Medical reviews before cardiac arrest, medical emergency call or unanticipated intensive care unit admission: their nature and impact on patient outcome

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ABSTRACT

Objective: To measure and describe the extent and consequences of documented medical patient reviews in the 24 hours before a cardiac arrest, medical emergency team (MET) call or an unanticipated intensive care unit admission ("event"), and the use of such reviews as a rapid response system performance measure.

Design: Retrospective case-note and database review.

Setting: Tertiary referral hospital, April–September, 2008.

Participants: Adult inpatients who had an event and a preceding hospital length of stay > 24 hours.

Main outcome measures: Hospital discharge status, ICU length of stay, not-for-resuscitation order.

Results: 443 patients had 575 events (6.1% cardiac arrests, 68.7% MET calls, 25.2% ICU admissions) in the study period. A documented medical review preceded 561 (97.6%) events. Patients whose review was a home team review (HTR; ie, from a general ward) only were older than those with a critical care review (CCR) (70.2 v 63.6 years; $P < 0.01$). A critical care discharge (CCD) or CCR preceded 39.5% and HTR only, 57.9% of events. A CCD preceded 25.7% of cardiac arrests, 32.4% of MET calls, and 29.0% unanticipated ICU admissions. Patients with a CCR or CCD had lower hospital mortality than those with an HTR only (27.3% v 41.7%; $P < 0.01$), and shorter median ICU length of stay (2 [interquartile range, 1–3] v 2 [interquartile range, 1–6] days; $P = 0.04$).

Conclusions: Medical reviews in the 24 hours before an adverse event are common. The type of medical review may influence patient outcome and thus may be a useful measure of rapid-response systems and critical care performance.

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Critical care areas provide critically ill patients with intense observation and treatment that cannot be provided on general wards.[1] These areas include intensive care units, high-dependency units, emergency departments (EDs), and operating theatres. Close monitoring enables early identification of patients with deteriorating conditions and allows implementation of prompt management by staff skilled in providing such care. In contrast, management of such patients on general wards is suboptimal, and associated with higher mortality rates.[2,3]

The intention of rapid-response systems is to identify and respond to patients outside the critical care environment who are at risk of progressing to a serious adverse event such as cardiac arrest, unanticipated ICU admission, or death. Typically, these patients are identified based on predefined criteria that include abnormalities in heart rate, blood pressure, respiratory rate and neurological status, and the subjective "worried" criterion.[4] The presence of any such criteria should trigger the prompt response of a rapid-response team (RRT), staffed and equipped to provide acute care not otherwise available on general wards.

Ideally, patients who have been reviewed by critical care personnel and not admitted to critical care areas, or who have been discharged from such areas, would not go on to have an adverse event or RRT call within 24 hours of such a review or discharge. In reality, resource shortages result in pressure for premature or out-of-hours discharges and limited capacity to accommodate additional patients when required.[5] Patients discharged from ICU at night or with residual organ dysfunction have higher mortality rates and are more likely to require ICU readmission, which itself is associated with poorer outcomes.[6,7] The ED is another

Abbeviations

APACHE	Acute Physiology and Chronic Health Evaluation
CCD	Critical care discharge
CCR	Critical care review
ED	Emergency department
HTR	Home team review
ICU	Intensive care unit
IQR	Interquartile range
LOS	Length of stay
MET	Medical emergency team
NFR	Not for resuscitation
RRT	Rapid-response team

example of a critical care area that can lower rates of progression to organ failure and death when appropriate acute management is provided before transfer to hospital wards.[8]

As with any clinical environment or system that has limited resources, yet has a significant impact on patient outcomes, critical care areas and their associated outreach services should have their performance monitored to enable optimal efficiency and efficacy. Key performance indicators can include patients discharged from a critical care area to a general ward, or who have been reviewed by critical care-based outreach services, and experience an adverse event shortly thereafter.

The aim of this study was to measure and describe the extent and consequences of documented medical patient reviews in the 24 hours before a cardiac arrest, RRT attendance or an unanticipated ICU admission, and the use of documented medical patient reviews in the 24 hours before a cardiac arrest, RRT attendance or an unanticipated ICU admission as a rapid-response system performance measure.

Methods

Setting

The Royal Adelaide Hospital is a 650-bed tertiary referral hospital affiliated with the University of Adelaide. Its medical emergency team (MET) system was introduced in 2003. The MET is overseen by a multidisciplinary hospital committee and a dedicated nursing MET coordinator who administers a MET database, follows up MET calls, manages MET-related Australian Incident Monitoring System reports and undertakes education. There are two types of calls — "code blue" calls and MET calls. A code blue is called in response to a cardiac arrest, respiratory arrest, threatened airway, or MET-type call to a non-ward area. The code blue team consists of an ICU doctor, two critical care registered nurses and two medical registrars. All other criteria result in activation of a MET call, which consists of two medical registrars and two ICU nurses.

Definitions

An "event" was defined as cardiac arrest, MET call, or unanticipated ICU admission (inpatient transferred from a general ward).

A medical review was defined as any one of the following in the 24 hours before, but not directly associated with, an event:

- critical care review (CCR) — MET attendance or ICU ward consultation.
- critical care discharge (CCD) — discharge from the ICU, ED or operating theatre.
- home team review (HTR) — review by the admitting team medical staff.

Study design

A retrospective case-note and database review of adult inpatients who experienced an event and whose preceding hospital length of stay (LOS) was > 24 hours.

Inclusion and exclusion criteria

Adult inpatients (aged > 16 years), within a general ward, whose hospital stay was > 24 hours were included. Patients with a code blue call that was not related to a cardiac arrest, respiratory arrest, or threatened airway were excluded, as were patients with MET calls in acute care areas (eg, ED, operating theatre) and those with a prior not-for-resuscitation (NFR) order. Unanticipated ICU admissions included patients transferred from a general ward, whether directly associated with a MET call or not, and excluded patients admitted from another acute care environment (eg, high-dependency unit, ED or operating theatre).

Data collection

Data were obtained between April and September, 2008. Code blue calls for a threatened airway and respiratory arrest were grouped with all other MET calls. Code blue calls for cardiac arrests were grouped as "cardiac arrests". Multiple events involving one patient within a 24-hour period were analysed as separate events. Data specific to a MET call (reason for call and outcome) were derived from a MET-specific database and medical-record review. ICU severity of illness measures, Acute Physiology and Chronic Health Evaluation (APACHE) II score and risk of death, and ICU LOS were derived from an ICU-specific database. Outcomes were hospital discharge status 28 days after the patient's last event, ICU LOS, and NFR order given at time of event.

When analysing for patient mortality, for patients with more than one event, analysis was based on their last event and associated preceding medical review. An audit of data accuracy based on 10% of the study records was undertaken before data analysis.

Statistical analysis

SPSS, version 15 (SPSS Inc, Chicago, Ill, USA) was used for data analysis and descriptive statistics. The χ^2 test was used to analyse primary events and their antecedents. LOS and time of day are given as median (interquartile range) and compared using the Mann–Whitney or the Kruskal–Wallis test. Other continuous data are described as the mean (SD) and comparisons made using the *t* test or one-way analysis of variance. Statistical significance was set at $P < 0.05$.

Ethics approval

Approval was obtained from and the need for informed consent waived by the Royal Adelaide Hospital Research Ethics Committee (approval no. 050516).

Table 1. Patient demographics, measures of severity illness and time of day for all events

	Cardiac arrest	MET call	Unanticipated ICU admission	Unanticipated ICU admission after MET call	*P**	All unanticipated ICU admissions	*P*†
No. of events (%)	35 (6.1%)	395 (68.7%)	39 (6.8%)	106 (18.4%)	—	145 (25.2%)	—
Male sex	37.1%	52.2%	56.4%	58.5%	0.17	57.9%	0.08
Mean age in years (SD)	74.9 (12.2)	67.5 (18.0)	61.9 (16.5)	64 (17.2)	< 0.01	63.1 (16.5)	< 0.01
Home team review only	77.8 (11.8)	70.6 (16.7)	63.2 (15.2)	65 (16.8)	< 0.01	64.5 (16.3)	< 0.01
Critical care review	81.0 (5.2)	60.9 (18.1)	64.1 (17.3)	65.2 (16.2)	< 0.01	64.8 (16.4)	< 0.01
Critical care discharge	78.3 (13.6)	64.2 (18.3)	56.1 (16.4)	61.8 (18.5)	< 0.01	60.7 (18.0)	< 0.01
P‡	0.96	< 0.01	0.41	0.48		0.44	
Mean APACHE II score (SD)	29.5 (6.2)	—	20.7 (7.5)	21.6 (7.0)	0.02	21.2 (7.1)	0.01
Mean APACHE II risk of death (SD)	0.705 (0.206)	—	0.362 (0.221)	0.377 (0.219)	< 0.01	0.372 (0.221)	< 0.01
Median ICU LOS in days (IQR)	1 (1–2)	—	2 (1–4)	2 (1–4)	0.51	2 (1–4)	0.10
Median time of day in hours (IQR)	12:15 (07:30–19:04)	12:40 (07:44–19:15)	11:45 (04:15–18:52)	14:37 (05:37–20:13)	0.94	13:00 (05:21–19:44)	0.98

APACHE = Acute Physiology and Chronic Health Evaluation. ICU = intensive care unit. IQR = interquartile range. LOS = length of stay. MET = medical emergency team. * Comparison between all cardiac arrests, MET calls, unanticipated ICU admissions, and unanticipated ICU admissions post-MET call. † Comparison between all cardiac arrests, MET calls and all unanticipated ICU admissions. ‡ Comparison between home team review only, critical care discharge and critical care review for age within each event.

Table 2. Medical reviews in the 24 hours before an event

Reviews	Cardiac arrest, no. (%)	MET call, no. (%)	Unanticipated ICU admission, no. (%)	*P*	All events, no. (%)
Any review	34 (97.1%)	386 (97.7%)	141 (97.2%)		561 (97.6%)
Home team review	33 (94.3%)	344 (87.1%)	139 (95.9%)		516 (89.7%)
Critical care review	3 (8.6%)	40 (10.1%)	36 (24.8%)		79 (13.7%)
Critical care discharge	9 (25.7%)	128 (32.4%)	42 (29.0%)		179 (31.1%)
Home team review only	20 (57.1%)	230 (58.2%)	83 (57.2%)	< 0.01	333 (57.9%)
MET call	3 (8.6%)	30 (7.6%)	24 (16.6%)		57 (9.9%)
ICU ward review	0	13 (3.3%)	16 (11.0%)		29 (5.0%)
ICU discharge	0	10 (2.5%)	11 (7.6%)		21 (3.7%)
Emergency department discharge	7 (20.0%)	77 (19.5%)	24 (16.6%)		108 (18.8%)
Operating theatre discharge	2 (5.7%)	45 (11.4%)	8 (5.5%)	< 0.01	55 (9.6%)

ICU = intensive care unit. MET = medical emergency team.

Results

Events

Over 6 months, there were 443 patients with 575 events (6.1% cardiac arrests, 68.7% MET calls, 25.2% unanticipated ICU admissions) (Table 1).

Age and sex were similarly distributed between MET calls and ICU admissions. Patients who had a cardiac arrest tended to be female and older, and those admitted to ICU had a higher APACHE II score. As there was no significant difference between demographics, severity of illness or ICU LOS, unanticipated ICU admissions both with and without a preceding MET call were combined for all subsequent analyses.

Reviews

Overall, 561 events (97.6%) were preceded by at least one medical review within 24 hours before an event; 14 events (2.4%) had no documented review. A CCR or CCD preceded 227 events (39.5%), and an HTR preceded 516 events (89.7%). There were 333 events (57.9%) that had an HTR only.

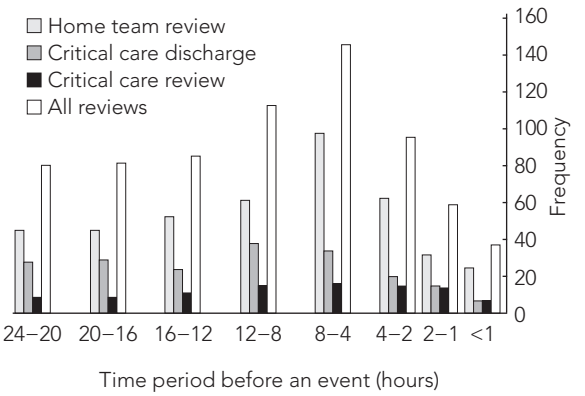
The distribution of reviews across all types of events was similar (Table 2). CCDs, in comparison to CCRs, were proportionally higher before a cardiac arrest (25.7% v 8.6%; $P < 0.01$) or a MET call event (32.4% v 10.1%; $P < 0.01$). An ED discharge was the most common type of CCD to precede any event (Table 2).

There was documentation of a review, but no documented time for 147 events among patients with HTR only (44.1%), five patients with CCR (6.3%) and one patient with a CCD (0.6%). Analysis of reviews for which an exact time was documented revealed that most reviews occurred within the 8-hour period before any event (Figure 1). Most reviews preceding a cardiac arrest occurred 12–24 hours prior; for MET calls, 4–8 hours prior; and for unanticipated ICU admissions; within 8–12 hours prior. For patients whose review was an ICU discharge ($n=21$), no patient was discharged after-hours (between 18:00 and 08:00 hours).

A nurse was more likely than a doctor to initiate a MET call (96% v 4% of all MET calls; $P<0.01$). A doctor was more likely than a nurse to call a MET for patients with a prior CCR and/or CCD (60% v 37.3%; $P=0.04$). In contrast, a nurse was more likely to call a MET for patients with a prior HTR only (59.6% v 35.0%; $P=0.03$).

Patients whose event was preceded by an HTR only were older than those whose event was preceded by a CCR or CCD (mean age, 70.1, 64.1 and 64.1 years, respectively; $P=0.002$). Age was similar for cardiac arrest patients, regardless of the type of preceding review, and for unanticipated ICU admissions. In contrast, patients whose event was a MET call preceded by an HTR only were significantly older (Table 1).

Figure 1. Occurrence of reviews in the 24-hour period before an event



Outcomes

Patients with an event preceded by an HTR only were no more likely than those with a CCR or CCD to be assigned an NFR order at a subsequent MET call (5.6% v 4.5%; $P=0.57$). Among patients admitted to the ICU, patients with a preceding HTR only did not have a significantly different APACHE II score, predicted risk of death or ICU mortality than those with a preceding CCR or CCD, but they had a significantly longer ICU LOS (Table 3).

Hospital mortality among all events was 37.7%, and highest for cardiac arrests (90.3%), followed by unanticipated ICU admissions (36.4%) and MET calls (32.8%) ($P<0.001$). Hospital mortality was not statistically significantly different between patients who did and did not have a medical review (37.2% v 71.4%; $P=0.074$). Hospital mortality was lower for patients with a preceding CCR or CCD than for patients with an HTR only, particularly for patients whose event was a MET call (Table 4).

Discussion

A medical review in the 24 hours before a cardiac arrest, a MET call or an unanticipated ICU admission was common. Only a small proportion of patients did not receive a medical review. It was common for an event to be preceded by a CCD in the 24 hours prior. Patients with events and a prior CCR or CCD had a lower hospital mortality and ICU LOS than patients with an HTR only, particularly if their event was a MET call.

Patients transferred to general wards from critical care areas who go on to have an adverse event suggests a triage

Table 3. Patient demographics, meaures of illness severity, ICU length of stay and hospital mortality for patients whose event was an unanticipated ICU admission

	Critical care review	Critical care discharge	*P*	Critical care review and critical care discharge	Home team review only	*P*
Male sex	63.9%	54.8%	0.41	60.0%	60.2%	0.98
Mean age in years (SD)	63.1 (16.5)	60.7 (18.0)	0.79	62.4 (17.5)	64.0 (16.8)	0.44
Mean ICU APACHE II (SD)	20.1 (6.6)	19.3 (7.6)	0.82	20.3 (7.1)	21.4 (8.1)	0.91
Mean ICU risk of death (SD)	0.354 (0.209)	0.301 (0.215)	0.56	0.345 (0.218)	0.377 (0.236)	0.69
Median ICU length of stay in days (interquartile range)	2 (1–4)	1 (1–2)	0.07	2 (1–3)	2 (1–6)	0.04
Hospital mortality	35.0%	22.6%	0.33	27.4%	37.9%	0.24

APACHE = Acute Physiology and Chronic Health Evaluation. ICU = intensive care unit.

Table 4. Patient hospital outcome, based upon event and corresponding preceding medical review in the preceding 24 hours

Adverse event	Hospital outcome		*P*
	Survived	Died	
All events			
Critical care review	27 (69.2%)	12 (30.8%)	
Critical care discharge	101 (75.9%)	32 (24.1%)	
Home team review only	161 (58.3%)	115 (41.7%)	< 0.01
Cardiac arrest			
Critical care review	1 (50.0%)	1 (50.0%)	
Critical care discharge	0	8 (100.0%)	
Home team review only	2 (10.0%)	18 (90.0%)	0.58
Medical emergency team call			
Critical care review	13 (76.5%)	4 (23.5%)	
Critical care discharge	77 (81.9%)	17 (18.1%)	
Home team review only	120 (62.5%)	72 (37.5%)	< 0.01
Unanticipated intensive care unit admission			
Critical care review	13 (65.0%)	7 (35%)	
Critical care discharge	24 (77.4%)	7 (22.6%)	
Home team review only	41 (62.1%)	25 (37.9%)	0.32

error at the time of discharge;[9] these events may be preventable.[10] These occurrences not only place patients at risk, but also contribute to RRT workload and place undue stress on ward areas not resourced to adequately manage critically ill patients.

These occurrences may also reflect the excessive demand placed on critical care areas, such as the ED, ICU and the operating theatre. EDs are commonly overcrowded and under pressure for early discharge of patients to the ward, particularly since the introduction of the "4-hour" ED LOS target.[11,12] Similarly, ICUs are subject to the pressures of bed shortages, resulting in inappropriate early and after-hours discharges, which increase the risk of readmission and patient mortality.[13-15] Potential considerations in mitigating adverse events following CCD are acute medical units[16] for patients discharged from the ED and high-dependency units.[17,18] Factors involved in the decision-making processes at the time of discharge of a patient from a critical care area, as well as better identification of at-risk patients and the underlying environment in which such decisions are made, require further evaluation.

There was a significantly lower mortality rate for patients with a CCR or CCD than for patients with an HTR only, particularly for patients whose event was a MET call, and a tendency for lower mortality for unanticipated ICU admissions. A possible explanation for these findings is that after a CCR, patients were brought closer to the attention of critical care-based staff and thus were more likely to receive timely ward-based therapy than those with an HTR only. A prior awareness of such patients may have facilitated subsequent ICU admission. Timely transfer of critically ill patients is associated with reduced ICU LOS and hospital mortality.[3,19,20] Time spent and early management in ED also positively affect patient outcomes.[8]

Although nurses typically made most MET calls, ward-based doctors were more likely than nurses to trigger a subsequent MET for patients with a prior CCR or CCD. This may suggest that a prior CCR or CCD acted as an indicator to highlight at-risk patients and resulted in ward-based doctors having more direct involvement with these patients.

Patient age was a significant discriminator for an event and associated review. Patients with an HTR only were older than those who had a CCR or CCD. Patient selection based on age may, in part, explain the higher mortality associated with the HTR-only group. Patients who had an HTR only and a subsequent unanticipated ICU admission were younger than those with an HTR only and a subsequent cardiac arrest or MET call. In contrast, patients with a CCR or CCD were of similar age regardless of the subsequent event. This suggests that ward-based medical staff use age as a significant discriminator when conducting triage referral of patients to critical care. However, our study population only included patients intended for active treatment (ie, they did not have an NFR order), and patients within the HTR-only group were no more likely to have an NFR order at subsequent MET calls. Similarly, it may indicate increased errors in medical judgement in relation to older patients. Further exploration is needed of factors influencing ward-based decisions and type of medical review and of the extent to which patient outcome was truly affected by a CCR or an HTR.

This study is important as it has described the extent of medical review before significant adverse events, and its association with patient outcomes. Ideally, there should not be a CCD or CCR before an adverse event. Thus, reporting on and further investigating the contributors to events with preceding medical reviews, particularly CCRs or CCDs, is a valuable performance measure. The distribution of reviews in the 24-hour period before an event varied, with most reviews being closer to the time of a MET and unanticipated admission, suggesting a greater potential for prevention among those events than for cardiac arrest.

Unfortunately, overall documentation of the time of reviews was poor, and this weakens the validity of our findings based around the time distribution of reviews and

events. Other weaknesses are our study's retrospective design and the reliance on relevant data being documented in the patient medical records.

Conclusions

The type of medical review preceding an adverse event influences hospital mortality and ICU LOS. The monitoring, analysing and reporting on adverse events and their preceding medical reviews may be a useful performance measure of rapid-response systems and critical care areas.

Competing interests

None declared.

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