Outcomes of second-tier rapid response activations in a tertiary referral hospital: A prospective observational study

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ABSTRACT

Introduction: A second-tier rapid response team (RRT) is activated for patients who do not respond to first-tier measures. The premise of a tiered response is that first-tier responses by a ward team may identify and correct early states of deterioration or establish goals of care, thereby reducing unnecessary escalation of care to the RRT. Currently, utilisation and outcomes of tiered RRTs remain poorly described.

Methods: A prospective observational study of adult patients (age ≥ 18 years) who required RRT activations was conducted from February 2018 to December 2019.

Results: There were 951 consecutive RRT activations from 869 patients and 76.0% patients had a National Early Warning Score (NEWS) ≥ 5 at the time of RRT activation. The majority (79.8%) of patients required RRT interventions that included endotracheal intubation (12.7%), point-of-care ultrasound (17.0%), discussing goals of care (14.7%) and intensive care unit (ICU) admission (24.2%). Approximately 1 in 3 (36.6%) patients died during hospitalisation or within 30 days of RRT activation. In multivariate analysis, age ≥ 65 years, NEWS ≥ 7 , ICU admission, longer hospitalisation days at RRT activation, Eastern Cooperative Oncology Group performance scores ≥ 3 (OR [odds ratio] 2.24, 95% CI [confidence interval] 1.45–3.46), metastatic cancer (OR 2.64, 95% CI 1.71–4.08) and haematological cancer (OR 2.78, 95% CI 1.84–4.19) were independently associated with mortality.

Conclusion: Critical care interventions and escalation of care are common with second-tier RRTs. This supports the need for dedicated teams with specialised critical care services. Poor functional status, metastatic and haematological cancer are significantly associated with mortality, independent of age, NEWS and ICU admission. These factors should be considered during triage and goals of care discussion.

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INTRODUCTION

Despite its widespread adoption, rapid response systems (RRS) and rapid response teams (RRT) vary significantly in composition and set-up.¹⁻³ While implementation of RRSs appear to be associated with reduced cardiac arrest rate and improved mortality,^{4,5} their optimal composition, activation criteria and how they should be evaluated, remain controversial.⁶⁻⁹ It is likely that RRS staffing, calling criteria and clinical pathways are influenced by the available expertise, patient case-mix and resources in each hospital.

Singapore General Hospital is a 1,800-bed tertiary referral hospital that encompasses a national cancer centre, specialist haematology service, and a 550-bed community hospital. Being a large tertiary centre with highly specialised clinical services, our RRS has evolved to include specialised (medical and surgical) and dedicated (separate from our cardiac arrest team) RRTs. Our RRS is based on a multitiered response. The primary or ward team leads the first-tier response (where initial clinical deterioration triggers a clinical review by the ward team) and makes the decision for RRT activation

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CLINICAL IMPACT

What is New

- Many patients with rapid response team (RRT) activations require 1 or more RRT interventions. Clinical factors such as poor functional status and metastatic and/or haematological cancer were significantly associated with poorer survival.

Clinical Implications

- Second-tier RRTs should be dedicated teams capable of providing specialised critical care services.
- Institutions should continually address potential barriers to RRT activation and consider measures to minimise delayed activations, such as the use of early warning scores. Clinical factors associated with poor outcomes should be taken into consideration during triage and goals of care discussion.

(second-tier response). The premise of a tiered response is that a first-tier response by the ward team allows early states of deterioration to be identified and corrected, and goals of care to be established, thereby reducing unnecessary escalation of care to the RRT. A tiered RRS response is not a new concept and it may promote more efficient use of critical care resources with improved staff satisfaction.^{10,11} Introduction of a tiered response has been reported to be associated with lower intensive care unit (ICU) mortality for patients admitted after RRT activations.¹² This plausibly relates to a decision by the ward team not to escalate the level of care, or establishing limits on the extent of medical therapy, for patients who are unlikely to benefit from aggressive medical therapy.¹² Tiered responses are commonplace in pre-hospital emergency services and increasingly being used in trauma centres to facilitate efficient use of resources.¹³⁻¹⁵

There is however, limited evidence describing the utilisation of a multitiered RRS in terms of RRT interventions, patient outcomes and prognostic markers. These factors are important for planning RRT composition, critical care resource management, and guiding RRT triaging and escalation of care. We aimed to evaluate second-tier RRT interventions and patient outcomes in a tertiary referral hospital. Additionally, we sought to investigate factors associated with mortality in patients requiring a second-tier RRT response.

METHODS

We conducted a prospective observational study of RRT activations from February 2018 to December 2019.

Prior to the implementation of RRTs, resuscitation at the ward level was performed by the primary or ward team. Ward teams were informed of deteriorating patients based on nurses' concerns, or critical values for single parameter vital signs such as systolic blood pressure ≤ 90 mmHg. RRTs were implemented in our institution in February 2018.

The medical RRT is also known as the Medical ICU Acute Response Team (SMART). The SMART team comprises an intensivist consultant (or registrar) from the medical ICU, medical junior resident (when available), critical care advanced practice nurse and a respiratory therapist. The medical emergency response is 3-tiered, where clinical deterioration or concerns from nursing staff is first escalated to the ward team (first tier), followed by activation of the RRT (second tier) if the patient requires escalation to a higher care ward or does not respond to first-tier management. The cardiac arrest team is the third tier.

No early warning system existed in our hospital at the time of our study. Similar to pre-RRT implementation, activation of the first tier (ward team) was based on deterioration of single parameter vital signs or concerns of ward and nursing staff. Ward teams were encouraged to activate the RRT if they were concerned about the patient or escalation of care is likely to be required, in the presence of any of the following criteria: respiratory rate ≤ 8 or ≥ 25 breaths per minute; SpO₂ $\leq 91\%$ on supplemental oxygen; systolic blood pressure ≤ 90 or ≥ 220 mmHg; heart rate ≤ 40 or ≥ 131 beats per minute; and acute change in Glasgow Coma Scale or unarousable patient. The 24-hour medical RRT service is supported by a night team of a medical registrar and respiratory therapist. Since its inception, there have been an average of 88 medical activations per month, with a utilisation rate (RRT dose) of approximately 22 activations per 1,000 medical admissions.

We recruited adult patients (age ≥ 18 years) by medical disciplines who required RRT activations during daytime hours (8am–5pm). Patient demographics, clinical characteristics and RRT interventions were recorded prospectively. National Early Warning Scores (NEWS)¹⁶ at the time of RRT activation were determined. Comorbidities as defined by Charlson Comorbidity Index (CCI)¹⁷ and Eastern Cooperative Oncology Group (ECOG) performance status¹⁸ scores based on functional status prior to hospitalisation were recorded. Patients with active malignancies or patients treated for malignancy in the last 5 years were considered to have an underlying malignancy as a comorbidity. Lymphoma, leukaemia and multiple myeloma were defined as haematological malignancies.

Patients who had more than 1 RRT activation during the same hospitalisation period were considered to have a repeat RRT activation. The reason for RRT activation was also categorised into airway concerns (included decreased airway patency, inability to protect airway, drowsiness or loss of consciousness); respiratory failure (included respiratory distress or tachypnoea); cardiovascular concerns (included hypotension, significant hypertension, tachycardia, bradycardia or arrhythmias); metabolic derangements; and primary team concern or request for closer monitoring. RRT response times were determined based on the time interval between receiving the call activation and time of arrival of the RRT by the bedside.

RRT interventions were defined as emergent bedside interventions performed in the general ward by the RRT, or escalation of care to the ICU, intermediate care area or high dependency ward directly from the RRT activation. These interventions include endotracheal intubation, initiation of non-invasive ventilation, fluid resuscitation and/or initiation of vasopressors, point-of-care ultrasound and discussion of limits of treatment or resuscitation orders by the RRT. Patients were followed up until hospital discharge for the primary outcome of inpatient mortality. Patients who were discharged alive from hospital but demised within 30 days of RRT activation were also included in the primary outcome. These outcomes were referenced from our electronic medical records, which included deaths occurring in the community. The study protocol (with a waiver of consent from participants) was submitted to our hospital's institutional review board (CIRB 2018/2190).

Statistical analysis

Continuous variables were expressed as mean and standard deviation or as median and interquartile range (IQR) for non-normally distributed variables. Categorical variables were expressed as frequency and percentage. Baseline characteristics, clinical severity scores, RRT interventions and outcomes of both survivors and non-survivors were compared using independent samples Student's t-test and Mann-Whitney U test for continuous variables, and chi-square or Fisher's Exact test for categorical variables. Univariate and multivariate logistic regression analyses were performed to identify factors associated with in-hospital mortality. Variables associated with mortality ($P < 0.20$) were identified and analysed using stepwise backward (likelihood ratio) logistic regression analysis, keeping variables with $P < 0.10$. Multicollinearity testing for variables included in the multivariable analysis was

performed with variance inflation factor analysis. Results were presented as odds ratios and 95% confidence intervals. Cut-offs for continuous variables (NEWS, CCI and ECOG performance status) that were used for the logistic regression analysis were determined based on recognised clinical significance, e.g. a NEWS score of 7 or more was high risk. All statistical analyses were performed using SPSS Statistics software version 22.0 (IBM Corp, Armonk, US).

RESULTS

Patient baseline characteristics

A total of 951 consecutive RRT activations from 869 patients were included in this study (Table 1). Pre-existing comorbidities of patients for moderate to severe chronic kidney disease and malignancy were 27.6% and 38.0%, respectively. A significant proportion of patients were admitted under the medical oncology (18.3%) and haematology (12.5%) departments, with the majority of patients admitted under internal medicine department (43.0%). Twenty-two (2.3%) patients had prior haematopoietic stem cell transplant. Eleven (1.2%) and 4 (0.4%) patients had prior kidney and liver transplants, respectively.

Interventions and outcomes of RRT activation

Table 2 summarises the characteristics and outcomes of RRT activations. Eighty-two (8.6%) of RRT activations were repeat activations. The proportion of patients with medium and high-risk NEWS scores at the time of RRT activation were 30.2% (285/944) and 45.8% (432/944), respectively. The majority (71.8%) of patients were referred for respiratory failure or cardiovascular-related concerns (haemodynamic instability, tachycardia, bradycardia and arrhythmia).

At the time of RRT activation, 11.9% of patients had 1 or more limits of medical therapy established. The majority of patients (79.8%) received 1 or more interventions by the RRT, including endotracheal intubation (12.7%) and point-of-care ultrasound for diagnostics (17.0%). Discussion of resuscitation status and goals of care were initiated by the RRT in 140 (14.7%) patients, of whom 110 (11.2%) had limits of medical therapy changed post-RRT activation. Approximately a quarter (24.2%) of patients required ICU admission directly from an RRT activation. The in-hospital or 30-day mortality rate for all RRT activations was 38.1% and the median length of stay was 20 (IQR 10–41) days. Among the 869 patients who required at least 1 RRT activation during hospitalisation, the in-hospital or 30-day mortality rate was 36.6%.

Table 1. Baseline patient characteristics

Characteristics (N=869)	
Age, mean (SD), years	64 (15)
Male sex, no. (%)	469 (54.0)
Ethnicity, no. (%)	
Chinese	620 (71.3)
Malay	120 (13.8)
Indian	77 (8.9)
Others	52 (6.0)
ECOG performance status, no. (%)	
0	236 (27.2)
1	380 (43.7)
2	144 (16.6)
3	81 (9.3)
4	28 (3.2)
Charlson Comorbidity Index, median (IQR)	6 (4–7)
Comorbidity, no. (%)	
Diabetes mellitus	310 (35.7)
Diabetes mellitus with end-organ damage	128 (14.7)
Moderate to severe chronic kidney disease	240 (27.6)
Congestive heart failure	159 (18.3)
Myocardial infarction	157 (18.1)
Chronic pulmonary disease	73 (8.4)
Liver cirrhosis or chronic hepatitis	117 (12.3)
Malignancy	330 (38.0)
Any leukaemia, lymphoma, or localised solid tumour	220 (25.3)
Metastatic solid tumour	110 (12.7)

ECOG: Eastern Cooperative Oncology Group

Factors associated with mortality

A comparison of clinical and RRT characteristics between survivors and non-survivors is summarised in Table 3. Non-survivors had worse clinical severity scores (CCI, ECOG and NEWS). A higher proportion of non-survivors had pre-existing metastatic or haematological cancers and were admitted to the ICU after RRT activation. A longer duration of hospitalisation at the time of RRT activation was also associated with mortality. In multivariate analysis, the above factors remained associated with mortality (Table 4, Fig. 1). On testing for multicollinearity, the average variance inflation factor of all 10 variables

included in the multivariate analysis was 1.07, indicating that no significant collinearity existed.

DISCUSSION

In this prospective observational study, the interventions and outcomes of patients who required second-tier RRT activations were investigated. A significant proportion of patients received 1 or more emergent interventions in the general ward. Approximately 1 in 4 patients were admitted to the ICU from an RRT activation, and 1 in 3 patients did not survive to hospital discharge. Older age, poorer functional status, known malignancy, higher NEWS scores, ICU admission and longer duration

Table 2. Characteristics and outcomes of rapid response team activations

RRT activation (N=951)	
Duration of hospitalisation at time of RRT activation, median (IQR), days	4 (1–14)
Repeat RRT activation, no. (%)	82 (8.6)
RRT response time, median (IQR), minutes	12 (8–17)
NEWS at time of activation, median (IQR)	6 (4–8) ^a
Low risk NEWS (0–4)	227 (24.0)
Medium risk NEWS (5–6 or 3 in any 1 parameter)	285 (30.2)
High risk NEWS (≥ 7)	432 (45.8)
Reason for RRT activation, no. (%)	
Airway concern	81 (8.5)
Respiratory failure or distress	381 (40.1)
Haemodynamic instability, tachycardia/bradycardia/arrhythmias	301 (31.7)
Primary team concerns or request for closer monitoring	131 (13.7)
Metabolic derangements	46 (4.8)
Others	11 (1.2)
Limits of medical therapy (pre-RRT activation), no. (%)	
Full care or care limits not yet established	838 (88.1)
Do not resuscitate, limit care to vasopressor support and/or dialysis	88 (9.3)
Do not resuscitate, general ward management	25 (2.6)
One or more interventions performed by RRT, no. (%)	
Endotracheal intubation	121 (12.7)
Non-invasive ventilation	44 (4.6)
Fluid resuscitation or vasopressor support	146 (15.4)
Point-of-care ultrasound	162 (17.0)
Central venous or arterial line insertion	9 (0.9)
Discussion of limits of medical therapy status	140 (14.7)
Limitation of medical therapy established	99 (10.4)
RRT disposition: ICU	230 (24.2)
RRT disposition: HD or ICA admission	325 (34.2)
Length of stay, median (IQR), days	20 (10–41)
24-hour mortality, no. (%)	45 (4.7)
In-hospital mortality, no. (%)	332 (34.9)
In-hospital or 30-day mortality, no. (%)	362 (38.1)

HD: high dependency; ICA: intermediate care area; ICU: intensive care unit; NEWS: National Early Warning Score;

RRT: rapid response team

^a Data missing for 7 activations

of hospitalisation at time of RRT activation were all independently associated with mortality.

Patients requiring second-tier RRT activations appeared to be of high acuity, with many requiring specialised interventions. A significant proportion of patients had a NEWS ≥ 7 at the time of RRT activation, and most activations were for respiratory failure and/or haemodynamic instability or tachy-bradyarrhythmia. In addition, most patients required 1 or more emergent bedside interventions, including endotracheal intubation and escalation of care to ICU. With the large

heterogeneity in patient and RRS characteristics, the outcomes of patients requiring RRT activations are currently not well established. While systematic reviews of non-tiered RRT activations reported an overall ICU admission and in-hospital mortality of approximately 23% and 26%, respectively, mortality rates from individual studies ranged widely from 12 to 60%.¹⁹ Reported in-hospital mortality rates (30–34%) from large single-centre studies designed to evaluate outcomes of patients requiring RRT activations were similar to our mortality outcomes.^{20,21} Notably, our

Table 3. Comparison of clinical and RRT characteristics between survivors and non-survivors (in-hospital or 30-day mortality)

	Survivors (n=589)	Non-survivors (n=362)	P value
Age, mean (SD), years	64 (15)	65 (14)	0.134
Male sex, no. (%)	308 (52.3)	210 (58.0)	0.086
ECOG performance status, median (IQR)	1 (0–1)	1 (1–2)	<0.001
Charlson Comorbidity Index, median (IQR)	5 (3–7)	6 (4–8)	<0.001
Comorbidity, no. (%)			
Metastatic cancer or haematological cancer	131 (22.2)	134 (37.0)	<0.001
Moderate to severe chronic kidney disease	151 (25.6)	113 (31.2)	0.062
Congestive heart failure	108 (18.3)	70 (19.2)	0.701
Myocardial infarction	99 (16.8)	77 (21.3)	0.085
Liver cirrhosis or chronic hepatitis	58 (9.8)	59 (16.3)	0.003
Chronic pulmonary disease	45 (7.6)	33 (9.1)	0.421
Duration of hospitalisation at time of RRT activation, median (IQR), days	2 (1–8)	10 (3–21)	<0.001
Repeat RRT activation, no. (%)	38 (6.5)	44 (12.2)	0.002
NEWS at time of activation, median (IQR)	6 (3–8) ^a	7 (5–9) ^b	<0.001
High risk NEWS (≥ 7)	235 (40.2)	197 (54.7)	<0.001
Reason for RRT activation, no. (%)			
Airway concern	50 (8.5)	31 (8.6)	0.968
Respiratory failure or distress	220 (37.4)	161 (44.5)	0.029
Haemodynamic instability, tachycardia/bradycardia/arrhythmias	190 (32.3)	111 (30.7)	0.608
Intervention performed by RRT, no. (%)			
Endotracheal intubation	57 (9.7)	64 (17.7)	<0.001
Non-invasive ventilation	28 (4.8)	16 (4.4)	0.812
Fluid resuscitation and/or vasopressor support	81 (13.8)	65 (18.0)	0.083
RRT disposition: ICU, no. (%)	116 (19.7)	114 (31.5)	<0.001
Hospital length of stay, median (IQR), days	18 (10–40)	22 (11–45)	0.067

ECOG: Eastern Cooperative Oncology Group; ICU: intensive care unit; NEWS: National Early Warning Score; RRT: rapid response team

^a Data missing for 5 activations

^b Data missing for 2 activations

Table 4. Univariate and multivariate analysis of factors associated with in-hospital or 30-day mortality

	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
Age ≥ 65 years	1.28 (0.98–1.66)	0.072	1.51 (1.12–2.04)	0.006
Male sex	1.26 (0.97–1.64)	0.086	–	–
ECOG performance status ≥ 3	2.45 (1.65–3.63)	<0.001	2.24 (1.45–3.46)	<0.001
Metastatic cancer	1.37 (0.93–2.01)	0.112	2.64 (1.71–4.08)	<0.001
Haematological cancer	2.33 (1.63–3.33)	<0.001	2.78 (1.84–4.19)	<0.001
Myocardial infarction	1.34 (0.96–1.86)	0.086	1.45 (1.00–2.09)	0.050
Moderate to severe chronic kidney disease	1.15 (0.99–1.33)	0.062	1.23 (1.04–1.45)	0.014
Liver cirrhosis or chronic hepatitis	1.78 (1.21–2.63)	0.004	1.95 (1.27–3.00)	0.002
Charlson Comorbidity Index ≥ 6	1.78 (1.37–2.32)	<0.001	–	–
Repeat RRT activation	2.01 (1.27–3.16)	0.003	–	–
Duration of hospitalisation, per 10-day increase	1.26 (1.16–1.37)	<0.001	1.26 (1.16–1.37)	<0.001
NEWS ≥ 7	1.80 (1.38–2.34)	<0.001	1.55 (1.16–2.08)	<0.001
Referral for respiratory failure or distress	1.34 (1.03–1.75)	0.030	–	–
Intubation performed by RRT	2.00 (1.37–2.94)	<0.001	–	–
Fluid resuscitation or initiation of vasopressor support by RRT	1.37 (0.96–2.96)	0.084	–	–
RRT disposition: ICU	1.87 (1.39–2.53)	<0.001	1.82 (1.31–2.55)	<0.001

CI: confidence interval; ECOG: Eastern Cooperative Oncology Group; ICU: intensive care unit; NEWS: National Early Warning Score; RRT: rapid response team

Fig. 1. Multivariate analysis of factors associated with in-hospital or 30-day mortality.

CKD: chronic kidney disease; ECOG: Eastern Cooperative Oncology Group; ICU: intensive care unit; RRT: rapid response team

centre is a tertiary hospital with a national cancer centre. Nearly half of our patients had underlying cancer, which was likely to have contributed to the significant mortality rates observed. Nevertheless, our study highlighted the high acuity of patients who required second-tier RRT responses, reinforcing the need for specialised and dedicated (without competing clinical responsibilities) RRT members, who are a cornerstone of efficient RRS to maximise delivery of timely and effective interventions.

Specialised services, however, increase the strain on limited critical care resources. The premise behind a second-tier response therefore is that first-tier responses by a ward team is effective in identifying and correcting early states of deterioration, or establishing goals of care to reduce unnecessary escalation, thereby reserving specialised RRT services to acutely deteriorating patients. Early involvement of the ward team may also address concerns with autonomy, de-skilling and continuity of care. Hospitals implementing a tiered response have reported more efficient use of resources, and even improved patient outcomes.^{10,22} The main concern with a tiered response, however, are delayed activations and interventions, which have been shown to be associated with worse clinical outcomes.²³ Furthermore, a high-risk NEWS ≥ 7 at the time of RRT activation was associated with increased mortality in our patient cohort. This reinforces the emphasis on early activation, especially in hospitals implementing second-tier RRTs. Considering the high acuity and mortality of patients with second-tier RRT activations, it will be important to identify cases with delayed first-tier or subsequent second-tier activations, and address potential barriers to activation. The implementation of early warning scores like NEWS, which has been validated in a Singapore hospital to predict critical illness in patients admitted to an acute medical ward,²⁴ may help to reduce delayed activations. These early warning scores serve as the afferent limb of the RRS. Unfortunately, evaluating the effectiveness of a RRS or RRT is challenging due to the inherent complexity and heterogeneity of strategies implemented and interactions within each healthcare institution.^{6,25} Indices such as “healthy” RRT utilisation rates have therefore been proposed as surrogates for a mature and effective RRS.²⁶ Ultimately, monitoring patient outcomes, RRT utilisation, process indicators such as timely activation, and review of cases with delayed activation will be important to ensure that an RRS remains timely and effective.

Predicting poor outcomes at the time of activation is also important for RRTs to facilitate timely transfers

to ICUs, optimise triage decisions and guide discussions on goals of care. Older age, deranged vital signs and longer duration of hospitalisation at RRT activation were found to be associated with in-hospital mortality in a retrospective analysis of large registry data by Shappell et al.²⁷ These were consistent with our study findings. In addition, metastatic cancer and haematological cancer as comorbidities were significantly associated with mortality, independent of age, performance status and physiological deterioration based on NEWS. In patients with cancer, reported in-hospital mortality after RRT activations were 33–40%,^{28–30} with mortality rates as high as 42% demonstrated in patients with haematological cancer.³¹ Clearly, patients with cancer were at a high risk of dying, especially so if RRT activations were required.^{32,33} However, patients with cancer were widely heterogeneous, with differences in cancer type, cancer staging, treatment options and response to cancer therapy. As cancer patients are living longer with access to improved cancer treatment, further studies are needed to evaluate how the above factors influence patient outcomes. This will help empower RRTs to make evidence-based triage decisions and guide discussions on goals of care.

There is increasing interest in leveraging RRTs to improve end-of-life care and avoid futile interventions,^{34–36} with some studies reporting improved end-of-life care such as reduced pain and patient distress.^{37,38} Considering the high patient acuity and mortality outcomes, discussions on resuscitation status and goals of care, when appropriate, are an important function of a second-tier response RRT. In our cohort, RRT-initiated discussion on resuscitation status resulted in a change in limits of medical therapy in a majority of cases. Notably, poor ECOG performance was found to be significantly associated with increased mortality. Similar associations have been reported when assessing patient frailty (by now a well-recognised clinical entity associated with mortality), increased healthcare utilisation and disability.^{32,39,40} As such, poor prognostic markers such as poor functional status, frailty or comorbidities such as metastatic cancer should guide discussions on goals of care, or trigger palliative services to improve end-of-life care.

There were limitations to our study. As this was a single-centre study at a tertiary hospital providing specialised care such as solid organ, haematological transplants and cancer therapy, generalisability of the results is limited. Only RRT activations from patients admitted under medical disciplines were included. Nighttime RRT activations, which appear to be

associated with higher risks of mortality,^{21,41} were not included. The absence of aggregate risk scores like NEWS in our hospital raises the question of whether delayed first-tier responses may have contributed to poorer outcomes. At the time of activation, NEWS was documented by the RRT but not used routinely in all general ward patients as part of the RRS afferent limb in our institution. Plans are currently being made to implement an early warning system. Finally, our study did not include information on first-tier activations, such as its number, patient characteristics and time between first- and second-tier activations, to identify delayed responses and associated outcomes. In our institution, ward teams were encouraged to activate the RRT if they were concerned or escalation of care was deemed likely, even in the absence of significant physiological deterioration.

CONCLUSION

To the best of our knowledge, this is the first study describing RRT intervention and patient outcomes in Singapore. Escalation of care and emergent interventions are common with second-tier RRTs. We highlight the need for second-tier RRTs to have dedicated and specialised critical care capability and measures to avoid delayed activations, including the use of early warning scores as the afferent limb of the RRS. In patients requiring RRT activations, prognostic markers such as poor functional performance status and metastatic or haematological cancer are helpful in guiding triage decisions and goals of care discussion.

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