


ORIGINAL ARTICLE

Medical Emergency Team call within 24 h of medical admission with a focus on sepsis: a retrospective review

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Key words

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Abstract

Background and Aims: Clinical deterioration within the first 24 h of patient admission triggering a Medical Emergency Team (MET) call is a common occurrence. A greater understanding of these events, with a focus on the recognition and management of sepsis, could lead to quality improvement interventions.**Methods:** A retrospective observational review of general and subspecialty medical admissions triggering a MET call within 24 h of admission at a quaternary Australian hospital.**Results:** 2648 MET calls occurred (47.9/1000 admissions), 527 (20% of total MET events, 9.5/1000 admissions) within 24 h of admission, with the trigger more likely to be hypotension (odds ratio: 1.5, $P = 0.0013$). There were 263 MET calls to 217 individual medical patients within 24 h of admission, of which 84 (38.7%) were admitted with suspected infection, 69% of which fulfilled sepsis criteria. Of these, 36.2% received antimicrobial therapy within the recommended timeframe and 39.6% received antibiotics in line with hospital guidelines. Sepsis was initially missed in 11% of patients. Afferent limb failure occurred in 29% of patients with 40.5% experiencing a failure of the ward-based response to deterioration prior to MET call. Median hospital length of stay was increased in patients admitted with suspected infection (7 vs 5 days, $P = 0.015$) and in those with sepsis not receiving antimicrobial therapy within guideline timeframes (9 vs 4 days, $P = 0.017$).**Conclusion:** There is a significant opportunity to improve care for patients who trigger a MET within 24 h of admission. This study supports the implementation of a hospital sepsis management guideline.

Introduction

Recognising and responding to deteriorating patients is one of the eight national safety and quality health service standards in Australia.¹ To identify patient deterioration in the state of Queensland (QLD), a validated early warning system (EWS), the QLD Health's Adult-Deterioration-Detection System (Q-ADDS), has been implemented.² Such multitiered, graded activation systems, which can be modified by senior clinicians if deemed clinically appropriate, are designed to initially trigger a ward-based response to patients with less severe physiological derangements.^{1,3,4} The goal is to manage and prevent

further clinical deterioration in a ward-based setting.⁵ Medical Emergency Teams (METs) respond to the most severely deteriorating ward patients.⁶ This rapid response system (RRS) has been shown to reduce in-hospital cardiac arrest (IHCA), emergency admission to intensive care unit (ICU) and unexpected deaths.^{7,8} However, adherence to and use of these tools and processes can be poor.^{9,10}

Afferent limb failure (ALF) is the presence and documentation of escalation criteria without the triggering of an appropriate response.¹¹ This is a significant issue in mature RRSs.¹² Delays in escalation are associated with increased emergency admission to ICU and in-hospital mortality.¹³ Failure of the ward-based response to EWS triggers to prevent further deterioration are less well

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understood.¹⁴ This is presumed to influence patient outcomes, but their effect on preventing clinical deterioration is unclear.¹⁴

MET calls within the first 24 h of patient admission have been identified as an area for review. Physiological abnormalities are often present in the emergency department (ED) or at the time of admission, and this cohort may be at increased risk of adverse outcomes.^{15,16} Sepsis, a significant cause for hospitalisation in Australia, has been identified as a common cause for hospital presentation and early inpatient deterioration triggering a MET review.¹⁷

Sepsis is associated with increased mortality, ICU admission and hospital length of stay (LOS) compared to non-sepsis patients.¹⁸ The QLD state-wide ED sepsis pathway is associated with reduced need for ICU admission and lower in-hospital mortality.¹⁹ Current literature suggests that implementation of a ward-based sepsis intervention also improves patient outcomes.²⁰

We hypothesised that a greater understanding of MET call events occurring within the first 24 h of patient admission, with a subanalysis of patients with sepsis, could identify areas where quality improvement interventions could occur. Our aim was to initially establish the baseline incidence and characteristics of our hospital's MET call events to define the RRS performance. We then aimed to further describe the cohort of medical patients triggering a MET call within 24 h of admission from the ED, the incidence of preceding clinical events prior to a MET call in reference to the hospital Q-ADDS, and the incidence of infection and adherence to the state-wide sepsis pathway and compare diagnostic fidelity through the patient journey, all in reference to patient outcomes.

Methods

Setting

A retrospective observational study was conducted at the Royal Brisbane and Women's Hospital (RBWH) from 1 July 2020 to 30 June 2021. The RBWH is a 1000-bed university-affiliated quaternary adult public hospital located in Brisbane, QLD, Australia.

All admissions to the RBWH who triggered a MET call within the study period were included in this study to define system activity. Patients were identified from an existing hospital RRS database. Patient and event characteristics were extracted from review of the clinical documentation through the electronic medical record (EMR). Further assessment was conducted on the general and subspecialty medical admissions triggering a MET call within 24 h of admission from the ED. Admissions were defined as patient separations lasting over 24 h. Surgical

patients were excluded from this subanalysis because of differing staffing profiles for patient admission and review and a lack of routine surgical attendance at the MET call event. Haematology and oncology patients were excluded because of existing sepsis management guidelines for febrile neutropenia. In our hospital, the MET is staffed at all hours by a senior medical registrar, senior intensive care nurse and supporting resident medical officers. Primary treating teams are also expected to attend during hours, with covering on-site registrars after hours. ICU medical attendance occurs at all cardiac arrest and airway emergencies but is otherwise at the discretion of MET personnel.

In our hospital, deranged patient vital observations are scored per the Q-ADDS, with higher cumulative scores triggering a corresponding escalation, as detailed in Table 1. The pre-MET medical ward-based tiered response to mild patient observation derangements (cumulative Q-ADDS score 4–5) initially triggers a resident medical officer review, expected to occur within 30 min of notification. Moderate derangements (cumulative Q-ADDS score 6–7) trigger a registrar review, expected to occur within 30 min of notification. A failure to attend triggers an escalation to the next senior response tier. Severely deranged observations (Q-ADDS score ≥ 8) trigger an immediate MET call.

The study period included the second wave of the coronavirus disease 2019 pandemic in Australia, June to November 2020, which predominantly occurred in Victoria, minimally impacting our hospital.

Ethics approval was provided by the hospital ethics and governance committee (QRBW/81728).

Study population data collection and definitions

Diagnosis was also extracted from EMR as documented by the most senior treating clinician at each event. For each patient, the Clinical Frailty Score (CFS) and Charlton Comorbidity Index (CCI) were determined.^{21,22} Sepsis was defined by the presence of infection and a quick Sequential Organ Failure Assessment score of 2 or more.²³ Infection was confirmed by review of the medical, pathology and radiology records. QLD state-wide ED sepsis pathway recommends that empirical antibiotics, based on the most likely source of infection, be initiated within 1 h for patients with septic shock, or within 3 h for those with sepsis.

Q-ADDS escalation and observation monitoring instructions and MET call triggers are demonstrated in Table 1.

ALF was defined as the presence of documented escalation criteria for resident or registrar review or MET call, occurring prior to the sentinel MET event, but no

Table 1 Hospital escalation and observation monitoring as per QLD Health Q-ADDS

Q-ADDS score	Observations (minimum frequency)	Notify	Escalate (if no review)
0	As per local protocol	N/A	N/A
1–3	4 hourly	- Nursing Team Leader	N/A
4–5	1 Hourly	- Nursing Team Leader - Resident review within 30 min	If no review after 30 min call Registrar
6–7	½ hourly	- Nursing Team Leader - Registrar review within 30 min	If no review after 30 min, or if concerned, initiate Emergency Call
≥8 or E	10 minutely	Initiate Emergency Call	Registrar to ensure Consultant is notified
MET criteria	Event	Airway threat Respiratory or cardiac arrest Q-ADDS score ≥8 New, repeated or prolonged seizure Oxygen saturation <90% without response to oxygen Sedation score of 3 Clinical concern	
	Vital observations	Respiratory rate ≥36 or ≤8 Oxygen delivery >15 L/min or ≥60% Systolic blood pressure <80 Heart rate ≥160 or <40 Conscious response only to Pain (AVPU scale)	

AVPU, alert, voice, pain, unresponsive; Q-ADDS, QLD Health's Adult-Deterioration-Detection System.

escalation occurring as per hospital protocols. Failure of the ward-based response to EWS triggers was defined as any pre-MET call resident of registrar review which occurred prior to a MET call trigger. Diagnostic fidelity was defined by comparison with that documented at the first review by senior attending consultant after admission.

Analytic methods

Categorical variables are expressed as numbers with percentages where applicable. SPSS Statistics was used to compare two categorical variables where appropriate to calculate odds ratios (ORs) and 95% confidence intervals (CIs), with statistical significance of two-sided *P* values set at <0.05. Non-parametric data are presented as a median and interquartile range, and the Mann–Whitney *U* test is used for comparison of such data with dichotomous outcomes.²⁴

Results

Hospital MET call characteristics and outcome

Over the study period, there were 2648 MET calls, at an event rate of 47.9/1000 admissions, with a breakdown per admitting service detailed in Table 2. There were 33 IHCA's (0.6/1000 admissions), 144 unplanned ICU admissions from MET events (2.6/1000 admissions) and an in-hospital mortality for patients triggering a MET call

of 16%. Five hundred and twenty-seven MET calls occurred within 24 h of patient admission from the ED (9.5/1000 admissions), representing 20% of total MET events. Comparison of these events versus those occurring at other times is presented in Table 3. MET triggers within 24 h of admission were more likely to be for hypotension (OR: 1.5, *P* = 0.0013) or new/prolonged seizure activity (OR: 2.1, *P* < 0.0001).

General and subspecialty medical patients trigger a MET call within 24 h of admission

There were 252 MET events, within 24 h of admission, to 217 individual patients, median age 65 (50–77) years, admitted under a general or subspecialty medical team, representing 19.7% of total MET calls to this cohort. Patient characteristics are shown in Table 4 and MET triggers in Table 5.

Table 2 MET call number and event rate per hospital service department

Department	<i>N</i> (%)	Rate (/1000 admissions)
Total	2648	47.9
Medicine	1154 (44%)	104.2
Surgery	930 (35%)	56.3
Cancer care	380 (14%)	149
Psychiatry	69 (3%)	17.1
Women's	103 (4%)	6.1

MET, Medical Emergency Team.

Table 3 MET call event and trigger within and beyond 24 h of admission

		Within 24 h of admission	Beyond 24 h of admission	P value
Event type	Total	527	2121	-
	Cardiac arrest	5	28	0.5
	MET call	522	2093	0.96
	In-hours	182	740	0.92
	After-hours	345	1381	0.94
Trigger	Q-ADDS ≥ 8	27	121	0.62
	Hypoxia	37	212	0.56
	Tachycardia	42	218	0.14
	Bradycardia	15	49	0.48
	Tachypnoea	40	212	0.12
	Bradypnoea	21	91	0.76
	Hypotension	106	287	0.0013
	Decreased level of consciousness	91	435	0.17
	New/alterd neurology	15	61	0.97
	New/prolonged seizure	50	95	< 0.001
	Clinical concern	74	299	0.98
	Airway threat	9	39	0.84
Admitting department	Medicine	263	891	0.044
	Surgery	137	793	0.0005
	Oncology	79	301	0.68
	Mental Health	6	63	0.026
	Women's	35	68	0.0007

MET, Medical Emergency Team; Q-ADDS, QLD Health's Adult-Deterioration-Detection System.

In-hospital mortality for this cohort was 39 (18%), with increasing age associated with increased in-hospital mortality, notably for patients older than 60 years (OR: 10.72, 95% CI: 3.18–36.1). Median CFS was 3 (2–5), with increased frailty associated with increased in-hospital mortality, notably for patients with CFS >3 (OR: 5.14, 95% CI: 2.3–11.5). Median CCI was 4 (1–6), with increased in-hospital mortality for patients with CCI >3 (OR: 3.56, 95% CI: 1.6–7.75). Twenty-seven (12.4%) patients had a valid pre-existing acute resuscitation plan (ARP), 19 (9%) had an ARP completed on admission, and 46 (21.2%) had a valid ARP at the time of MET call. Median hospital length of stay (LOS) for the study cohort was 5 (3, 12) days.

Twenty-seven patients (12.4%) triggered more than one MET event within the first 24 h of admission. There was no increased risk of in-hospital mortality in this cohort (OR: 1.04, 95% CI: 0.37–2.87). All recurrent MET events in individual patients were for the same indication.

Modification of MET calling criteria occurred for 27 (12.4%) patients on admission, of which two-thirds were temporary, with 52% for respiratory and 44% for cardiovascular indications. Following the MET event, 92 (42.4%) patients' calling criteria were modified, of which 85.8% were temporary, with 47.8% for respiratory, 29.3% for cardiovascular and 22.8% for neurological

indications. After senior consultant review, following the MET event, 60 (27.6%) patients' calling criteria were modified, of which 73.3% were temporary, with 63.3% for respiratory and 25% for cardiovascular indications.

MET events were deemed to be for the same reason as their presentation to hospital in 138 (64%) cases, whereas 79 (36%) were for new issues not documented during hospital admission. There was no increased risk of in-hospital mortality between these cohorts (OR: 1.02, 95% CI: 0.5–2.08). Where applicable, the diagnostic agreement between the admitting medical officer and MET was 90%, with 10% disagreement. There was no increased risk of in-hospital mortality between these cohorts (OR: 1.8, 95% CI: 0.67–5.05). In comparison to senior clinician diagnosis, there was disagreement with admission diagnosis in 24 (12.4%) patients and disagreement with MET diagnosis in 18 (9%) patients. Patients with senior clinician diagnostic disagreement from admission or MET did not have an increased risk of in-hospital mortality (OR: 1.5, 95% CI: 0.56–3.85 and OR: 1.62, 95% CI: 0.56–4.65).

Infection

Eighty-four (38.7%) patients were admitted with suspected infection, of which 20 died in hospital (23.8%, OR: 1.875, 95% CI: 0.93–3.77). These patients were

Table 4 Demographics of medical patients triggering MET call within 24 h of admission from ED

		N	%
Sex	Male	114	52.5
	Female	103	47.5
Age	0–20	4	2
	21–30	13	6
	31–40	16	7
	41–50	23	11
	51–60	31	14
	61–70	48	22
	71–80	41	19
	81–90	25	12
	91–100	16	7
Admitting Medical Team	General medicine	86	39.6
	Cardiology	33	15.2
	Neurology	26	12
	Renal medicine	25	11.5
	Stroke	17	7.8
	Respiratory	13	6
	Gastroenterology	4	1.8
	Obstetric medicine	4	1.8
	Immunology	1	0.5
	Endocrinology	1	0.5
MET trigger	Decreased level of consciousness	49	19.4
	Hypotension	44	17.5
	Clinical concern	34	13.5
	New/prolonged seizure	30	11.9
	Tachypnoea	25	9.9
	Tachycardia	18	7.1
	Hypoxia	12	4.8
	New/alterd neurology	12	4.8
	Q-ADDS ≥ 8	11	4.3
	Bradycardia	6	2.4
	Bradypnoea	6	2.4
	Cardiac arrest	3	1.2
	Airway threat	2	0.8

ED, emergency department; MET, Medical Emergency Team; Q-ADDS, QLD Health's Adult-Deterioration-Detection System.

Table 5 Indications for MET call to medical patients within 24 h of admission from ED

MET trigger	Number	%
Decreased level of consciousness	49	19.4
Hypotension	44	17.5
Clinical concern	34	13.5
New/prolonged seizure	30	11.9
Tachypnoea	25	9.9
Tachycardia	18	7.1
Hypoxia	12	4.8
New/alterd neurology	12	4.8
Q-ADDS ≥ 8	11	4.3
Bradycardia	6	2.4
Bradypnoea	6	2.4
Cardiac arrest	3	1.2
Airway threat	2	0.8

ED, emergency department; MET, Medical Emergency Team; Q-ADDS, QLD Health's Adult-Deterioration-Detection System.

predominantly admitted under general medicine (55 patients), respiratory (nine patients) and nephrology (eight patients). For these patients with suspected infection, 58 (69%) fulfilled sepsis criteria. A complete septic screen was completed for 45 (54%) with a lactate measured in 62 (73.8%) patients. Sepsis was associated with an increased risk of in-hospital mortality for the cohort with suspected infection (OR: 2.84, 95% CI: 1.05–7.74) and across the entire cohort of patients triggering a MET call within 24 h of admission (OR: 3.96, 95% CI: 1.94–8.07).

For the cohort with suspected infection, 7/84 (8.3%) did not receive antimicrobial therapy. In the cohort meeting sepsis criteria, 21/58 (36.2%) received antimicrobial therapy within the recommended timeframe, and 23/58 (39.6%) received antibiotics, in line with hospital guidelines. There was no increased risk of in-hospital mortality in patients not receiving timely antibiotics (OR:

0.4, 95% CI: 0.14–1.19), but there was a trend towards increased in-hospital mortality for those not receiving guideline-directed antimicrobial therapy (OR: 2.46, 95% CI: 0.73–8.36).

Based on senior clinician review and current definitions, sepsis was missed at admission in 24/217 (11%) of medical patients triggering a MET call within 24 h of admission of which 7/24 (29.2%) died in hospital. Of this cohort, 16/24 were admitted under general medicine. On review by the MET sepsis was missed in 10/217 (4.6%) medical patients triggering a MET call within 24 h of admission, with four dying in hospital.

For those admitted with suspected infection LOS was 7 (4–15) days, whereas it was 5 (2–9) for those without suspected infection ($P = 0.015$). In the cohort with sepsis who received antibiotics within the guideline timeframe, LOS was 4 (3–10) days, and for those beyond the timeframe it was 9 (6–16) days ($P = 0.017$). For patients with sepsis who did and did not receive guideline-directed therapy, median LOS was 8 (5–14) and 7 (3–15) respectively ($P = 0.56$).

Afferent limb failure

Between medical admission from the ED and MET trigger, there were 134 instances of ALF, with at least one such event occurring for 63/217 (29%) individual patients, with more than one episode occurring for 32 (50.7%) patients. ALF was defined as a failure to trigger a resident review in 50/134 (37.3%), registrar review in 38/134 (28.4%) and MET call in 46/134 (34.3%) cases. The predominant errors were lack of escalation in 71/134 (53%), incorrect escalation of patient care to a lower tier of the Q-ADDS escalation pathway in 29/134 (21.6%) and a failure to correctly calculate deranged observations in 19/134 (14.2%) instances. There was a trend towards increased risk of in-hospital mortality in patients experiencing at least one ALF for this cohort (OR: 1.7, 95% CI: 0.82–3.5).

Failure of the ward-based response to EWS triggers

Between medical admission from the ED and MET trigger, 88 (40.5%) patients' care was escalated by ward staff for at least one medical review prior to MET call, of which 68 (43%) were to resident medical officers and 90 (57%) to registrars. Care was escalated for medical review once for 53 (21%), twice for 25 (10%) and three times for 10 (4%) patients prior to MET event. There was a failure to review in 57 (32%) instances and delayed review in 10 (5.6%) instances. There was a trend towards an increased risk of in-hospital mortality in

patients who experienced one or more episodes, where, despite care escalation, a subsequent MET call occurred (OR: 1.9, 95% CI: 0.96–3.9).

Discussion

This study has five major findings. First, MET calls to patients within 24 h of admission from the ED were a significant component of overall RRS activity. Second, the cohort of medical patients triggering a MET within 24 h of hospital admission were a generally older, vulnerable and comorbid population, with increasing age, frailty and comorbidity associated with increased risk of in-hospital mortality. Third, there was good diagnostic fidelity across the study. Fourth, rates of infection and associated sepsis in medical patients triggering a MET call within 24 h of admission were significant, with poor clinician recognition and response, and associated poor patient outcomes. Finally, there was a significant incidence of ALF and failure of the ward-based response to EWS triggers to prevent further clinical deterioration and subsequent MET call, with an associated increased risk of in-hospital mortality.

The event rate of MET calls in our hospital was comparable to the current published literature. However, our cohort had a lower IHCA, unplanned ICU admission and in-hospital mortality rate.^{25,26} This could suggest our mature RRS is working as intended, with a balance between event rates and patient outcomes.^{8,27} In comparison to all hospital MET events, those occurring within the first 24 h of admission from the ED were more commonly triggered for hypotension and new or prolonged seizure, suggesting underrecognition or undertreatment of diseases leading to such deranged physiology, such as sepsis in those with hypotension.²⁸

The described cohort of medical patients triggering a MET call within 24 h of hospital admission are in line with previously described populations, trending towards an older, frail and comorbid population.^{4,13} Patients were more likely to be admitted under general medicine, where patient characteristics and pathology are more heterogeneous.²⁹ As is known, patients who were older, frailer and more comorbid were at higher risk of in-hospital mortality.^{30,31}

Initial utilisation of EWS modification in this cohort was less than that reported in the literature; however, it increased following MET event to levels in line with that reported.^{9,32} Under utilisation of temporary modifications may suggest an incomplete appreciation of deranged physiology and temporary need for acceptance to allow for response to therapy.³³

Diagnostic agreement among the admitting medical officer, attending MET and attending consultant was

high. This suggests that it may not be diagnostic, but management issues drive MET events within the first 24 h of admission.³⁴ Although diagnostic errors were not overly prevalent in our cohort, they can still have significant consequences for patient outcomes, with missed sepsis in approximately 10% of patients.³⁵

Our study demonstrated poor compliance in the management of sepsis per hospital guidelines and reflected a known associated increased risk of in-hospital mortality.¹⁸ As is well described, there was a trend towards increased in-hospital mortality in circumstances of inappropriate antibiotic selection and a significantly increased LOS for patients who received antibiotics beyond the recommended timeframe.³⁶

Recognition and escalation of care for deteriorating patients, in line with the hospital EWS, is known to be poor, and this was reflected in our cohort. It has been demonstrated, and there was a trend in our study that such failures to respond to clinical deterioration are associated with an increased risk of in-hospital mortality and increased LOS.^{11,30,37} Instances where a ward-based response to EWS triggers failed to prevent further deterioration and MET call, suggesting that any medical intervention enacted failed to prevent further clinical deterioration.^{38,39}

The limitations of the study include its retrospective, cross-sectional, observational nature, with resultant selection bias and limited control for confounding. Use of organisational databanks and retrospective data collection from medical records does not account for incomplete documentation and temporal relationships with associated misclassification bias potentially overstating outcomes. A lack of comparison arm limits the statistical analysis and generalisability across the hospital system. Numbers within our study limit the statistical power of results. Our study comprises a selective, unwell cohort, but it has been suggested that MET events can be used as surveillance to detect medical errors and identify underlying processes as impetus for hospital-wide quality improvement.⁴⁰ Despite the fact that it was a single-centre study, our RRS event rates, cohort and outcomes are comparable to current published literature in this area.

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To our knowledge, this is the first study to assess the characteristics of MET events within 24 h of admission, with a focus on sepsis identification and management, pre-MET events and medical diagnostic agreement. Although it could be argued that MET rates in this study appear low, in the context of total hospital admissions, the review of deteriorating patients and staffing of an RRS requires considerable resources. MET events may also be representative of wider clinical care within a hospital environment. Our results add evidence to support the implementation of a sepsis management guideline beyond the bounds of the ED through integration into medical admission and MET processes.^{41,42} Results of this study suggest that this may improve patient outcomes and reduce hospital LOS. This study also adds to the literature highlighting the complexity of ALF and ward-based response to clinical deterioration and raising the need to further understand how medical staff currently respond to deteriorating hospital patients.

Conclusion

This study highlights the complex area of recognising and responding to acute clinical deterioration within the first 24 h of hospitalisation. Infection and associated sepsis are a major cause for admission in this cohort of patients. A delayed time to treatment with antibiotics is associated with a longer LOS. Improved diagnostic and management fidelity has the potential to enhance patient outcomes. Improved adherence to and broader implementation of sepsis guidelines may reduce inpatient mortality and hospital LOS. More research is required to better understand ALF and the ward-based response to clinical deterioration.

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