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Characteristics and outcomes of patients receiving review requests for pre-medical emergency team deterioration: a cohort study

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Abstract.

Objective. The aim of this study was to describe the epidemiology of pre-medical emergency team (pre-MET) reviews, including patient characteristics, the frequency and nature of triggers and interventions and in-hospital outcomes.

Methods. An exploratory retrospective cohort study was performed using a medical record audit. Fifty orthopaedic and general medicine patients at a hospital in Melbourne, Australia, with requests for pre-MET reviews in 2016 were included. Descriptive analyses were performed.

Results. The median patient age was 80 years (interquartile range 19 years). Most patients were female (64%), general medical patients (82%), with limitation of medical treatment orders (52%) and modified pre-MET triggers (42%). Documented pre-MET reviews occurred for 68% of requests. Tachypnoea (24%) and staff worry (24%) were the most common pre-MET triggers. One-third of patients received two clinical interventions. One in five patients had repeat requests for a pre-MET review within 12 h. In-hospital mortality was 12%.

Conclusions. Most requests for pre-MET reviews related to older female patients. Clinician adherence to pre-MET policy was variable. Multicentre studies are needed to inform improvements to pre-MET strategies.

What is known about the topic? Australian hospitals have introduced multi-tiered rapid response systems (RRSs) that consist of pre-MET review to comply with accreditation standards. Pre-MET reviews are triggered by early signs of clinical deterioration and are provided by admitting medical teams or senior nurses. There is limited understanding of the characteristics and outcomes of patients receiving pre-MET reviews for early clinical deterioration.

What does this paper add? In a cohort of orthopaedic and general medicine patients, most patients receiving requests for pre-MET reviews were older, female medical patients, with existing modifications to pre-MET triggers. Most requests for pre-MET review were for tachypnoea or staff worry; the latter included clinical problems not addressed by predefined organisational triggers. One in five patients continued to deteriorate within 12 h of the pre-MET request. Clinician adherence to pre-MET policy varied.

What are the implications for practitioners? Patients in this study frequently deteriorated in ways that did not breach predefined pre-MET triggers, demonstrating that pre-MET requests are made for a range of clinical concerns. Doctors and nurses must be vigilant for ongoing clinical deterioration in patients receiving requests for pre-MET reviews. Reflecting the timing of the recent introduction of the pre-MET review system, variable adherence to pre-MET policy raises questions about clinicians' awareness of and responsibilities in this RRS tier, the impact of workloads on RRS response capability and the suitability of existing escalation policies. Evaluation of the implementation of pre-MET review is warranted.

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Introduction

Clinical deterioration in hospital patients results in morbidity and mortality.[1] Rapid response systems (RRSs) help clinicians (nurses and doctors) to recognise and respond to deteriorating patients to prevent in-hospital cardiac arrest and improve patient outcomes.[2] The afferent ('detector') limb of RRSs facilitates timely recognition of clinical deterioration and prompts escalation of care.[3] The efferent ('response') limb of RRSs in Australia commonly includes a medical emergency team (MET).[4] METs are physician-led teams of intensive care unit (ICU) clinicians who manage deteriorating ward patients at the point of care.[2,4]

In-hospital mortality of patients who have a MET review is 24–32%, which is higher than for general hospital (1.6–2.5%) and ICU (13.8%) patients.[5–10] To address the high mortality of patients who have MET reviews, pre-MET review was implemented.[11–14] In Australia, a tiered approach to recognising and responding to clinical deterioration is recommended in the national consensus statement Essential Elements for Recognising and Responding to Clinical Deterioration[1] and the National Safety and Quality Health Service Standards.[15] Pre-MET reviews are triggered by earlier clinical deterioration than MET reviews. Responses are by patients' admitting medical teams (or covering doctors) or senior ward nurses.[12,13] Other names for pre-MET reviews include clinical review criteria,[13] multidisciplinary team reviews[16] and urgent clinical reviews.[12]

As many as 47% of patients fulfilling pre-MET triggers have escalation of care using the pre-MET policy.[13] There is a limited understanding of the characteristics and outcomes of patients who have pre-MET triggers, and the types of clinical interventions provided.[17] Greater understanding of pre-MET reviews is vital to support policy makers and clinicians to tailor pre-MET strategies to their intended patient cohorts and to inform future risk management strategies.

The aim of this study was to describe the epidemiology of pre-MET reviews, including patient characteristics, the frequency and nature of triggers and interventions and in-hospital outcomes.

Table 1. Pre-MET triggers used at the study site
Worry was defined as a worry or concern about a patient who did not fit the other criteria. SpO_2, peripheral oxygen saturation

Trigger	Value
Respiratory rate (b.p.m.)	<10 or >24
Unrelenting shortness of breath	–
SpO_2	≤94%
Systolic blood pressure (mmHg)	<100 or >180
Heart rate (b.p.m.)	<50 or >100
Increasing or unexpected fluid or blood loss	–
New presence of oliguria	–
Temperature (°C)	≤35.5 or ≥38.0
Any change in consciousness or mental state	–
Staff worry	–

Methods

An exploratory retrospective cohort study using medical record data was undertaken. Human Research Ethics Committee approvals were granted by the university (2016–275) and study site (LNR/16/Austin/260), including a waiver of patient consent. The study site was a 400-bed public tertiary referral hospital in Melbourne, Australia, with a mature RRS. The MET was introduced in 2000, with pre-MET review ('urgent clinical review' at the site) added to the RRS in 2012. Pre-MET triggers are presented in Table 1.

In line with local pre-MET policy, to request a pre-MET review, clinicians (mostly nurses) were instructed to send a pager message to the intern (first-year doctor) or resident (second- or third-year doctor) directly. Nurses were instructed to page more senior doctors if the patient was not reviewed within 30 min. The process for escalating care using a pre-MET review is summarised in Fig. 1 and explained in further detail elsewhere.[18] The pre-MET review was to be documented in the patient's medical record. There was no designated hospital-wide database or registry to track pre-MET review requests or actual pre-MET reviews retrospectively.

Because this study was exploratory in nature and there was no database from which to randomly select the sample, our

Fig. 1. Escalation procedure for a pre-MET review. UR, unique record.

sampling was based on the existing hospital system of pre-MET pager messages. Because most patients cross pre-MET thresholds before having a MET review,[12] the hospital MET database showed that the general medical and orthopaedic surgery units had the highest frequency of MET reviews. Sequential convenience sampling was used to identify a sample of 50 adult (age ≥18 years) patients admitted to the general medical or orthopaedic surgery unit who had pre-MET reviews requested.

Patients who had a pre-MET review request via the paging system between 23 August and 5 October 2016 were eligible for inclusion. Patients were only included once at their first pre-MET review request. Subsequent requests for pre-MET reviews were collected as patient outcomes. To identify relevant patients, the hospital's information technology department generated reports of pager messages sent to 34 pager numbers that were used by general medicine and orthopaedic surgery doctors. Pager messages were then hand-searched by one researcher (MM) for requests for patient reviews or variations of these terms (Fig. 2).

The data collected from patients' medical records by one researcher using a structured data collection tool and data dictionary were: patient characteristics (demographics, medical history, admitting unit, principal diagnosis, resuscitation plan); the characteristics of the requested pre-MET reviews (trigger, time from request to review, interventions, review outcome); and in-hospital patient outcomes (immediate discharge destination, repeat requests for pre-MET reviews, MET reviews, cardiac arrests, ICU admissions, death, hospital length of stay (LOS)).

The data collection tool was tested on five patients to establish usability and content validity. The final version of the tool was reviewed by coauthors (JCu, JCo, DJ) who are experts in RRS research, addressing face validity. Because a single researcher (MM) collected data, inter-rater reliability testing was not conducted. Descriptive analyses (frequencies, percentages, measure of central tendency and dispersion) were conducted using SPSS version 22 (IBM Corp.).

Results

In all, 7140 pager messages were sent during the study period. Of these, 191 related to a review, so were analysed further to identify the first 50 patients who had a pre-MET review requested (Fig. 2). For 68% of patients ($n = 34$), requests were associated with a documented pre-MET review from doctors. It was unclear whether the remaining 16 patients (32%) received medical reviews with no associated documentation, or whether the medical reviews were not conducted. Half the documented pre-MET reviews ($n = 17/34$) occurred within the expected 30-min time frame; however, time was undocumented for 15% ($n = 5/34$).

Patient characteristics

Patient characteristics are presented in Table 2. The median age was 80 years (interquartile range (IQR) 19 years). Most patients were female (64%; $n = 32$), admitted under the general medical unit (82%; $n = 41$) and were from home (76%; $n = 38$). Respiratory (26%; $n = 13$) and cardiovascular (16%; $n = 8$) diagnostic conditions were consistent with most participants being admitted under general medical (82%). Approximately one-third of patients (36%; $n = 18$) were not admitted to their team's dedicated ward. Limitation of medical treatment (LOMT) orders existed for 52% ($n = 26$) of patients. Twenty-one patients (42%) had modified pre-MET triggers before the pre-MET review request.

Characteristics of requests

Sixteen per cent ($n = 8$) of patients had two pre-MET triggers at the time of the pre-MET review request. Of 50 pager messages analysed, 98% ($n = 49$) did not include the required details as outlined in the policy (Fig. 1). Pre-MET reviews were requested more frequently during the day (0700–1659 hours; 64%; $n = 32$) than overnight (1700–0659 hours; 36%; $n = 18$), and occurred at a median of 2.5 days (IQR 6.25 days) after admission to hospital.

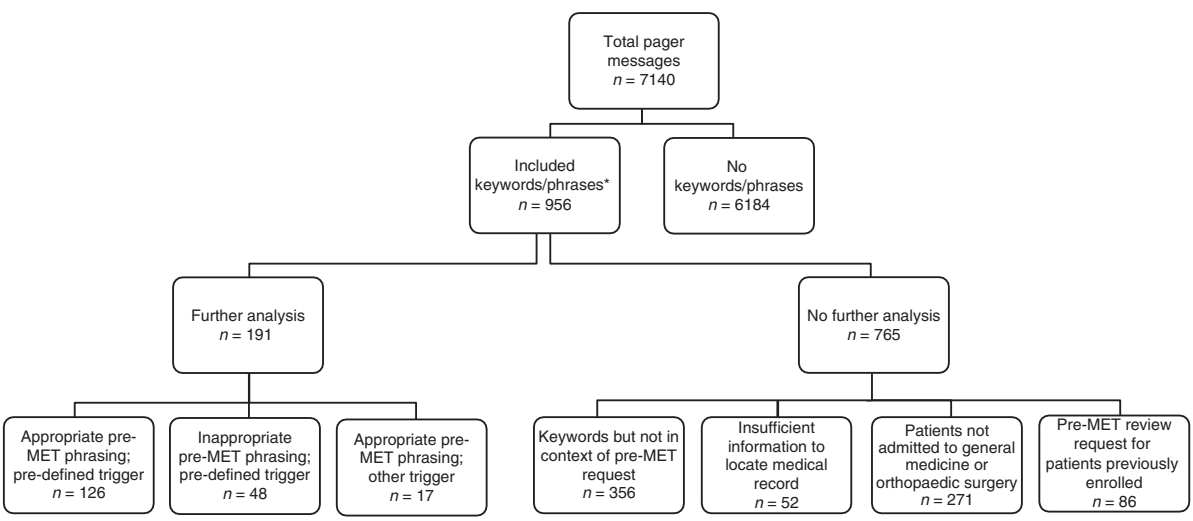

Fig. 2. Search of pager messages for pre-MET review requests. *Recognising that pre-MET reviews were called 'urgent clinical reviews (UCR)' at the study site, keywords/phrases included 'urgent', 'clinical', 'review', 'UCR, 'urgent clinical review', 'urgent review' or listing of pre-defined or other UCR trigger/s with 'please review'. *n*, frequency of pager messages.

Table 2. Characteristics of patients with a pre-MET review request ($n = 50$)

Unless indicated otherwise, data are presented as *n* (%). Limited resuscitation included three sub-categories: (1) not for cardiopulmonary resuscitation, but for intubation; (2) not for cardiopulmonary resuscitation, but for non-invasive ventilation and inotropes; and (3) not for cardiopulmonary resuscitation, intubation or inotropes, but for limited active treatment

Age (years)	
Median (IQR)	80 (19)
Range	28–96
Sex	
Female	32 (64.0)
Male	18 (36.0)
Usual place of residence	
Home	38 (76.0)
Residential aged care	9 (18.0)
Supported accommodation	3 (6.0)
Admitting unit	
General medicine	41 (82)
Orthopaedic surgery	9 (18)
Primary diagnosis by body system	
Respiratory	13 (26.0)
Cardiovascular	8 (16.0)
Orthopaedic surgery	9 (18.0)
Other	6 (12.0)
Renal	4 (8.0)
Gastrointestinal	3 (6.0)
Neurological	2 (4.0)
Musculoskeletal	2 (4.0)
Haematological	2 (4.0)
Dermatological	1 (2.0)
Resuscitation status	
Limited resuscitation	26 (52)
Not documented	14 (28)
Full resuscitation	10 (20)
Treatment aimed at symptom management	0 (0)

Table 3. Frequency of triggers for pre-MET review requests ($n = 50$)

Worry included review requests for nausea and vomiting, chest pain, hypoglycaemia and vital sign triggers that were within the limits of modified pre-MET triggers but did not fulfil other pre-MET criteria. Frequency and percentage results reflect multiple triggers for some requests

Trigger	No. patients (%)
Tachypnoea	12 (24)
Staff worry	12 (24)
Tachycardia	8 (16)
Hypoxaemia	5 (10)
Hypotension	5 (10)
Change in conscious state	5 (10)
Hypertension	3 (6)
Hyperthermia	3 (6)
Shortness of breath	2 (4)
Bradycardia	1 (2)
Bradypnoea	0
Hypothermia	0
Oliguria	0
Fluid/Blood loss	0

Table 4. Interventions provided to patients with pre-MET review requests ($n = 50$)

Asterisks indicate interventions initiated by nurses or doctors. Frequency and percentage results reflect multiple interventions for each patient event

	No. patients (%)
Increased vital sign monitoring*	46 (92)
Pharmacological therapy*	22 (44)
Modification to pre-MET triggers	11 (22)
Order for pathological investigation	9 (18)
12-lead electrocardiogram*	9 (18)
Discussion with more senior doctor*	9 (18)
Modifications to MET criteria	7 (14)
Order for radiological investigation	6 (12)
Intravenous fluid therapy	5 (10)
Oxygen therapy commenced or increased*	4 (8)
Increased oral fluid intake*	3 (6)
Further escalation to MET review*	2 (4)
Antibiotics changed	1 (2)
New limitation of treatment order	1 (2)

Tachypnoea (24%; $n = 12$), staff worry (24%; $n = 12$) and tachycardia (16%; $n = 8$) were the most frequent pre-MET triggers (Table 3). Assessment of vital signs preceding the pre-MET review request showed 18% ($n = 9$) of patients had documented pre-MET triggers: the median time between documentation pre-MET triggers and request for pre-MET review was 149 min (IQR 124.5 min).

Requests for pre-MET reviews were associated with 135 documented nursing- and medically led interventions. Interventions occurred at a median of 19 min (IQR 39 min) after the initial request. Most patients received one (26%; $n = 13$), two (34%; $n = 17$) or three (26%; $n = 13$) interventions (Table 4). Vital sign monitoring (92%; $n = 46$) and pharmacological therapies (44%; $n = 22$) were the most common interventions.

Patient outcomes

All 50 patients remained on wards after the initial review request. Nine patients (18%) had repeat pre-MET review requests and one (2%) had a MET review within 12 h of a pre-MET review. Outcomes beyond 12 h from the review request included further episodes of clinical deterioration (8%; $n = 4$) that led to a MET review (6%; $n = 3$) and ICU admission (2%; $n = 1$). No patient had a cardiac arrest. Six patients (12%) died, all of whom had active LOMT orders at the time of death. The median hospital LOS was 9 days (IQR 11 days); after the pre-MET review request, the median LOS was 5 days (IQR 9 days). Of patients who survived to discharge ($n = 44$), 84% ($n = 37$) returned to their usual residence.

Discussion

This study had four major findings. First, most patients with pre-MET review requests were older females and almost half had modified pre-MET triggers. Second, there was variable adherence to pre-MET policy. Third, tachypnoea and staff worry were the most prevalent pre-MET triggers. Fourth, one in five patients experienced ongoing clinical deterioration within 12 h, and the

hospital LOS of patients with pre-MET requests was prolonged (median 9 days) compared to the mean LOS at this site.

Characteristics and in-hospital outcomes of patients receiving pre-MET review requests, and specific process issues associated with pre-MET requests, are poorly understood. Bingham *et al.* found that 84% ($n = 49$) of patients with documented pre-MET triggers had reviews documented by resident doctors.[13] The patients in that study[13] were predominantly male (57%) and younger (mean age 61 years) than those in the present study. Our sampling strategy and study duration may account for the differences in patient characteristics. Bingham *et al.*[13] used a cross-sectional design to identify pre-MET triggers over a 24-h period and associated clinician responses, whereas we analysed pager messages requesting pre-MET reviews over a 6-week period. No other studies report pre-MET patient characteristics. General medical patients were over-represented in the present study (82%) compared with orthopaedic surgical patients, which reflects, in part, the study design. Sprogis *et al.*[12] found that 52% of patients who had MET reviews were admitted under surgical units, with other studies showing medical patients are more likely to have MET triggers than surgical patients.[19,20] Fewer reviews for orthopaedic patients in the present study may be due to two junior doctors staffing the ward daily; nurses may have requested reviews in person rather than via pagers.

In the present study, 42% of patients had modifications to pre-MET triggers. Flabouris *et al.*[21] reported modified pre-MET triggers were present for 28–32% of patients across their admission. Although exact thresholds for vital sign triggers used in RRSs are not evidence based,[2] vital sign derangements before serious adverse events are well documented.[22–25] It may be appropriate to modify pre-MET triggers in particular circumstances; however, these modifications may also place patient safety at risk.[26] For patients with MET reviews, modified MET triggers were associated with multiple reviews, prolonged hospital stay and mortality.[27,28] Research is required to understand the impact of modified pre-MET triggers on patient outcomes.

Adherence to pre-MET policy varied, with 98% of pager messages lacking details stipulated by policy; 32% of pre-MET review requests were not associated with documented pre-MET reviews. Inadequate information or inconsistent nomenclature within messages may have affected doctors' understanding of the patient's situation and responses. Further, 18% of patients had documented pre-MET triggers before the request for pre-MET review that had not been actioned by nurses. Timely escalation of care is essential to prevent treatment delays and serious adverse events.[1,29,30] Other studies have reported low clinician adherence to pre-MET policies, with as many as 87–92% of patients with pre-MET triggers not having documented pre-MET reviews.[12,13,17] Variable adherence to policy may reflect the immaturity of the pre-MET review process (<4 years old), inadequate education regarding escalation processes and expected responses, high workloads for junior doctor that limit their responsiveness or policies not meeting clinicians' needs.[31–33] Doctors may have made informed decisions not to review patients based on their knowledge of the patient.

Tachypnoea (24%) and staff worry (24%) were the most common pre-MET triggers. In other studies, hypotension/hypertension and hypoxaemia were the most common pre-MET triggers,[12,13] with respiratory rate derangements accounting for between 2.5%[12] and 12%[13] of pre-MET triggers. Differences in pre-MET triggers may reflect that most patients in the present study were older and admitted with respiratory or cardiovascular illnesses. The frequency of staff worry as a pre-MET trigger resembles the findings of a multisite study[34] that showed that 29% of MET reviews were triggered by worry. Nurse concern typically manifests before RRS vital sign triggers, thus enabling earlier identification of deterioration.[35,36] The significant proportion of pre-MET review requests for staff worry in the present study suggests early deterioration manifests in ways different to MET triggers. How clinicians use pre-MET reviews to seek assistance for clinical concerns warrants further investigation.

One in five patients experienced ongoing clinical deterioration within 12 h of the review request, highlighting the need for clinicians to be vigilant in assessing for further deterioration. Other studies of pre-MET systems report that 19–64% of patients have multiple triggers on one or more occasions.[12,13] In studies of MET reviews, ongoing clinical deterioration requiring repeat reviews (compared with single MET review) is associated with a higher mortality.[6] The effect of repeated episodes of pre-MET deterioration on patient outcomes is unknown. It is unknown whether the persistent clinical deterioration in the present study represented efferent limb failure or whether further deterioration would have occurred regardless of intervention. The median hospital LOS was 9 days, more than double the mean LOS at the study site (4.1 days)[37] during the study year. Similarly, Bingham *et al.*[13] reported a median hospital LOS of 12 days for patients with pre-MET triggers. The association between clinical deterioration and increased LOS is well documented, particularly in general medical patients.[38] Our finding of 12% in-hospital mortality is similar to the 14.6% reported in patients with physiological derangements less severe than MET criteria.[39] In response to the study findings, a committee has been convened to explore and improve pre-MET processes. In addition, further research has been undertaken to improve the clarity of pre-MET policy.[18]

This study was limited by its relatively small sample of specific diagnostic groups at a single site, so the findings may not be generalisable to other settings or populations. The representative nature of the sample could not be determined because there was no existing patient database. Reliance on record data was a further limitation[40] because appropriate action may have occurred without associated documentation. It was logistically difficult to identify patients who had pre-MET review requests due to lack of organisational systems for tracking pre-MET reviews and outcomes. Searching pager messages was a novel but time-consuming methodological approach that may be useful to other sites with similarly immature systems.

Conclusions

In this study, patients who had pre-MET review requests were older and mostly female. Considerable proportions of patients had modified pre-MET triggers, pre-MET requests for staff worry and experienced further clinical deterioration after a pre-MET review request. Clinician adherence to pre-MET policy was variable; evaluation of pre-MET implementation is

warranted. The study findings provide insights into pre-MET request processes that may inform improvements to pre-MET systems. Methodological challenges encountered should prompt consideration of standardised systems for tracking clinicians' responses to pre-MET requests to enable practice evaluation and quality improvement. Larger multicentre studies including patients from a range of clinical units are required to further understand the characteristics and outcomes of patients receiving pre-MET reviews.

Data availability

The data that support this study cannot be publicly shared due to ethical and privacy reasons.

Competing interests

None to declare.

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