Rapid Response Team Calls and Unplanned Transfers to the Pediatric Intensive Care Unit in a Pediatric Hospital

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Background Variability in disposition of children according to the time of rapid response calls is unknown.
Objective To evaluate times and disposition of rapid response alerts and outcomes for children transferred from acute care to intensive care.
Methods Deidentified data on demographics, time and disposition of the child after activation of a rapid response, time of transfer to intensive care, and patient outcomes were reviewed retrospectively. Data for rapid-response patients on time of activation of the response and unplanned transfers to the intensive care unit were compared with data on other patients admitted to the unit.
Results Of 542 rapid responses activated, 321 (59.2%) were called during the daytime. Out of all rapid response activations, 323 children (59.6%) were transferred to intensive care, 164 (30.3%) remained on the general unit, and 19 (3.5%) required resuscitation. More children were transferred to intensive care after rapid response alerts ($P = .048$) during the daytime (66%) than at night (59%). During the same period, 1313 patients were transferred to intensive care from acute care units. Age, sex, risk of mortality, length of stay, and mortality rate did not differ according to the time of transfer. Mortality among unplanned transfers (3.8%) was significantly higher ($P < .001$) than among other intensive care patients (1.4%).
Conclusion Only 25% of transfers from acute care units to the intensive care unit occurred after activation of a rapid response team. Most rapid responses were called during daytime hours. Mortality was significantly higher among unplanned transfers from acute care than among other intensive care admissions. (*American Journal of Critical Care.* 2016;25:e9-e13)

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Children who are transferred from acute care units to a higher level of care because of a worsening clinical condition are at a high risk for morbidity and mortality. Failure to recognize and treat critical conditions may lead to marked preventable harm to children admitted to acute care units. Rapid response teams (RRTs) have been instituted in many hospitals to identify, evaluate, and treat patients with critical changes in clinical status. Data on decreases in mortality and cardiopulmonary arrests after implementation of RRTs vary.[1-7] Use and composition of the teams also vary. These factors may influence the effect of RRTs on mortality and cardiac arrest rates in the hospital. At Miami Children's Hospital, Miami, Florida, not all transfers from an acute care unit to the pediatric intensive care unit (PICU) are preceded by an RRT call.

With the initiation of RRTs at any institution, resources must be available to support and sustain the teams. In a study by Wang et al,[8] a higher number of rapid responses were called during the day shift (6 AM-6 PM) than during the night shift. In contrast, Jones et al[5] reported that more rapid responses were called during the night shift. Knowledge of the diurnal variation in use of RRTs is important to optimize allocation of resources.

Rapid response teams identify, evaluate, and treat patients with critical changes in clinical status.

Currently, no data are available on the variability of disposition of children according to the time of the RRT call. We evaluated the times of the rapid responses at Miami Children's Hospital and the disposition of the patients after the rapid response. We also evaluated the outcome of unplanned transfers from acute care units to the PICU during the same period.

Methods

This study was a retrospective cohort study with deidentified data. After the study was approved by the appropriate institutional review board, data were collected from databases compiled at Miami Children's Hospital, a single tertiary care, freestanding 289-bed facility, for the period July 2007 through September 2012. The databases included local RRT logs and the VPS database (a clinical database dedicated to standardized data sharing and benchmarking among PICUs). The hospital has a neonatal ICU, a PICU, and a pediatric cardiac ICU. The hospital is a level 1 pediatric trauma center.

The RRT was instituted in 2007 and consists of the PICU charge nurse, a respiratory therapist, and a third-year pediatric resident. Backup team members include a PICU fellow and a PICU attending physician. Rapid response calls can be initiated by health care providers, hospital employees, and patients' family members. Each rapid response call is evaluated by the RRT, and disposition is based on the team's clinical judgment. Criteria for RRT activation include worsening of respiratory or cardiovascular status, change in mental status, and a health care provider's concern about a child's condition. An RRT call is not required before every unplanned transfer. If a patient's health care team on an acute care unit decides that a child needs a higher level of care, then the patient is transferred to the PICU after discussion with the PICU health care team without activation of the RRT team. The hospital does not have intermediate care or a high-dependency unit. All unplanned transfers to a higher level of care are to one of the ICUs (pediatric, cardiac, or neonatal).

With the initiation of the RRT, a database was created in which demographic information, time and date of call, and disposition were recorded. The PICU charge nurse was responsible for completing the database immediately after the evaluation of a rapid-response patient. Data collected included time of rapid response and disposition of the patient after the rapid response and demographic information on the child. Demographic information included age, weight, and sex. In addition, data on unplanned transfers to the PICU during the same period as the study period were retrieved from the local VPS database and were compared with data on all other PICU admissions.

The rate of RRT calls during the day shift and the night shift and differences in disposition rate after RRT calls between day and night shifts were

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analyzed by using χ^2 analysis. For disposition, binary data (transfer to PICU or not) were used. The differences in mean length of stay and scores on the Pediatric Index of Mortality 2 risk of mortality between unplanned transfers and other PICU admissions were analyzed by using the Mann Whitney test, and differences in mortality rate were analyzed by using χ^2 analysis. The value $P<.05$ was considered significant.

Results

During the study period, 542 rapid responses were initiated. Of these, 321 (59.2%) were called during the daytime (7 AM-7 PM). During the responses, 323 children (59.6%) were transferred to the PICU, 164 (30.3%) remained in an acute care unit, 19 (3.5%) required resuscitation and eventually were transferred to the PICU, 5 (0.9%) were transferred to the emergency department, and 31 (5.7%) had an unknown disposition. More children ($P=.048$) were transferred to the PICU after RRT calls during the daytime (66% of daytime calls) than during the nighttime (59% of nighttime calls). During the same period, the total number of unplanned transfers to the PICU from the acute care units was 1313. Of these, 323 children were transferred after RRT activation. Age, sex, scores on the Pediatric Index of Mortality 2 risk of mortality, length of stay, and mortality rate did not differ according to the time of transfer among all unplanned transfers from acute care units to the PICU. The mortality rate among children transferred from acute care units (3.8%) to the PICU was significantly higher ($P<.001$) than the rate among other PICU admissions (1.4%).

Discussion

We found that more rapid responses were called during the daytime shift than during the night shift and that the mortality rate among patients transferred to the PICU from the acute care units was greater than that of PICU admissions from all other sources, such as the emergency department or operating room. Most patients who required an RRT call were transferred to a higher level of care. Of the total unplanned transfers from an acute care unit to the PICU, only 25% occurred after an RRT call. In contrast, in a study of adults, Jäderling et al[9] reported that 51% of unplanned transfers occurred after an RRT call. At Miami Children's Hospital, an RRT call is not required before every transfer to the PICU. If the health care team on an acute care unit decides that a child needs a higher level of care, then the patient is transferred to the PICU after discussion with the PICU health care team without activation of the RRT team. When activated, the RRT stabilizes the patient's condition, determines if a child requires a higher level of care, and expedites transfer. In our study, the rate of transfer to a higher level of care after RTT activation was higher than that reported from Canada.[3] The higher rate may have occurred because not all unplanned transfers in our institution are preceded by RRT activation and the acuity was probably higher in the children who required RRT activation.

Our results are similar to those of Wang et al,[8] who found that emergency response teams for resuscitation were called more often during the daytime hours. In a study in adult patients, Jones et al,[5] found that more calls were made during the change of nursing shifts. Although the time of transfer to the PICU did not affect length of stay or mortality in our study, more RRT calls were made during the daytime and more children were transferred to the PICU after RRT calls during the daytime. The reason for more calls for rescue during the daytime is not clear. Possibly, critical worsening of clinical status is more often detected during daytime hours because of the availability of a higher number of health care staff than during the nighttime. In addition, the change of shifts from day to night is another time when systematic review of patients' condition is done and may provide an opportunity to escalate care. Jones et al[5] have speculated that less patient observation is performed at nighttime and at the change in shifts when patients are reevaluated and worsening of clinical status is detected.

Of note, we detected an increase in mortality for patients transferred to the PICU from acute care units compared with the mortality of patients transferred from other sources. In another single-center study in the United States, Odetola et al[10] found a higher risk of mortality in patients transferred from acute care units than in patients transferred from the emergency department. In a tertiary care PICU in Brazil, mortality was twice as high in patients admitted from acute care units compared with patients admitted from the emergency department.[11] Although unplanned readmissions are infrequent, the outcomes are worse than those of planned readmissions.[12,13] In a study by Jäderling et al,[9] adult patients admitted to the ICU from general medical units after RRT initiation had higher mortality than did patients admitted after direct physician contact and admission with no activation of the RRT. In our study, we were unable to compare mortality rate between RRT and non-RRT transfers to the PICU because the data in our RRT database was delinked from patient identifiers such as name and medical record number.

> More children were transferred to the PICU after RRT calls during the day than during the night.

Our findings of increased RRT use during daytime hours and increased mortality among patients with unplanned transfers from an acute care unit to the PICU are important for planning resource allocations and improving quality and safety measures. With increased use of outpatient and ambulatory services, sicker patients are being admitted to children's hospitals. Children admitted to acute care units are at risk for further worsening in clinical status; they are less frequently monitored than are children in other units and are at risk for unsuccessful resuscitation if their condition worsens further. Several system-based quality improvement methods have been advocated for an early recognition and treatment of children with critical changes in clinical status. Various pediatric early warning systems have been studied.[14-18] The effect of combined use of pediatric early warning systems for early detection of critical worsening in clinical status and rapid response systems for early treatment is yet to be determined. In addition, mandatory RRT activation determined by using a pediatric early warning scoring system algorithm may further enhance the effectiveness of RRT use. In a study by Panesar et al,[19] mandatory RRT activation based on a pediatric early warning scoring system increased the rate of nighttime activation of RRT.

Our study has several limitations. The documentation of disposition of all RRT calls was incomplete. Our RRT database was delinked from patient identifiers; hence, we could not compare the outcome among RRT transfers and non-RRT transfers. Because our data were collected from a single institution, generalization of the findings must be done with caution.

Our results suggest several additional areas of investigation. Detailed evaluation of causes for higher rate of RRT activation and transfer to a PICU during the daytime is warranted. Day-night variation in outcomes differs according to the population studied. Outcomes are worse for out-of-hospital and in-hospital cardiac arrests,[20-24] trauma admissions,[25] unplanned cesarean deliveries,[26] and emergency percutaneous coronary intervention[27] if these events occur during the nighttime. However, this diurnal variation is not present in all hospital admissions,[28] in patients with community-onset bloodstream infections,[29] and in patients with severe head injuries admitted to a neurological ICU.[30] Diurnal variation may not be detected in a single-center study for infrequent outcomes such as cardiac arrests and mortality in a children's hospital. Infrequent or less optimal monitoring and evaluation of children admitted to acute care units during the nighttime is a potential reason for the diurnal variation in RRT activation and needs to be further evaluated.

Conclusion

Only 25% of transfers from acute care units to the PICU occurred after RRT activation. The majority of rapid responses were called during daytime hours (7 AM-7 PM), and most patients (63%) were transferred to the PICU. Mortality was significantly higher in patients transferred from acute care units than in other PICU admissions. Because a significantly higher number of RRTs are called during the day shift and mortality is higher among children transferred from acute care units, further evaluation is needed to pinpoint the reasons. The finding that only 25% of patient transfers to the PICU occurred after RRTs suggests that RRTs may be underused and that education of the staff as well as patients' families about RRT may need to be increased.

FINANCIAL DISCLOSURES
None reported.

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REFERENCES

1. Sharek PJ, Parast LM, Leong K, et al. Effect of a rapid response team on hospital-wide mortality and code rates outside the ICU in a children's hospital. *JAMA.* 2007;298(19):2267-2274.
2. Tibballs J, Kinney S. Reduction of hospital mortality and of preventable cardiac arrest and death on introduction of a pediatric medical emergency team. *Pediatr Crit Care Med.* 2009;10(3):306-312.
3. Kotsakis A, Lobos AT, Parshuram C, et al; Pediatric Critical Care Response Team Collaborative. Implementation of a multicenter rapid response system in pediatric academic hospitals is effective. *Pediatrics.* 2011;128(1):72-78.
4. Joffe AR, Anton NR, Burkholder SC. Reduction in hospital mortality over time in a hospital without a pediatric medical emergency team: limitations of before-and-after study designs. *Arch Pediatr Adolesc Med.* 2011;165(5):419-423.
5. Jones D, Bates S, Warrillow S, et al. Circadian pattern of activation of the medical emergency team in a teaching hospital. *Crit Care.* 2005;9(4):R303-R306.
6. Van Voorhis KT, Willis TS. Implementing a pediatric rapid response system to improve quality and patient safety. *Pediatr Clin North Am.* 2009;56(4):919-933.
7. Bonafide CP, Localio AR, Roberts KE, Nadkarni VM, Weirich CM, Keren R. Impact of rapid response system implementation on critical deterioration events in children. *JAMA Pediatr.* 2014;168(1):25-33.
8. Wang GS, Erwin N, Zuk J, Henry DB, Dobyns EL. Retrospective review of emergency response activations during a 13-year period at a tertiary care children's hospital. *J Hosp Med.* 2011;6(3):131-135.
9. Jäderling G, Bell M, Martling CR, Ekbom A, Bottai M, Konrad D. ICU admittance by a rapid response team versus conventional admittance, characteristics, and outcome. *Crit Care Med.* 2013;41(3):725-731.

10. Odetola FO, Rosenberg AL, Davis MM, Clark SJ, Dechert RE, Shanley TP. Do outcomes vary according to the source of admission to the pediatric intensive care unit? *Pediatr Crit Care Med.* 2008;9(1):20-25.
11. El Halal MG, Barbieri E, Filho RM, Trotta Ede A, Carvalho PR. Admission source and mortality in a pediatric intensive care unit. *Indian J Crit Care Med.* 2012;16(2):81-86.
12. Bernard AM, Czaja AS. Unplanned pediatric intensive care unit readmissions: a single-center experience. *J Crit Care.* 2013;28(5):625-633.
13. Czaja AS, Hosokawa PW, Henderson WG. Unscheduled readmissions to the PICU: epidemiology, risk factors, and variation among centers. *Pediatr Crit Care Med.* 2013;14(6):571-519.
14. Robson MA, Cooper CL, Medicus LA, Quintero MJ, Zuniga SA. Comparison of three acute care pediatric early warning scoring tools. *J Pediatr Nurs.* 2013;28(6):e33-e41.
15. Skaletzky SM, Raszynski A, Totapally BR. Validation of a modified pediatric early warning system score: a retrospective case-control study. *Clin Pediatr (Phila).* 2012;51(5):431-435.
16. Parshuram CS, Duncan HP, Joffe AR, et al. Multicentre validation of the bedside paediatric early warning system score: a severity of illness score to detect evolving critical illness in hospitalised children. *Crit Care.* 2011;15(4):R184.
17. Parshuram CS, Hutchison J, Middaugh K. Development and initial validation of the Bedside Paediatric Early Warning System score. *Crit Care.* 2009;13(4):R135.
18. Duncan H, Hutchison J, Parshuram CS. The Pediatric Early Warning System score: a severity of illness score to predict urgent medical need in hospitalized children. *J Crit Care.* 2006;21(3):271-278.
19. Panesar R, Polikoff LA, Harris D, Mills B, Messina C, Parker MM. Characteristics and outcomes of pediatric rapid response teams before and after mandatory triggering by an elevated Pediatric Early Warning System (PEWS) score. *Hosp Pediatr.* 2014;4(3):135-140.
20. Wallace SK, Abella BS, Shofer FS, et al. Effect of time of day on prehospital care and outcomes after out-of-hospital cardiac arrest. *Circulation.* 2013;127(15):1591-1596.
21. Koike S, Tanabe S, Ogawa T, et al. Effect of time and day of admission on 1-month survival and neurologically favourable 1-month survival in out-of-hospital cardiopulmonary arrest patients. *Resuscitation.* 2011;82(7):863-868.
22. Rafati H, Saghafi A, Saghafinia M, Panahi F, Hoseinpour M. Survival after In-hospital cardiopulmonary resuscitation in a major referral center during 2001-2008. *Iran J Med Sci.* 2011;36(1):50-53.
23. Peberdy MA, Ornato JP, Larkin GL, et al; National Registry of Cardiopulmonary Resuscitation Investigators. Survival from in-hospital cardiac arrest during nights and weekends. *JAMA.* 2008;299(7):785-792.
24. Rakic D, Rumboldt Z, Carevic V, et al; Approach to Sudden Cardiac Death Study Investigators. In-hospital cardiac arrest and resuscitation outcomes: rationale for sudden cardiac death approach. *Croat Med J.* 2005;46(6):907-912.
25. Egol KA, Tolisano AM, Spratt KF, Koval KJ. Mortality rates following trauma: the difference is night and day. *J Emerg Trauma Shock.* 2011;4(2):178-183.
26. Peled Y, Melamed N, Chen R, Pardo J, Ben-Shitrit G, Yogev Y. The effect of time of day on outcome of unscheduled cesarean deliveries. *J Matern Fetal Neonatal Med.* 2011;24(8):1051-1054.
27. Lairez O, Roncalli J, Carrié D, et al. Relationship between time of day, day of the week and in-hospital mortality in patients undergoing emergency percutaneous coronary intervention. *Arch Cardiovasc Dis.* 2009;102(12):811-820.
28. Khanna R, Wachsberg K, Marouni A, Feinglass J, Williams MV, Wayne DB. The association between night or weekend admission and hospitalization-relevant patient outcomes. *J Hosp Med.* 2011;6(1):10-14.
29. Laupland KB. Admission to hospital with community-onset bloodstream infection during the 'after hours' is not associated with an increased risk for death. *Scand J Infect Dis.* 2010;42(11-12):862-865.
30. Lee KK, Ng I, Ang BT. Outcome of severe head injured patients admitted to intensive care during weekday shifts compared to nights and weekends. *Ann Acad Med Singapore.* 2008;37(5):390-396.