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Factors associated with delayed rapid response team activation

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ABSTRACT

Delayed activation of the rapid response team (RRT) is common and has been associated with adverse outcomes. However, little is known about the factors associated with delayed activation.
This was an observational study from two hospitals in Ottawa, Canada, including adult inpatients with experiencing an activation of the RRT. Data was collected between May 1, 2012 and May 31, 2016 and groups were divided between those with activation within 1 h of meeting call criteria and those with >1 h (delayed activation). The primary outcome was in-hospital mortality. There were 6131 patients included in the study, of which 1441 (26.0%) experienced a delay. The reasons for RRT call were significantly different ($P < 0.001$) with respiratory distress (29.3% versus 24.8%), and hypotension (17.4% versus 13.2%) being more common in the delayed group, and dysrhythmias (15.9% versus 18.5%) and altered level of consciousness (13.5% versus 18.7%) being less common. RRT activation was more delayed on non-surgical services ($P < 0.001$). Delayed activation was associated with increased mortality (Adjusted odds ratio [OR] 1.23, 95% CI 1.07–1.41), ICU admission (Adjusted OR 1.72, 95% CI 1.51–1.96), and hospital length of stay (13 versus 15 days, $P < 0.001$).

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1. Introduction

Rapid response teams (RRT) were developed as a preventative measure against serious adverse events among hospital inpatients [1,2]. They are defined as a safety net for patients who suddenly become critically ill and have a mismatch of needs and resources [3]. In theory, by recognizing the early signs and symptoms of sick patients, health care providers can facilitate intervention and prevent negative outcomes and illness progression [4].

Although early observational trials demonstrated reduced morbidity and mortality [5-9], the only published randomized trial, the MERIT study, did not show a reduction in the incidence of cardiac arrest, unplanned ICU admission, or unexpected death [10]. However, more recent systematic reviews and meta-analyses have shown more encouraging results [11,12].

Many explanations for the ineffectiveness of the RRT have been proposed, however afferent limb failure, or inadequate recognition of call criteria and timely activation of the response team, has been recognized as one of the most important [11,13]. In the MERIT study, only 30% of eligible patients had an RRT activation during their study period, likely limiting the success of their implementation [14]. Studies have also shown that activation is often delayed, leading to increased morbidity and mortality [15-19]. However, though many studies have demonstrated this association, little is known about the situational or patient factors leading to delayed RRT activation. Given that the rapid response system relies on early recognition and response to deterioration to be detected, delay in activation might undermine this effectiveness.

The objective of this study is to examine and further describe the factors associated with delayed activation of the RRT. More knowledge about the patient demographics, admission characteristics and call criteria of patients experiencing a delayed activation may offer an opportunity for targeted intervention to improve the effectiveness of the RRT and mitigate the risk of adverse events.

2. Materials and methods

Ethics approval for this study was obtained from The Ottawa Health Science Network Research Ethics Board. Ethics approval number is 20170016-01H.

2.1. Study design, setting and subjects

The study was performed at two hospitals within The Ottawa Hospital network, a Canadian tertiary care network. Combined, the network has a 1163-bed capacity, and handles over 160,000 emergency visits, 50,000 inpatients, and roughly 35,000 surgical cases annually. The

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Ottawa Hospital has had an RRT program since 2005. This is a retrospective study. We analyzed data, which was prospectively collected and contained in the Ottawa Hospital Data Warehouse, a health administrative database widely used in previous research [20,21]. Extensive assessments of data quality were performed during database development, and quality-assurance initiatives to ensure completeness and accuracy of the data are conducted regularly [21].

Patients were included if they were over the age of 18 and received RRT activation between May 1, 2012 and May 31, 2016. Patients with incomplete demographic or outcome data were excluded. We also excluded cases of scheduled RRT follow-up. At our centre, the RRT performs routine follow-up of patients after ICU discharge and after an RRT call, until deemed clinically stable. Data related to cases of in-hospital cardiac arrest, without a preceding RRT activation, are not included in the database, as they involve a different response team. Patients were categorized by estimated delay from onset of concerning signs and symptoms to time of RRT activation. Patients with multiple activations during their admission were categorized based on the time of their initial activation. Activations were classified as occurring either within 1 h from onset of concerning signs and symptoms (<1 h) or 1 h or greater from onset of concerning signs and symptoms (≥1 h).

At our centre, the RRT is comprised of an attending intensivist, along with an experienced critical care nurse and respiratory therapist. During the evening (past 5 pm), night time, and weekends, the intensivist is replaced by a resident physician with the attending physician available on call. The RRT only responds to inpatients, outpatients experiencing distress (e.g. in radiology and endoscopy suites), or patients requiring immediate care in hospital clinics or waiting rooms. The RRT does not respond to patients being assessed in the ED (who have not yet been admitted). The criteria for RRT activation have been previously published [9] and include significant alterations in vital signs and signs of clinical deterioration (e.g. decreased urine output or altered level of consciousness). Additionally, healthcare providers are encouraged to activate the RRT for any reason of concern, even in the absence of objective changes in clinical status. The full criteria are available in the Supplemental Appendix.

2.2. Data collection

Patient information including demographic data, comorbidities, previous ED visits, previous hospital admissions, and previous ICU admissions in the year prior to the index admission were collected by registration clerical staff at the time of admission and were stored in Data Warehouse [18]. Data related to RRT activation are gathered by the RRT nursing staff at the time of patient assessment by the RRT, and are also stored in the Data Warehouse. This includes the most recent vital signs and laboratory values at the time of activation, reason for activation, and admitting service. Outcome at hospital discharge (including death or disposition) and length of hospital and ICU stay are also stored in the Data Warehouse. At the time of RRT assessment, the RRT staff estimate the time from onset of concerning symptoms or signs to the time of RRT activation, for quality assurance purposes. This data is also prospectively stored in the Data Warehouse.

The primary outcome was in-hospital mortality, comparing patients with activation <1 h from onset of concerning symptoms or signs against those with activation ≥1 h from onset of concerning symptoms or signs. Secondary outcomes included ICU admission following RRT assessment, and overall hospital length-of-stay.

2.3. Statistical analysis

All statistical analyses were performed with commercially available statistical packages (R, Version 3.3.3 and IBM SPSS, Version 24.0). Data are presented as mean values (with standard deviation [SD]), or as medians (with interquartile range [IQR]), where indicated. Between-group comparisons were made using the Student's *t*-test for continuous variables, and χ^2 for categorical variables. In evaluating the outcomes of in-hospital mortality and ICU admission after RRT activation, we used multivariable logistic regression modeling to adjust for potential confounders including patient characteristics (age, sex, comorbidities, comorbidity index, previous ED visits in the past year, previous hospital admissions in the past year, and previous ICU admissions in the past year), most recent laboratory investigations at the time of RRT activation, and vital signs at the time of RRT activation. We analyzed disposition of survivors at hospital discharge using a similarly constructed multivariable logistic regression model but restricted to patients originally from home, assuming that patients initially from peripheral acute or long-term care centres were likely to return to those centres when discharged from the hospital. Adjusted odds ratios (OR) with 95% confidence intervals (CI), and adjusted *P* values.

3. Results

3.1. Patients and demographics

There were 206,308 inpatient admissions over the study period (Fig. 1). Of these, 6131 patients had at least one RRT activation during their admission. After exclusion criteria were applied, 5550 patients were included in the final study cohort. Overall, 1441 (26.0%) experienced a delay of ≥1 h between the time call criteria were met and activation of the RRT.

Baseline characteristics of the included patients are depicted in Table 1. The mean age of patients with delayed activation was 66.8 years (SD = 16.2), compared to 68.2 years (SD = 16.5) for the group with no delay ($P < 0.01$). In terms of admission source, the delayed group had a larger proportion coming from home (73.8% versus 69.0%, $P < 0.001$) and a smaller fraction being admitted from long-term care facilities (8.3% versus 11.6%, $P < 0.001$). Baseline comorbidities are shown. The delayed group had less valvular disease (2.1 versus 3.3%, $P = 0.02$), but higher baseline rates of chronic obstructive pulmonary disease (17.6% versus 15.4%, $P = 0.04$) and liver disease (7.4% versus 5.4%, $P < 0.01$). There were no significant differences in the number of previous ED visits, hospital or ICU admissions over the year preceding study inclusion. There were more patients with no limitations of care in the delayed group (71.2% versus 67.2%) and less patients with a "Do Not Resuscitate" order (16.5% versus 20.4%). These differences were statistically significant ($P = 0.002$) and have not been replicated in previous study.

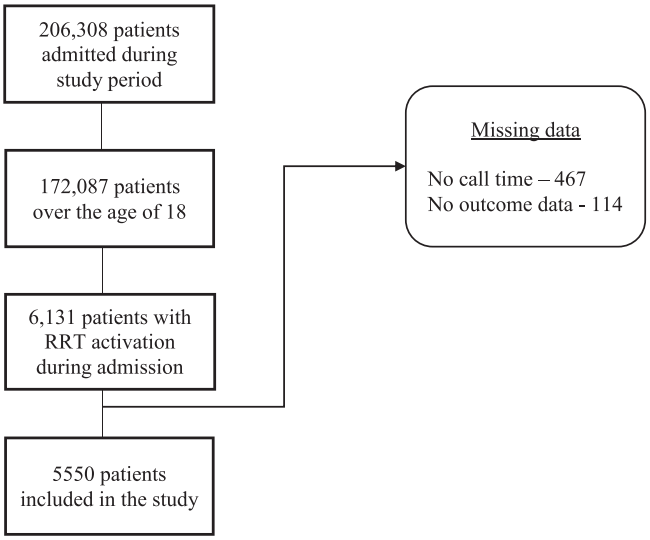

Fig. 1. Flow chart of study patients.

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