medication errors, and mortality during night and weekend or holiday time periods.^{38–43} We found that unplanned nighttime transfers were more likely to be associated with adverse events though we did not find an association between nighttime events and preventability. The incidence of adverse events leading to ICU transfers on weekends was not greater than expected, nor were these associated with preventability.

We observed a decline in the rate of preventable adverse events over the final 2 years of our period of study. It was at the beginning of our study period that the Automated Adverse Event Detection Steering Committee began to systematically evaluate each adverse event and disseminate the information to care team members throughout the organization. This likely led to enhanced recognition of adverse events associated with ICU transfer and potential ways to prevent these events. Additionally, the aforementioned requirement that an ICU physician examine all patients within the hour before transfer to an acute care unit was instituted during the study period. Both of these interventions may have contributed to the decrease in preventable adverse events over time. There were no changes to ICU or hospitalist staffing models during the study time frame.

Of note, when examining the harm and severity ratings associated with preventable adverse event-related ICU transfer, 76% of the readmissions to an ICU within less than 24 hours of transfer to an acute care unit were associated with prolonged hospitalization and temporary harm. In contrast, 33% of ICU admissions within less than 12 hours of hospital admission received this rating. This raises additional concern that children

recently admitted to an ICU are at high risk for adverse event-related transfer and harm related to these events.

Identifying the transfers to our ICU that were associated with adverse events was the primary goal of our study. Learning from these cases can take several different directions and making changes based on these data presents possible positive and negative ramifications. Lowered thresholds for admissions to an ICU may assist in triage-related adverse events but may also lead to increased patient dissatisfaction and increased resource utilization as well as creating possible delays for sicker patients when ICU census is near capacity. Measuring delays in admission and patient flow metrics may assist in assessment of this possible concern.

Our study has some important limitations. The retrospective nature limited our assessment of the clinical scenario surrounding each adverse event to what was documented in the patient's medical record. It is possible that significant contributing events were not detected if they were not recorded in the EMR. Additionally, though consensus opinion of the Automated Adverse Event Detection Steering Committee was required for classification of each adverse event as preventable or nonpreventable, this classification may still be considered subjective and vulnerable to reviewer variation and misclassification although the committee membership has been consistent. Generalizability of our findings may be limited due to local institutional factors including admission criteria, patient flow between the emergency department, acute care floors, and ICU, staffing, methods of communication between units, and bed capacity.

We are limited in our knowledge of ICU and acute ward census numbers at the time of unplanned ICU transfer, as it could be argued that during times of high ICU census, the threshold for ICU transfer to acute care ward may be lower. Our experience is such that during high ICU census times there is a simultaneous high acute care ward census leading to delays in ICU to acute care ward transfer. Finally, a longer study is needed to further investigate trends and risk factors for adverse events related to unplanned ICU transfer in pediatrics.

Conclusion

Unplanned transfers to an ICU are an important consequence of significant adverse events. Interventions directed at triage processes and ICU discharge criteria may be warranted, as the vast majority of preventable adverse events occurred either in the first 12 hours of hospital admission or the first 24 hours after ICU discharge to an acute care unit. The most common diagnoses leading to ICU transfer within less than 12 hours of admission to an acute care floor were sepsis, pneumonia, asthma, and status epilepticus. In developing protocols for ICU versus acute care unit admission, it would be reasonable to focus on these populations.

Note

This study was conducted at Children's National Health System, Washington, DC.

Acknowledgments

This study was supported in part by a research grant from the Cerner Corporation to Dr. David C. Stockwell.

References

- Angus DC, Shorr AF, White A, Dremsizov TT, Schmitz RJ, Kelley MA; Committee on Manpower for Pulmonary and Critical Care Societies (COMPACCS). Critical care delivery in the United States: distribution of services and compliance with Leapfrog recommendations. *Crit Care Med* 2006;34(4):1016–1024
- Groeger JS, Guntupalli KK, Strosberg M, et al. Descriptive analysis of critical care units in the United States: patient characteristics and intensive care unit utilization. *Crit Care Med* 1993;21(2):279–291
- Liu V, Kipnis P, Rizk NW, Escobar GJ. Adverse outcomes associated with delayed intensive care unit transfers in an integrated health-care system. *J Hosp Med* 2012;7(3):224–230
- Bapojie SR, Gaudiani JL, Narayanan V, Albert RK. Unplanned transfers to a medical intensive care unit: causes and relationship to preventable errors in care. *J Hosp Med* 2011;6(2):68–72
- Escarce JJ, Kelley MA. Admission source to the medical intensive care unit predicts hospital death independent of APACHE II score. *JAMA* 1990;264(18):2389–2394
- Hillman KM, Bristow PJ, Chey T, et al. Duration of life-threatening antecedents prior to intensive care admission. *Intensive Care Med* 2002;28(11):1629–1634
- Escobar GJ, Greene JD, Gardner MN, Marelich GP, Quick B, Kipnis P. Intra-hospital transfers to a higher level of care: contribution to total hospital and intensive care unit (ICU) mortality and length of stay (LOS). *J Hosp Med* 2011;6(2):74–80
- Rosenberg AL, Hofer TP, Hayward RA, Strachan C, Watts CM. Who bounces back? Physiologic and other predictors of intensive care unit readmission. *Crit Care Med* 2001;29(3):511–518
- Baker DR, Pronovost PJ, Morlock LL, Geocadin RG, Holzmüller CG. Patient flow variability and unplanned readmissions to an intensive care unit. *Crit Care Med* 2009;37(11):2882–2887
- Haller G, Myles PS, Wolfe R, Weeks AM, Stoelwinder J, McNeil J. Validity of unplanned admission to an intensive care unit as a measure of patient safety in surgical patients. *Anesthesiology* 2005;103(6):1121–1129
- Haller G, Myles PS, Langley M, Stoelwinder J, McNeil J. Assessment of an unplanned admission to the intensive care unit as a global safety indicator in surgical patients. *Anaesth Intensive Care* 2008;36(2):190–200
- Marquet K, Claes N, De Troy E, et al. One fourth of unplanned transfers to a higher level of care are associated with a highly preventable adverse event: a patient record review in six Belgian hospitals. *Crit Care Med* 2015;43(5):1053–1061
- Cullen DJ, Bates DW, Small SD, Cooper JB, Nemeskar AL, Leape LL. The incident reporting system does not detect adverse drug events: a problem for quality improvement. *Jt Comm J Qual Improv* 1995;21(10):541–548
- Silver MP, Antonow JA. Reducing medication errors in hospitals: a peer review organization collaboration. *Jt Comm J Qual Improv* 2000;26(6):332–340
- Dickerman MJ, Jacobs BR, Vinodrao H, Stockwell DC. Recognizing hypoglycemia in children through automated adverse-event detection. *Pediatrics* 2011;127(4):e1035–e1041
- Resar RK, Rozich JD, Classen D. Methodology and rationale for the measurement of harm with trigger tools. *Qual Saf Health Care* 2003;12(Suppl 2):ii39–ii45
- IHI Global Trigger Tool for Measuring Adverse Events. 2nd ed. Available at: <http://www.ihl.org>. Accessed June 6, 2015
- Soop M, Fryksmark U, Köster M, Haglund B. The incidence of adverse events in Swedish hospitals: a retrospective medical record review study. *Int J Qual Health Care* 2009;21(4):285–291
- Fortescue EB, Kaushal R, Landrigan CP, et al. Prioritizing strategies for preventing medication errors and adverse drug events in pediatric inpatients. *Pediatrics* 2003;111(4, Pt 1):722–729
- Kilbridge PM, Noirot LA, Reichley RM, et al. Computerized surveillance for adverse drug events in a pediatric hospital. *J Am Med Inform Assoc* 2009;16(5):607–612
- Larsen GY, Donaldson AE, Parker HB, Grant MJ. Preventable harm occurring to critically ill children. *Pediatr Crit Care Med* 2007;8(4):331–336
- Kaushal R, Bates DW, Landrigan C, et al. Medication errors and adverse drug events in pediatric inpatients. *JAMA* 2001;285(16):2114–2120
- Miller MR, Elixhauser A, Zhan C. Patient safety events during pediatric hospitalizations. *Pediatrics* 2003;111(6, Pt 1):1358–1366
- Stockwell DC, Kirkendall E, Muething SE, Kloppenborg E, Vinodrao H, Jacobs BR. Automated Adverse Event Detection Collaborative. Automated adverse event detection collaborative: electronic adverse event identification, classification, and corrective actions across academic pediatric institutions. *J Patient Saf* 2013;9(4):203–210
- Ferranti J, Horvath MM, Cozart H, Whitehurst J, Eckstrand J. Reevaluating the safety profile of pediatrics: a comparison of computerized adverse drug event surveillance and voluntary reporting in the pediatric environment. *Pediatrics* 2008;121(5):e1201–e1207
- Ferranti J, Horvath MM, Cozart H, et al. A multifaceted approach to safety: the synergistic detection of adverse drug events in adult inpatients. *J Patient Saf* 2008;4:184–190
- Classen DC, Pestotnik SL, Evans RS, Burke JP. Computerized surveillance of adverse drug events in hospital patients. 1991. *Qual Saf Health Care* 2005;14(3):221–225, discussion 225–226
- Jha AK, Kuperman GJ, Teich JM, et al. Identifying adverse drug events: development of a computer-based monitor and comparison with chart review and stimulated voluntary report. *J Am Med Inform Assoc* 1998;5(3):305–314
- Bates DW, Evans RS, Murff H, Stetson PD, Pizziferri L, Hripcsak G. Detecting adverse events using information technology. *J Am Med Inform Assoc* 2003;10(2):115–128
- Takata GS, Mason W, Taketomo C, Logsdon T, Sharek PJ. Development, testing, and findings of a pediatric-focused trigger tool to identify medication-related harm in US children's hospitals. *Pediatrics* 2008;121(4):e927–e935
- Leape LL, Brennan TA, Laird N, et al. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *N Engl J Med* 1991;324(6):377–384
- NCC MERP Index for Categorizing Medication Errors. Available at: <http://www.nccmerp.org/medErrorCatIndex.html>. Accessed June 22, 2015
- National Quality Forum NQF #0335 PICU Unplanned Readmission Rate. http://www.qualityforum.org/Projects/n-r/Pulmonary_Endorsement_Maintenance/0335PICUReadmissions.aspx. Accessed June 19, 2015
- Child Health Corporation of America. Available at: www.chca.com. Accessed June 19, 2015
- Guidelines for developing admission and discharge policies for the pediatric intensive care unit. American Academy of Pediatrics. Committee on Hospital Care and Section of Critical Care. Society of Critical Care Medicine. Pediatric Section Admission Criteria Task Force. *Pediatrics* 1999;103(4, Pt 1):840–842
- Woods D, Thomas E, Holl J, Altman S, Brennan T. Adverse events and preventable adverse events in children. *Pediatrics* 2005;115(1):155–160

- 37 Bonafide CP, Brady PW, Keren R, Conway PH, Marsolo K, Daymont C. Development of heart and respiratory rate percentile curves for hospitalized children. *Pediatrics* 2013;131(4): e1150–e1157
- 38 Agarwal S, Classen D, Larsen G, et al. Prevalence of adverse events in pediatric intensive care units in the United States. *Pediatr Crit Care Med* 2010;11(5):568–578
- 39 Cavallazzi R, Marik PE, Hirani A, Pachinburavan M, Vasu TS, Leiby BE. Association between time of admission to the ICU and mortality: a systematic review and metaanalysis. *Chest* 2010; 138(1):68–75
- 40 Bhonagiri D, Pilcher DV, Bailey MJ. Increased mortality associated with after-hours and weekend admission to the intensive care unit: a retrospective analysis. *Med J Aust* 2011;194(6):287–292
- 41 Bendavid E, Kaganova Y, Needleman J, Gruenberg L, Weissman JS. Complication rates on weekends and weekdays in US hospitals. *Am J Med* 2007;120(5):422–428
- 42 Morris PE. Assessing ICU transfers at night: a call to reduce mortality and readmission risk. *Am J Crit Care* 2009;18(1):6–8
- 43 Miller AD, Piro CC, Rudisill CN, Bookstaver PB, Bair JD, Bennett CL. Nighttime and weekend medication error rates in an inpatient pediatric population. *Ann Pharmacother* 2010;44(11):1739–1746