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Association Between Survival and Time of Day for Rapid Response Team Calls in a National Registry

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Abstract

Objective—Decreased staffing at nighttime is associated with worse outcomes in hospitalized patients. Rapid response teams (RRTs) were developed to decrease preventable harm by providing additional critical care resources to patients with clinical deterioration. We sought to determine whether RRT call frequency suffers from decreased utilization at night and how this is associated with patient outcomes.

Design—Retrospective analysis of a prospectively collected registry database

Setting—National registry database of inpatient RRT calls

Patients—Index RRT calls occurring on the general wards in the American Heart Association Get With the Guidelines-Medical Emergency Team database between 2005 and 2015 were analyzed.

Interventions—None

Measurements and Main Results—The primary outcome was in-hospital mortality. Patient and event characteristics between the hour with the highest and lowest mortality were compared, and multivariable models adjusting for patient characteristics were fit. A total of 282,710 RRT calls from 274 hospitals were included. The lowest frequency of calls occurred in the consecutive 1 AM–6:59 AM period, with 266/274 (97%) of hospitals having lower than expected call volumes during those hours. Mortality was highest during the 7 AM hour and lowest during the noon hour (18.8 vs. 13.8%; adjusted OR 1.41 (1.31–1.52); $P < 0.001$). Compared to calls at the noon hour,

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those during the 7 AM hour had more deranged vital signs, were more likely to have a respiratory trigger, and were more likely to have >2 simultaneous triggers.

Conclusions—RRT activation is less frequent during the early morning and is followed by a spike in mortality in the 7 AM hour. These findings suggest that failure to rescue deteriorating patients is more common overnight. Strategies aimed at improving RRT utilization during these vulnerable hours may improve patient outcomes.

Keywords

Rapid response team; Medical emergency team; Cardiac arrest; Hospital quality and safety; Clinical deterioration; Early warning systems

Introduction

Variations in care by time of day are common in hospitals, with nighttime hours often associated with decreased staffing and the availability of diagnostic tests or procedures (1–5). These discrepancies have been associated with treatment delays and worse outcomes at night for many conditions including maternal outcomes after childbirth (1), stroke (2), myocardial infarction (3), and in-hospital cardiac arrest (4,5). Of note, the disparity in outcome by time of day is most pronounced in lower acuity settings such as unmonitored units, as opposed to intensive care units (ICUs), which are more likely to maintain higher levels of support at all hours (6).

Rapid response teams (RRTs) were designed to rapidly deploy critical care resources to deteriorating patients outside critical care areas around the clock and have been associated with decreases in cardiac arrest rates outside the ICU, and, in some studies, in-hospital mortality (7). In theory, RRTs could ameliorate the day-night disparity in care. However, prior work has shown that the majority of RRT activations occur during daytime hours (8). It is not known whether that phenomenon represents appropriate utilization with higher needs during daytime hours or a delay in recognition and activation on the part of caregivers at night. Therefore, we investigated the frequency of RRT calls by time of day and the association with in-hospital mortality in a large, national registry. We hypothesized that RRT calls would be underutilized at night, with an associated increased mortality of patients receiving RRT calls in the early morning hours.

Materials and Methods

Study population

Within Get With The Guidelines®-Resuscitation, all patients from June 2005 to February 2015 were eligible for study inclusion. This database is an American Heart Association (AHA) sponsored registry in which hospitals voluntarily prospectively collect and input data regarding RRT calls at their institution using the AHA's online Patient Management Tool™. All participating institutions were required to comply with local regulatory and privacy guidelines and, if required, to secure institutional review board approval. Because data were used primarily at the local site for quality improvement, sites were granted a waiver of informed consent under the common rule. Institutional data are then linked from the

American Hospital Association database to provide hospital-level information, and random patient and hospital identifiers are generated for de-identification purposes in order to be compliant with the Health Insurance Portability and Accountability Act. In this study, the index (first) RRT during hospital admission occurring on the general medical-surgical wards or telemetry units (non-ICUs) were included in the analysis. Hospitals with less than 50 RRT calls in the registry were excluded.

Study variables and outcomes

Data collected for each RRT call include patient demographics (age, sex, race), illness type (medical-cardiac, medical-non-cardiac, surgical-cardiac, surgical-non-cardiac, obstetric, trauma), event characteristics (whether the patient was previously in an intensive care unit (ICU), post-anesthesia care unit (PACU), emergency department (ED) or received sedation in the prior 24 hours; the trigger for the RRT call; vital signs at the time of the RRT call; length of stay prior to call; location of call; therapies given during the call; outcomes from the call (death, cardiac arrest, acute respiratory compromise, ICU transfer after the call), and hospital characteristics (teaching status, rural vs. not, bed size).

Two primary variables were investigated in the study: 1) the percentage of RRT calls occurring at each clock hour, and 2) in-hospital mortality at each clock hour. The percentage of RRT calls per clock hour was calculated by dividing the frequency of RRT calls for each hour by the total number of RRT calls included in the study. In-hospital mortality for each hour was calculated by dividing the number of patients who died in each clock hour by the number of calls for that hour. Clock hour was defined as the time of day that that RRT call occurred (i.e., the time of the RRT activation). For those calls with missing RRT activation time, the time of RRT arrival was used; if both activation time and arrival time were missing then time of RRT departure was used. Secondary outcomes investigated in the study were acute respiratory compromise (defined as events that required emergency assisted ventilation), cardiac arrest during the RRT call, and ICU transfer after the RRT call.

Statistical analysis

The frequency of RRT calls and the respective in-hospital mortality for each clock hour were presented graphically using descriptive statistics. To determine what proportion of hospitals had decreased nighttime call rates, the percentage of RRT calls occurring during the six hours with the lowest call rate at night was calculated for each hospital. The observed percentage of calls during this six-hour period at each hospital was then compared to the expected 25% rate that should occur if call frequency was uniform over the 24-hour clock to determine what proportion of hospitals have decreased call rates overnight. Hospital characteristics were then compared across quintiles of call frequency during the lowest six-hour call period using a non-parametric test for trend.

At the patient level, comparisons of demographics, illness type, prior hospital care, event characteristics, call outcomes, and in-hospital mortality were compared between calls during the hour with the highest compared to the lowest in-hospital mortality. A multivariable hierarchical logistic regression model was then fit, with a random effect for each center, adjusting for patient and prior hospital care characteristics (age, sex, race, illness category,

location of the call, length of stay prior to the call, whether the patient had a prior ICU stay, and whether that patient was in the emergency department, received sedation, or was in the post-anesthesia care unit within 24 hours prior to the call) to determine whether this difference in mortality was independent of these factors. Further models were fit to determine the association between time of day and cardiac arrest, acute respiratory compromise, and transfer to the ICU during the call. Analyses were performed using Stata 14.2 (College Station, TX), and $P < 0.05$ (two-tailed) denoted statistical significance.

Results

A total of 282,710 RRT calls on the general medical-surgical or telemetry wards from 274 hospitals were included in the study. In the study population, the mean age of the included patients was 65 (SD 17), 47% were female, and 69% were non-Hispanic white. Forty percent of calls occurred on the telemetry wards. Call frequency varied by hour of day, with the six hours with the fewest calls occurring in the consecutive time block from 1 AM to 6:59 AM (range 9,402–10,334 calls) and the greatest number of calls occurring at 8 AM (14,329 calls; Figure 1). Mortality also varied by time of day, with the 7 AM hour (7–7:59 AM) having the highest mortality (18.8%) and the noon hour (12–12:59 PM) having the lowest mortality (13.8%).

As shown in Table 1, patient demographics were similar for RRT calls during the 7 AM hour compared to the noon hour. Patients at 7 AM were more likely to be non-cardiac medical patients (64% vs. 60%) and less likely to be non-cardiac surgical patients (14% vs. 16%) ($P < 0.001$). RRT calls during the 7 AM hour more likely to be activated due for respiratory reasons (44% vs. 36%; $P < 0.001$) and had a higher proportion of patients with a respiratory rate ≥ 25 (29% vs. 22%), heart rate ≥ 131 (15% vs. 12%), and oxygen saturation $\leq 91\%$ (23% vs. 18%) (Table 2; $P < 0.01$ for all comparisons). RRTs at 7 AM were less likely to be activated for neurologic triggers (30% vs. 34%; $P < 0.001$) and fewer patients with a 7 AM RRT calls received sedation within the prior 24 hours compared to the noon hour (6% vs. 8%; $P < 0.001$).

Multivariable hierarchical models with adjustment for patient and prior hospital care variables demonstrated that RRT calls at 7 AM had significantly higher odds of acute respiratory compromise (OR 1.35 [95% CI 1.18–1.53]), cardiac arrest during the RRT call (OR 1.41 [95% CI 1.08–1.83]), ICU transfer after the call (OR 1.18 [95% CI 1.11–1.25]), and in-hospital mortality (OR 1.41 [95% CI 1.31–1.52]) (Table 3). Adjusted in-hospital mortality by time of day is shown in Figure 1.

As shown in Figure 2, 97% (266/274) of the hospitals had a lower observed early morning call proportion than the expected 25% during the 1 AM–6:59 AM time block, with a median of 16%. Major teaching hospitals had the lowest mean early morning call frequency (14%), followed by minor teaching (16%), and non-teaching hospitals (17%). Hospital characteristics compared across quintiles of early morning call percentage are shown in Appendix Table 1.

Discussion

In this large study from a national RRT call registry, we found that the frequency and in-hospital mortality of RRT calls varied significantly by time of day. In particular, the six hours of lowest call frequency in the early morning were followed by the hour with the highest in-hospital mortality (7–7:59 AM). Compared to the noon hour, which had the lowest mortality, calls during the 7 AM hour had more deranged vital signs and were more likely to have respiratory triggers as the cause for RRT activation, suggesting increased delays in identification and treatment at night. These findings demonstrate that RRTs are subject to the same diurnal trends in patient contact as the usual hospital care they are meant to supplement, which highlights an important deficiency in these systems. Improving the recognition of impending critical illness and the rate of RRT calls at nighttime could have a large potential benefit for the care of hospitalized patients.

Our finding of a lower frequency of calls at night is consistent with prior smaller studies. In one study across seven hospitals in Australia, Canada, and Sweden over a one-month period, call frequency was highest between 8 AM and 6 PM (9). A single-center study by Jones and colleagues found that RRT call frequency was highest during nurse hand-off times and after vital signs were obtained (10). Furthermore, a study by Benin and colleagues (11) found that 40% of calls occurred during the day, 35% during the evening, and 25% at night at their hospital. Finally, a single-center study in the U.S. by Galhotra and colleagues at the University of Pittsburgh found that call frequency was lowest from midnight to seven AM, although they did not investigate the in-hospital mortality associated with the calls over time (12).

Our associated finding that calls in the 7 AM hour, which followed the six-hour span with the lowest call frequency, presented with vital signs that were significantly more deranged than the noon hour suggests a delay in recognition and treatment of clinical deterioration at night as the likely explanation for the early morning peak in mortality. This would also be consistent with a prior study by Chen and colleagues across 23 hospitals, which demonstrated that delayed calls were associated with a 79% increase in the odds of death and were more likely to occur between 12 AM–6 AM (13). Another study by Jones et al. found an inverse relationship between the occurrence of cardiac arrest on the wards and RRT call frequency (14). Our study, combined with these, suggests that decreased utilization of RRTs at night may increase mortality of critically ill ward patients and that improving recognition and increasing nighttime RRT call frequency has the potential to improve the safety of hospitalized patients.

One potential solution for improving the utilization of RRTs overnight is increased frequency of monitoring in high-risk patients paired with universal monitoring with evidence-based early warning scores. This could lead to automated notification of the RRT when vital signs become deranged to allow for prompt recognition of clinical deterioration at all hours of the day or night. Respiratory rate and heart rate have been shown to be the two most accurate predictors for clinical deterioration on the wards (15). Novel sensors now enable continuous or high frequency measurement of these two parameters, and prior work suggests that this technology may decrease cardiac arrest rates (16). Early warning scores,

such as the Modified Early Warning Score (MEWS) (17), can be used to risk stratify patients for additional surveillance. We have previously shown that an 11 PM MEWS score correlates well with overnight risk of clinical deterioration on the general wards (18) and that more advanced tools which incorporate vital signs, laboratory data and demographics with machine learning modeling are even more accurate (19). Further, these tools can be configured to automatically notify caregivers and even activate the rapid response team directly when patients pass a pre-set threshold.

The disproportionate number of non-cardiac medical patients in the 7 AM cohort of RRT calls may indicate that this patient population is particularly prone to overnight failures to rescue. Further, the higher proportion of surgical patients in the noon RRT cohort may be related to interventions received in the morning and/or the surgical schedule, which may decrease surgeon availability on the general wards in the middle of the day. In addition our finding that major teaching hospitals were over-represented in the lowest quintile of observed to expected early morning RRT utilization suggests the possibility of an interaction between hospital teaching status and overnight surveillance or willingness of nurses to call for help.

There are several important limitations of this work. First, this was a retrospective observational study and therefore a causal link between the diurnal rates of RRT calls and in-hospital mortality cannot be determined with certainty. In addition, there may be important differences between hospitals included in the GWTG-MET registry compared to those not included, which could result in an under- or over-estimation of our results compared to a random sample of all hospitals in the U.S. The effect may also differ based on the composition of the hospital's RRT and staff availability. However, our study included a large sample of hospitals, and it is likely that the quality of the RRTs at the included hospitals that chose to participate in the registry is higher than hospitals that did not participate. Furthermore, the timing and availability of different tests, such as early morning laboratory draws, may skew the distributions of some of the RRT triggers at different times of day. Finally, we did not have access to detailed co-morbidity information, test results, and other data to determine if there are other important differences between patients with early morning RRT calls and those occurring during the daytime.

Conclusions

In conclusion, in a large national RRT registry, we found that RRT calls are less common during the early morning hours, which is associated with a peak in mortality during the 7 AM hour that is independent of patient characteristics. These findings demonstrate a major weakness in the current rapid response system and efforts to improve overnight call frequency may improve patient safety and mortality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Lyndon A, Lee HC, Gay C, et al. Effect of time of birth on maternal morbidity during childbirth hospitalization in California. *Am J Obstet Gynecol*. 2015; 213(5):705e1–11. [PubMed: 26196454]
2. Bray BD, Cloud GC, James MA, et al. Weekly variation in health-care quality by day and time of admission: a nationwide, registry-based, prospective cohort study of acute stroke care. *Lancet*. 2016; 388(10040):170–177. [PubMed: 27178477]
3. Sorita A, Ahmed A, Starr SR, et al. Off-hour presentation and outcomes in patients with acute myocardial infarction: systematic review and meta-analysis. *BMJ*. 2014; 348:f7393. [PubMed: 24452368]
4. Peberdy MA, Ornato JP, Larkin GL, et al. Survival from in-hospital cardiac arrest during nights and weekends. *JAMA*. 2008; 299(7):785–792. [PubMed: 18285590]
5. Robinson EJ, Smith GB, Power GS, et al. Risk-adjusted survival for adults following in-hospital cardiac arrest by day of week and time of day: observational cohort study. *BMJ Qual Saf*. 2016; 25(11):832–841.
6. Sundararajan K, Flabouris A, Thompson C. Diurnal variation in the performance of rapid response systems: the role of critical care services-a review article. *J Intensive Care*. 2016; 4:15. [PubMed: 26913199]
7. Solomon RS, Corwin GS, Barclay DC, et al. Effectiveness of rapid response teams on rates of in-hospital cardiopulmonary arrest and mortality: A systematic review and meta-analysis. *J Hosp Med*. 2016; 11(6):438–445. [PubMed: 26828644]
8. Mullins CF, Psirides A. Activities of a Medical Emergency Team: a prospective observational study of 795 calls. *Anaesth Intensive Care*. 2016; 44(1):34–43. [PubMed: 26673587]
9. Medical Emergency Team End-of-Life Care investigators. The timing of Rapid-Response Team activations: a multicentre international study. *Crit Care Resusc J Australas Acad Crit Care Med*. 2013; 15(1):15–20.
10. 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. [PubMed: 16137341]
11. Benin AL, Borgstrom CP, Jenq GY, et al. Defining impact of a rapid response team: qualitative study with nurses, physicians and hospital administrators. *Postgrad Med J*. 2012; 88(1044):575–582. [PubMed: 23014939]
12. Galhotra S, DeVita MA, Simmons RL, et al. Impact of patient monitoring on the diurnal pattern of medical emergency team activation. *Crit Care Med*. 2006; 34(6):1700–1706. [PubMed: 16625132]
13. Chen J, Bellomo R, Flabouris A, et al. Delayed Emergency Team Calls and Associated Hospital Mortality: A Multicenter Study. *Crit Care Med*. 2015; 43(10):2059–2065. [PubMed: 26181217]
14. Jones D, Bellomo R, Bates S, et al. Patient monitoring and the timing of cardiac arrests and medical emergency team calls in a teaching hospital. *Intensive Care Med*. 2006; 32(9):1352–1356. [PubMed: 16826391]
15. Churpek MM, Yuen TC, Huber MT, et al. Predicting cardiac arrest on the wards: a nested case-control study. *Chest*. 2012; 141(5):1170–1176. [PubMed: 22052772]
16. Brown R, Bratton S, Cabana M, et al. Physician asthma education program improves outcomes for children of low-income families. *Chest*. 2004; 126(2):369–374. [PubMed: 15302719]
17. Subbe CP, Kruger M, Rutherford P, et al. Validation of a modified Early Warning Score in medical admissions. *QJM*. 2001; 94(10):521–526. [PubMed: 11588210]
18. Yoder JC, Yuen TC, Churpek MM, et al. A prospective study of nighttime vital sign monitoring frequency and risk of clinical deterioration. *JAMA Intern Med*. 2013; 173(16):1554–1555. [PubMed: 23817602]
19. Churpek MM, Yuen TC, Winslow C, et al. Multicenter Comparison of Machine Learning Methods and Conventional Regression for Predicting Clinical Deterioration on the Wards. *Crit Care Med*. 2016; 44(2):368–374. [PubMed: 26771782]

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Figure 1.

Distribution of RRT call frequency and adjusted in-hospital mortality over clock time*

*Adjusted for patient and prior hospital care characteristics (age, sex, race, illness category, location of the call, length of stay prior to the call, whether the patient had a prior ICU stay, and whether that patient was in the emergency department, received sedation, or was in the post-anesthesia care unit within 24 hours prior to the call) in a hierarchical random effects model, with noon as the reference time.

Figure 2. Percentage of daily RRT calls occurring from 1 AM to 6:59 AM in individual hospitals. As shown, <5% of hospitals have the expected 25% call rate during this six-hour time period.

Table 1

Patient and event characteristics of Rapid Response Team calls from 7 AM–7:59 AM compared to 12 PM–12:59 PM

Variable	7 AM–7:59 AM n=12,280	12 PM–12:59 PM n=11,674	P value
Age, y, mean (SD)	66 (17)	66 (17)	0.92
Male sex, n (%)	5,796 (47%)	5,579 (48%)	0.35
Race/Ethnicity, n (%)			
White, non-Hispanic	8,682 (71%)	8,049 (69%)	0.01
Black, non-Hispanic	2,200 (18%)	2,217 (19%)	
Hispanic	557 (5%)	615 (5%)	
Other*	207 (2%)	206 (2%)	
Unknown or missing	634 (5%)	587 (5%)	
Illness category, n (%)			
Medical, cardiac	2,337 (19%)	2,357 (20%)	<0.001
Medical, non-cardiac	7,814 (64%)	7,038 (60%)	
Surgical, cardiac	256 (2%)	264 (2%)	
Surgical, non-cardiac	1,726 (14%)	1,845 (16%)	
Obstetric	35 (0.3%)	48 (0.4%)	
Trauma	112 (0.9%)	122 (1.1%)	0.02
Length of stay prior to call, hours, median (IQR)	56 (19 – 134)	55 (22–136)	
Location, n (%)			
General inpatient	7,359 (60%)	6,954 (60%)	
Telemetry or step down	4,921 (40%)	4,720 (40%)	0.57
ICU stay prior to RRT, n (%)	1,557 (13%)	1,408 (12%)	0.15
PACU within 24 hours, n (%)	572 (5%)	713 (6%)	<0.001
ED within 24 hours, n (%)	2,632 (21%)	2,216 (19%)	<0.001
Sedation within 24 hours, n (%)	699 (6%)	938 (8%)	<0.001

Table 2

Call triggers and vital signs at time of RRT for 7 AM–7:59 AM calls compared to 12 PM–12:59 PM.

Variable	7 AM–7:59 AM n=12,280	12 PM–12:59 PM n=11,674	P value
Respiratory trigger	5,364 (44%)	4,219 (36%)	<0.001
Cardiovascular trigger	4,621 (38%)	4,445 (38%)	0.48
Neurologic trigger	3,669 (30%)	4,010 (34%)	<0.001
Staff worry	3,010 (25%)	2,963 (26%)	0.19
More than 2 triggers	2,797 (23%)	2,368 (20%)	<0.001
Respiratory rate ≥25, n (%)	3,557 (29%)	2,620 (22%)	<0.001
Respiratory rate <8, n (%)	158 (1%)	157 (1%)	0.69
Heart rate ≥131, n (%)	1,852 (15%)	1,345 (12%)	<0.001
Heart rate <40, n (%)	133 (1%)	160 (1%)	0.043
Systolic blood pressure ≥220, n (%)	129 (1%)	90 (0.8%)	<0.001
Systolic blood pressure <90, n (%)	1,945 (16%)	2,123 (18%)	<0.001
Temperature ≥35 °C	114 (0.9%)	102 (0.9%)	0.66
Oxygen saturation <91%	2,846 (23%)	2,102 (18%)	<0.001

Table 3

Outcomes for RRT calls from 7 AM–7:59 AM compared to 12 PM–12:59 PM

Outcome	7 AM–7:59 AM n=12,280	12 PM–12:59 PM n=11,674	Adjusted odds ratio*	Adjusted <i>P</i> value*
Required assisted ventilation during the RRT	644 (5.3%)	461 (4.0%)	1.35 (1.18 to 1.53)	<0.001
Cardiac arrest during RRT	149 (1.2%)	99 (0.9%)	1.41 (1.08 to 1.83)	<0.001
ICU transfer after call	4,554 (37%)	3,857 (33%)	1.18 (1.11 to 1.25)	<0.001
In-hospital mortality	2,310 (18.8%)	1,616 (13.8%)	1.41 (1.31 to 1.52)	<0.001

* Adjusted for patient and prior hospital care characteristics (age, sex, race, illness category, location of the call, length of stay prior to the call, whether the patient had a prior ICU stay, and whether that patient was in the emergency department, received sedation, or was in the post-anesthesia care unit within 24 hours prior to the call).