

# Characteristics and outcomes of patients requiring rapid response system activation within 24 hours of emergency admission

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Rapid response systems (RRSs) facilitate early recognition of, and response to, deteriorating patients.<sup>1</sup> Any member of hospital staff can activate an RRS, guided by objective calling criteria and, once activation occurs, an organisational response is triggered in which experts in the management of critically ill patients provide assessment and management at the point of care.<sup>1,2</sup> RRSs evolved from cardiac arrest teams (CATs), in which organisational responses were triggered by cardiac arrest (unresponsiveness, apnoea or pulselessness).<sup>1</sup> There were three major catalysts for the evolution of RRSs. First, despite advances in resuscitation techniques and training, improvements in cardiac arrest patient outcomes have been modest, and inhospital cardiac arrest continues to carry high levels of mortality and morbidity.<sup>3</sup> Second, unplanned intensive care unit admission was recognised as a largely preventable adverse event associated with an up to 10-fold increase in mortality.<sup>4,5</sup> Third, most inhospital cardiac arrests and unplanned ICU admissions are preceded by a period of physiological instability (abnormal vital signs, biochemical derangements, changes of behaviour or new complaints).<sup>6</sup> In Australia, the most common model of RRS is the medical emergency team (MET), which functions in parallel with the CAT and is activated for patients who have not yet had a cardiac arrest but have respiratory, cardiovascular or neurological deterioration.<sup>1</sup>

Over recent years there has been increased interest in the interface between emergency departments (EDs) and general wards, as many countries implement performance targets related to reducing the ED length of stay (LOS).<sup>7,8</sup> In 2010, the Australian Government implemented the national emergency access target (NEAT) ("4-hour rule"<sup>9</sup>) with the aim that by 2015, more than 90% of patients will have their ED episode of care complete within 4 hours.<sup>8</sup> One of the primary concerns about time-driven performance indicators is the balance between efficiency and patient safety.<sup>10</sup> Of particular concern is whether shorter ED LOSs will result in increased numbers of physiologically unstable patients in general wards, which may lead to increased adverse events such as cardiac arrests and RRS activations during the early stage of hospital admission.

Currently, there are no published data on the timing of RRS activations in patients admitted to hospital via the ED. Our aim was to examine the characteristics and outcomes

## ABSTRACT

**Objectives:** To establish the prevalence of emergency responses for clinical deterioration (cardiac arrest team or medical emergency team [MET] activation) within 24 hours of emergency admission, and determine if there were differences in characteristics and outcomes of ward patients whose emergency response was within, or beyond, 24 hours of emergency admission.

**Design, setting and participants:** A retrospective, descriptive, exploratory study using MET, cardiac arrest, emergency department and inpatient databases, set in a 365-bed urban district hospital in Melbourne, Australia. Participants were adult hospital inpatients admitted to a medical or surgical ward via the emergency department (ED) who needed an emergency response for clinical deterioration during 2012.

**Main outcome measures:** Inhospital mortality, unplanned intensive care unit admission and hospital length of stay (LOS).

**Results:** A total of 819 patients needed an emergency response for clinical deterioration: 587 patients were admitted via the ED and 28.4% of emergency responses occurred within 24 hours of emergency admission. Patients whose first emergency response was within 24 hours of emergency admission (compared with beyond 24 hours) were more likely to be triaged to Australasian triage scale category 1 (5.4% v 1.2%,  $P=0.005$ ), less likely to require ICU admission after the emergency response (7.6% v 13.9%,  $P=0.039$ ), less likely to have recurrent emergency responses during their hospital stay (9.7% v 34%,  $P<0.001$ ) and had a shorter median hospital LOS (7 days v 11 days,  $P<0.001$ ).

**Conclusions:** One-quarter of emergency responses after admission via the ED occurred within 24 hours. Further research is needed to understand the predictors of deterioration in patients needing emergency admission.

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of patients admitted to a medical or surgical ward who required an emergency response for clinical deterioration within 24 hours of emergency admission. For the purposes

**Table 1. Number of patients needing ER for clinical deterioration after emergency admission**

Number of ERs	Pts needing ER, n (%)	Pts needing CAT activation, n (%)	Pts needing MET activation, n (%)
1	428 (72.9%)	47 (11%)	381 (89%)
2	112 (19.1%)	11 (9.8%)	101 (90.2%)
3	29 (4.9%)	4 (13.8%)	25 (86.2%)
4	11 (1.9%)	2 (18.2%)	9 (80.8%)
5	6 (1%)	0 (0%)	6 (100%)
6	1 (0.2%)	0 (0%)	1 (100%)
Total [%]	587	64 [10.9%]	523 [89.1%]

ER = emergency response. Pts = patients. CAT = cardiac arrest team. MET = medical emergency team.

of this study, we defined an emergency response as including an RRS or cardiac arrest activation for clinical deterioration, and an emergency admission as beginning at the time of ED discharge. The research questions (all about general ward patients admitted via the ED) were:

- What was the proportion of emergency responses?
- What was the prevalence of emergency responses within 24 hours of admission?
- Were there differences in characteristics and outcomes for patients whose first emergency response was within and beyond 24 hours of emergency admission?

## Method

### Design

We used a retrospective, descriptive, exploratory design to audit cardiac arrest, MET, ED and inpatient databases. Our study was approved by the human research and ethics committees at the study site and at Deakin University.

### Setting

The study was conducted at Box Hill Hospital (BHH), Eastern Health, Melbourne, Australia. BHH is a 365-bed hospital that supports high-complexity inpatient and outpatient health care across a broad range of clinical services including paediatrics, maternity, general and specialist medicine and surgery, emergency medicine, intensive care, postacute care, and mental health services for children, adolescents and adults.<sup>11</sup> During the 2011–12 financial year, the ED managed 46 640 presentations and had 17 343 adult patients (aged  $\geq 18$  years) needing emergency medical and surgical admissions.<sup>12</sup> BHH has a nine-bed ICU and has had an RRS in the form of an MET since early 2012. There are nine medical or surgical wards at BHH, servicing about 214 beds.

### Sample

The sample population was of adult hospital patients admitted to a medical or surgical ward via the ED, aged  $\geq 18$  years and who needed an emergency response for clinical deterioration during the calendar year of 2012. Patients in the birthing suite, mental health ward or critical care unit when their emergency response was activated were excluded. Patients were identified by the MET and code blue (cardiac arrest) database maintained by the ICU, and based on data entered by the ICU liaison nurses immediately after each code blue and MET call.

### Rapid response systems

At BHH, the CAT is activated for adult inpatients with acute airway problems, cardiac or respiratory arrest, or unconscious collapse.<sup>13</sup> The RRS (MET) is activated for:

- difficulty breathing
- respiratory rate  $< 8$  breaths/minute or  $> 30$  breaths/minute
- oxygen saturation  $< 90\%$ , despite oxygen administration at 6 L/minute via a simple mask
- heart rate  $< 50$  beats/minute or  $> 130$  beats/minute
- systolic blood pressure  $< 90$  mmHg
- new or unrelenting chest pain
- acute change in conscious state, or seizure
- clinician concern.<sup>14</sup>

An RRS team consists of a consultant intensivist or ICU registrar, a specialist ICU nurse, a medical registrar and medical staff from the patient's treating team.

### Data collection

The following data were collected from the MET and code blue databases: patient name, medical record number, age, sex, date, time, location, and immediate outcome of emergency response for clinical deterioration. In terms of immediate patient outcomes, information contained in the code blue and MET databases was limited to whether the patient remained on the ward, died, or was transferred to the ICU, coronary care unit, operating theatre or ED. Changes in the care plan, such as a new limitation-of-medical-treatment order after an emergency response for clinical deterioration, were not within the scope of this study. For patients who met the study inclusion criteria, the following data were extracted from the Victorian Emergency Minimum Dataset (VEMD): Australasian triage scale (ATS) category, waiting time, and ED LOS. The Victorian Admitted Episodes Dataset (VAED) was used to ascertain acute care LOS and in-hospital mortality.

### Data analysis

Data were analysed using SPSS version 21.0 (SPSS Inc). Descriptive statistics were used to summarise data. As data

**Table 2. Characteristics and outcomes of patients who had first ER for clinical deterioration within and beyond 24 hours after emergency admission**

Patient characteristic or outcome	1st ER < 24 h after emergency admission (N= 167)	1st ER ≥ 24 h after emergency admission (N= 416)	P
Sex (male)*	83 (49.7%)	201 (48.3%)	0.763 <sup>†</sup>
ER activation type*			
CAT	13 (7.8%)	40 (9.6%)	0.487 <sup>†</sup>
MET	154 (92.2%)	376 (90.4%)	NA
ATS category*			
1	9 (5.4%)	5 (1.2%)	0.005 <sup>‡</sup>
2	44 (26.3%)	119 (28.6%)	0.583 <sup>†</sup>
3	93 (55.7%)	214 (51.4%)	0.353 <sup>†</sup>
4	21 (12.6%)	74 (17.8%)	0.123 <sup>†</sup>
5	0	4 (1%)	NA
Seen within ATS*			
Nursing	120 (75.9%)	255 (69.3%)	0.122 <sup>*</sup>
Medical	84 (50.3%)	197 (47.4%)	0.520 <sup>*</sup>
ER outcome*			
Stayed on ward	140 (88.6%)	337 (83.8%)	0.152 <sup>†</sup>
CCU	3 (1.9%)	6 (1.5%)	0.731 <sup>†</sup>
ICU	12 (7.6%)	56 (13.9%)	0.039 <sup>†</sup>
OR	1 (0.6%)	2 (0.5%)	0.613 <sup>‡</sup>
ED	2 (1.3%)	1 (0.2%)	0.193 <sup>‡</sup>
ER activations*			
Recurrent	18 (9.7%)	214 (34%)	<0.001 <sup>†</sup>
In-hours (0800–1800)	92 (31.3%)	75 (26%)	0.154 <sup>†</sup>
Out of hours (1801–0759)	92 (55.1%)	202 (48.6%)	0.154 <sup>†</sup>
Overnight (2200–0759)	60 (33.9%)	107 (26.4%)	0.064 <sup>†</sup>
Inhospital mortality*	27 (16.2%)	90 (21.6%)	0.153 <sup>†</sup>
Age, years <sup>§</sup>	79 (66–85)	79.5 (65–86)	0.687 <sup>¶</sup>
Waiting time, mins <sup>§</sup>			
Nursing assess.	7 (0–28)	10 (0–37)	0.324 <sup>¶</sup>
Medical assess.	25 (4–78)	31 (7–84.25)	0.224 <sup>¶</sup>
Length of stay <sup>§</sup>			
ED, hours	7.6 (5.7–10.8)	7.8 (5.3–11)	0.912 <sup>¶</sup>
Acute care, days	7 (3.25–10.75)	11 (6–19)	<0.001 <sup>¶</sup>

ER = emergency response. CAT = cardiac arrest team. MET = medical emergency team. ATS = Australasian triage scale. NA = not applicable. CCU = coronary care unit. ICU = intensive care unit. OR = operating room. ED = emergency department. IQR = interquartile range.

assess. = assessment. \* n (%). †  $\chi^2$  test. ‡ Exact test. § Median (IQR). ¶ Mann–Whitney U test.

were not normally distributed (according to the Kolmogorov–Smirnov test), medians and interquartile ranges (IQRs) are quoted. We performed between-group comparisons using the  $\chi^2$  test and the Mann–Whitney U test.

## Results

During 2012, there were 1480 emergency responses for clinical deterioration in 819 patients at the study site. Of these, 1203 responses (81.3%) were MET activations and 277 (18.7%) were CAT activations. Just over half the emergency responses for clinical deterioration were for patients admitted via the ED (55.3%; 819 responses in 587 patients). Most of these patients (428 [72.9%]) had only one emergency response during their hospital admission (Table 1).

Of the 587 patients who had an emergency response for clinical deterioration after admission via the ED, 534 (91%) were MET activations and 53 (9%) were CAT activations. The median patient age was 79 years (IQR, 65–86 years) and 299 (50.9%) were men. The triage category distribution based on the Australasian triage scale (ATS) was as follows:

- ATS 1 (immediate assessment and treatment): 14 (2.4%)
- ATS 2 (treatment within 10 minutes): 163 (27.8%)
- ATS 3 (treatment within 30 minutes): 310 (52.8%)
- ATS 4 (treatment within 60 minutes): 96 (16.4%)
- ATS 5 (treatment within 120 minutes): 4 (0.7%).

The median waiting time in the ED was 9 minutes (IQR, 0–32.75 minutes) for nursing assessment, and 30 minutes (IQR, 6–82 minutes) for medical assessment. In total, 378 patients (64.4%) were seen by nursing staff and 282 (48%) were seen by medical staff within the time period recommended for their triage category. The median ED LOS was 7.7 hours (IQR, 5.42–11 hours) and 81 patients (13.8%) had an ED LOS of less than 4 hours.

The median time from ED discharge to first emergency response was 59 hours (IQR, 22–132.6 hours). Most patients (481 [81.9%]) stayed on the ward after the first emergency response, 68 (11.6%) were transferred to the ICU, nine (1.5%) were transferred to the coronary care unit, three (0.5%) were transferred back to the ED, and three (0.5%) were transferred to the operating room. There were 23 patients (3.9%) for whom the immediate outcome after the first emergency response could not be ascertained.

## Comparison of emergency responses

The first emergency response for clinical deterioration occurred within 24 hours after emergency admission to a medical or surgical ward in 167 patients (28.4%). There were four patients for whom the time of first emergency response was unknown, so the following analysis is for 583 patients. There were no significant differences in age, sex,

waiting times or the ED LOS between patients whose first emergency response was within 24 hours of emergency admission and patients whose first emergency response was more than 24 hours after emergency admission. Patients whose first emergency response occurred within 24 hours after emergency admission were more likely to be triaged to ATS category 1 (5.4% v 1.2%,  $P=0.005$ ) but were less likely to be admitted to the ICU after the emergency response (7.6% v 13.9%,  $P=0.039$ ), and less likely to have recurrent emergency responses during their hospital stay (9.7% v 34.0%,  $P<0.001$ ). Patients whose first emergency response occurred within 24 hours of emergency admission also had a shorter median hospital LOS (7 days v 11 days,  $P<0.001$ ). These results are summarised in Table 2.

## Discussion

Analysis of all emergency responses for clinical deterioration at a major acute care hospital during 2012 showed that just over half (55.3%) were for general ward patients admitted via the ED. Most emergency responses for clinical deterioration in this patient cohort were MET activations (9% were CAT activations). This finding is lower than in other Australian studies that show the proportion of CAT activations in response to clinical deterioration ranging from 17% to 20%; however, these studies include all patients who required emergency responses for clinical deterioration, not just patients admitted via the ED.<sup>15-17</sup>

The median time from ED admission to first emergency responses for clinical deterioration was 59 hours and for just over one-quarter of patients (28.4%), the first emergency response occurred within 24 hours of emergency admission. There are few published studies on the timing of emergency responses, and none specifically focus on patients who have needed admission via the ED. A recently published multisite study of the timing of RRS calls showed that the median time between admission and RRS activation was 4 days (IQR, 1–10 days) and that 177 of 652 RRS calls (27.1%) occurred on the day of, or on the day after, admission (Day 0 and Day 1). The proportion of RRS calls on Day 0 and Day 1 was 20%–36.4% between the seven hospitals (median, 28.7%; IQR, 23.4%–31%).<sup>18</sup> This prospective observational study included all RRS calls over a 1-month period among seven hospitals during 2009, so it included patients admitted via the ED and via elective surgical pathways.<sup>1</sup> It was also unclear which wards or patient cohorts were included in or excluded from this study.<sup>15</sup>

## Triage categories

In our study, there were clear differences between patients whose first emergency response for clinical deterioration

occurred within 24 hours after emergency admission and patients whose first emergency response occurred later in their hospitalisation. Patients who had an emergency response for clinical deterioration within 24 hours of admission were more likely to be triaged to ATS category 1, to which patients with “conditions that are threats to life ... and require immediate and aggressive treatment”<sup>19</sup> are allocated. It is uncommon for ATS 1 patients to be admitted to medical or surgical wards, and ATS 1 patients tend to have high rates of admission to the ICU.<sup>20,21</sup> In our study, there were only 14 ATS 1 patients, so although the numbers are small, triage to ATS 1 should perhaps be a trigger for inpatient teams to increase physiological surveillance or to ensure regular review by senior medical or ICU liaison staff in the first 24 hours of hospitalisation.

## Recurrent activations

Recurrent emergency response activations occurred for 9.7% of patients whose first emergency response was within 24 hours of emergency admission, compared with a 34% recurrence rate in patients whose first emergency response was more than 24 hours after emergency admission. When all 587 patients who had an emergency response for clinical deterioration after emergency admission were considered, almost three-quarters (72.9%) had only one activation during their hospital stay. This finding is consistent with the findings of the only Australian study of patients with multiple MET reviews, which found that 77.5% of patients received a single MET review during an episode of hospitalisation.<sup>22</sup> The reasons for high levels of single activations are unclear and warrant further investigation. One possible explanation is that an emergency response heightens the awareness of clinicians about the vulnerability of specific patients to clinical deterioration, resulting in increased vigilance of physiological status and prompt escalation of care to the treating unit, preventing subsequent deterioration to levels requiring RRS activation. Alternatively, some emergency responses may have resulted in initiation of limitation of medical treatment (LOMT) orders. A recent multisite international study showed that an LOMT order was instituted in almost 11% of patients after an MET activation.<sup>23</sup> The same study also showed that an MET was activated in 31% of patients with a pre-existing LOMT order, so LOMT orders do not necessarily decrease the need for emergency responses, in particular MET activations for clinical deterioration.<sup>23</sup>

## ICU admissions

Patients who had an emergency response activation for clinical deterioration within 24 hours of emergency admission were less likely to need ICU admission as an outcome of their deterioration. However, ICU admission occurred for

one in eight patients overall (11.6%) and one in 12 patients (7.6%) whose emergency response for clinical deterioration occurred within 24 hours of emergency admission. These ICU admission rates are higher than national data that suggest an ICU admission rate after MET activation of 4.9%.<sup>17</sup> There is evidence that patients who need only one emergency response during their hospitalisation have lower unplanned ICU admission rates ( $P=0.025$ ),<sup>22</sup> and that may also be the case in this study. The reduction in unplanned ICU admissions may be due to the early input of senior decisionmakers with expertise in managing clinical deterioration and specialist expertise of the treating team. Although it is beyond the scope of this study, other research shows that end-of-life care decisions arise in as many as one-third of MET activations.<sup>22-25</sup> MET activation has also been associated with increased documentation of LOMT orders,<sup>26</sup> so in this study, initiation of LOMT orders after MET activation may have also influenced decisions related to the ICU admission. The timing of emergency response for clinical deterioration was not associated with a significant difference in hospital mortality rates.

### Hospital LOS

The median hospital LOS for patients whose emergency response for clinical deterioration occurred within 24 hours of emergency admission was 4 days shorter than for patients for whom the emergency response occurred after 24 hours of emergency admission. This finding may be confounded by other factors. First, there were low ICU admission rates for the patient cohort in this study. There are surprisingly few studies on the association between unplanned ICU admissions of general ward patients and hospital LOS; most of the relevant literature relates to unplanned ICU readmission. Haller and colleagues found that an unplanned ICU admission increased the median hospital LOS by 14 days in surgical patients (2 days v 6 days;  $P<0.001$ ).<sup>4</sup> Analysis of 94 482 hospital admissions by Tam and colleagues showed that an unplanned ICU admission ( $n=672$ ) increased the median hospital LOS by 3.3 days ( $P<0.001$ ).<sup>27</sup> Another recently published study showed that the median hospital LOS increased by 2.1 days ( $P<0.001$ ) in medical patients who had an unplanned transfer to the ICU within the first 24 hours of admission.<sup>28</sup> Second, the patients in our study had low recurrent emergency response rates. This relationship between recurrent emergency responses for clinical deterioration and hospital LOSs is supported by other researchers.<sup>22</sup> Calzavacca and colleagues showed that patients needing multiple MET reviews had a 50% longer hospital LOS (22 days v 13 days;  $P<0.001$ ) than patients who needed only one MET activation during their hospitalisation.<sup>22</sup> The hospital LOS outcomes reported by Calzavacca and colleagues<sup>4</sup> are more

than double those reported in our study, but they studied all 2237 MET reviews from 2005 to 2007 so were not specifically focused on patients who needed hospital admission via the ED.<sup>22</sup>

### Study limitations

There are several limitations that should be considered when interpreting our study results. First, the data were derived from the MET and code blue databases and the VEMD and VAED administrative databases, so there may have been other factors that were not assessed affecting patient characteristics and outcomes, and affecting between-group differences. Second, the immediate patient outcomes listed in the database were related to patient location and it is not known whether emergency responses for clinical deterioration changed the plan of care (eg, resulted in a new LOMT order).

### Conclusion

This study has established that over half of the emergency responses for clinical deterioration in an urban district hospital were for inpatients admitted via the ED, with one-quarter of these responses occurring within 24 hours of admission. One in eight patients needed ICU admission after an emergency response, and patients admitted via the ED constituted 55.3% of all RRS activations, resulting in the use of considerable ICU resources. Further studies exploring the predictors of clinical deterioration in patients needing emergency admission may help establish risk management strategies to reduce RRS activations.

### Competing interests

None declared.

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