

# Missed medical emergency team activations: tracking decisions and outcomes in practice

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Despite efforts to improve early recognition of abnormal vital signs and response to the affected patient, ward patients are still at risk of deterioration, which can lead to a serious adverse event. One model to identify and respond to this is the medical emergency team (MET). An MET is activated based on the measurement and recognition of clinical deterioration by clinicians, and their response. Clinical deterioration is identified by predefined vital sign derangements or subjective concern for a patient's condition. The MET consists of critical care clinicians who make time-critical decisions. These might include continuing current treatment; transferring a patient to an area for higher acuity patients; implementing a limitation-of-medical-therapy directive; or facilitating a transition to palliative care.<sup>1,2</sup> Failed MET activation or delayed MET calls commonly occur and are associated with worse patient outcomes.<sup>3-5</sup> Patients who are subject to an MET call or who fulfil MET criteria have an inhospital mortality rate of around 25%<sup>6-8</sup> and about 10% will require intensive care unit services.<sup>6-7</sup> Despite this observation, compliance with activation remains suboptimal.<sup>9</sup>

To our knowledge, no study has assessed the proportion of patients who fulfil MET criteria during their admission in a private institution, or how clinicians respond to abnormal vital signs if MET activation does not occur. Buist and colleagues have prospectively reported the incidence of abnormal clinical observations for patients' entire admission durations.<sup>10</sup> However, this study took place in a public setting and the major aim was to assess the association between abnormal vital signs and subsequent inhospital mortality.

We assessed the incidence of patients fulfilling MET criteria during their hospital admission, and their outcomes. We also compared the outcomes of patients with documented vital signs which fulfilled MET criteria, with the outcomes of patients whose documented vital signs did not fulfil MET criteria. Finally, we examined the actions that staff took in response to documented vital signs fulfilling MET criteria, and the time taken for aberrant vital signs to resolve.

## Methods

Following ethics approval (approval 03-26-10-09), an observational study using a retrospective chart audit was

## ABSTRACT

**Background:** Despite extensive work to improve early recognition of and response to abnormal vital signs, a failure or delay in response to clinical deterioration by activating a medical emergency team (MET) can affect patient safety.

**Objectives:** To determine incidence, management and outcomes of patients having vital signs fulfilling MET call criteria during their entire admission, and to compare baseline characteristics and outcomes of patients who fulfilled MET call criteria with patients who did not.

**Design:** A retrospective chart audit was conducted in a private Melbourne hospital. All patients hospitalised for  $\geq 24$  hours in general wards and discharged in the 7-day study period were included. Medical records were reviewed for all patients who fulfilled MET criteria to assess escalation of care.

**Results:** Of the sample ( $N = 568$ ), 82 patients (14%) had one or more documented vital signs fulfilling MET criteria. Hospital length of stay (LOS) for these patients was twice that of those who did not (8.6 days versus 4.3 days;  $P < 0.001$ ). Medical patients were more likely to meet MET criteria than surgical patients ( $P = 0.03$ ), and there were no significant differences for sex or between elective and emergency admissions. In the 79 patients not reviewed by the MET, the primary nurse escalated care for 36 patients (46%). Nurses independently initiated treatment for 23 of these patients (64%) and when unable to, they referred the patient for medical review (36%). Presence of MET criteria had resolved within 1 hour for 37 patients (45%) who fulfilled criteria.

**Conclusions:** Despite one in seven patients fulfilling MET criteria, MET activation occurred infrequently. The presence of MET criteria was associated with a doubling of the hospital LOS. Escalation of care in response to detection of MET criteria fulfilment was variable. Further research tracking patient management is needed to understand the decision-making process that occurs in the presence of clinical deterioration.

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**Table 1. Study inclusion criteria for adult and paediatric vital sign values**

Vital sign	Value
<b>Adult</b>	
Systolic blood pressure (mmHg)	< 90
Heart rate (beats/minute)	> 130
Respiratory rate (breaths/minute)	> 30 or < 6
Oxygen saturation	< 90% on oxygen therapy
<b>Paediatric</b>	
Systolic blood pressure (mmHg)	
Age term–3 months	< 50
4–12 months	< 60
1–4 years	< 70
5–12 years	< 80
≥ 12 years	< 90
Heart rate (bradycardia; tachycardia) (beats/minute)	
Age term–3 months	< 100; > 180
4–12 months	< 100; > 180
1–4 years	< 90; > 160
5–12 years	< 80; > 140
≥ 12 years	< 60; > 130
Respiratory rate (breaths/minute)	
Age term–3 months	> 60
4–12 months	> 50
1–4 years	> 40
5–12 years	> 30
≥ 12 years	> 30
Oxygen saturation	< 90% on oxygen therapy

conducted for patients hospitalised between 10 and 16 October 2009. Data were collected using a standardised case report form (CRF). Vital sign charts were reviewed to determine if patients had documented vital signs that fulfilled the MET calling criteria at any stage during their admission. The study parameters included systolic blood pressure, heart rate, respiratory rate and oxygen saturation. Only objective MET criteria from the institution were reviewed. Subjective criteria were purposely excluded; this decision was based on the knowledge that there is generally a large discrepancy in the interpretation and measurement of these criteria by nursing staff. Further, it would have been difficult to ensure reliability and consistency in results by retrospectively collecting these data, as they may not have been documented. The adult and paediatric MET calling criteria are shown in Table 1. Patients who fulfilled MET criteria were cross-referenced with the ICU database to determine whether they received an MET review.

## Setting

Our study was conducted in a private health care facility in Melbourne, Australia. The hospital has about 400 beds, an emergency department (ED), a coronary care unit and a 12-bed ICU. The hospital implemented an MET in 2003, and all staff were trained in when and how to activate an MET call and the reason for doing so. MET training is compulsory for all new staff during their hospital orientation. The MET can be activated by any staff member if a patient fulfils one or more of the objective criteria or for any subjective concern. At the time of our study, vital signs were transcribed on a hospital-specific observation chart in a horizontal manner, so no graphical trends were possible to establish. Hospital policy stated that observations were to be performed 4-hourly for all patients, and were to include temperature, heart rate, respiration rate, blood pressure and pulse oximetry, unless otherwise ordered by medical staff or determined by the patient's clinical status.

## Participants

Adult, paediatric and neonatal medical and surgical patients were included in the study if they were hospitalised for 24 hours or more in general ward areas or the postanaesthetic care unit (PACU), and discharged from the hospital during the 7-day study period.

Patients were excluded if they were hospitalised for less than 24 hours (eg, day oncology, day procedure unit or ED short-stay patients) or had a documented not-for-resuscitation order. If a patient had a concurrent ward and ICU admission, vital signs taken during the ICU stay were excluded.

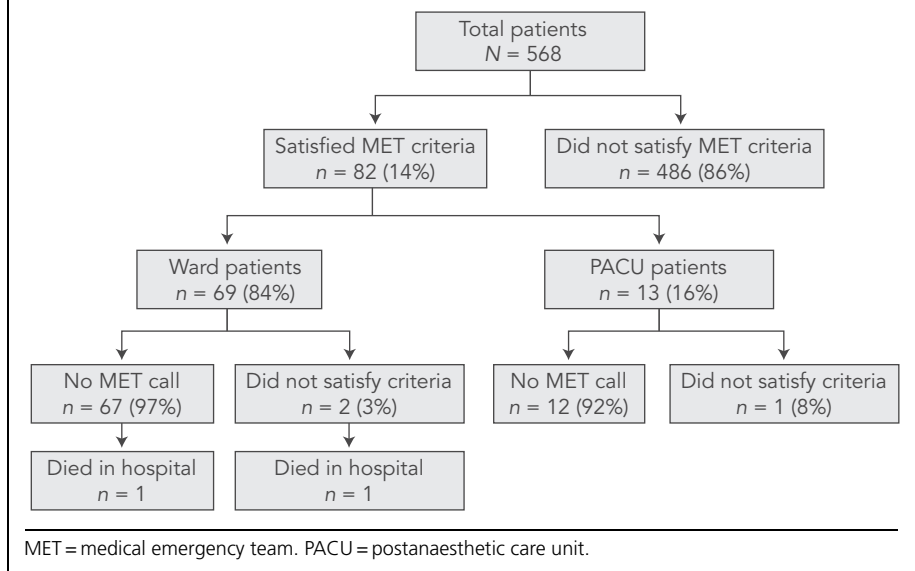
## Data collection

Patient characteristics and demographics were recorded for every patient. For patients who fulfilled MET criteria, the date and time of the criteria being met and specific vital signs were documented. If MET activation did not occur, patient progress notes and intravenous and medication charts were reviewed to ascertain if other clinical escalation responses occurred. Alternative escalation responses were categorised as follows:

- the nurse in charge or doctor was notified and treatment ordered
- the primary nurse managed the patient
- the nurse in charge or doctor was notified and no treatment orders were made
- there was no documentation of recognition or response.

The time taken for the aberrant vital sign to resolve was determined as the time from the initial documented time that the vital sign parameter fulfilled an MET call criterion, to the documented time that the parameter returned to normal (did not fulfil an MET call criterion).

**Figure 1. Summary of numbers of patients who did and did not satisfy MET activation criteria (N = 568)**



### Outcome measures

Our primary aim was to determine the incidence of patients who had vital signs that fulfilled the MET activation criteria at any stage during their admission, and the proportion who received an MET review.

We compared differences in baseline characteristics (gender, admission type and parent unit) and outcomes (length of stay [LOS] and in-hospital mortality) for patients who fulfilled MET criteria with patients who did not. If MET activation failed, we examined if any alternative interventions occurred. Finally, we documented the time taken for aberrant vital signs to resolve.

### Data analysis

All data were analysed using SPSS version 16 (SPSS Inc). Categorical variables (gender, admission type and parent unit) were analysed using the  $\chi^2$  value for determining significance, and obtained using the Yates correction for continuity. The *P* value set at 0.05 was considered statistically significant. Continuous variables (age and LOS) were compared using student *t* tests based on two independent samples.

## Results

### Patient characteristics

Of the sample (*N* = 568), 82 patients (14%) had an aberrant vital sign during their admission that fulfilled MET criteria; 69 patients (84%) were situated on a ward, and 13 (16%) were located in the PACU. Only 3 of 82 patients (4%) had a

documented MET review; one patient in the PACU and the other two on wards. One ward patient with an MET activation was transferred to the ICU and the other patient was stabilised and remained on the ward. The patient reviewed in the PACU was transferred to the ward once haemodynamic stability was achieved.

Two patients of the sample of 568 (0.35%) died while in hospital, both with vital signs fulfilling MET criteria; only one patient received an MET review (Figure 1).

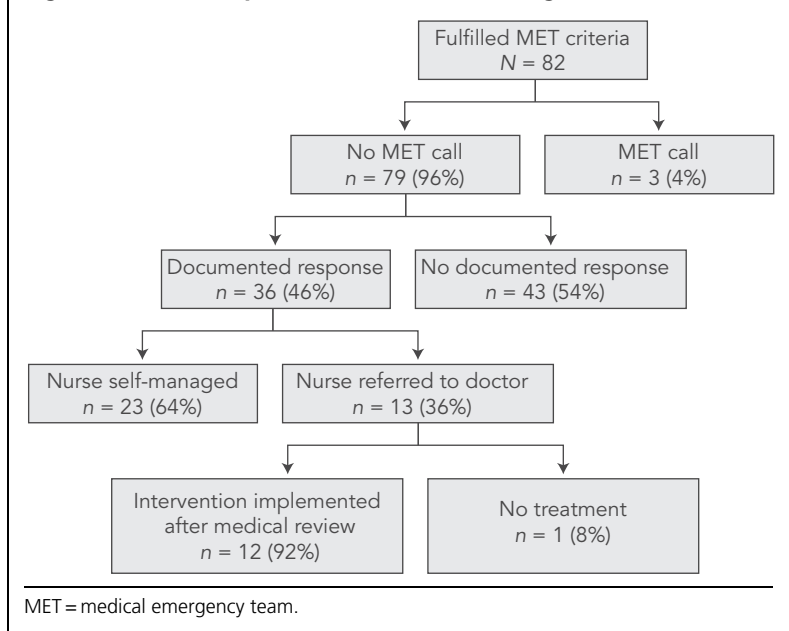
Hospital LOS for patients who fulfilled MET criteria was double that of patients who did not (8.6 days versus 4.3 days, respectively; *P* < 0.001). Medical patients were more likely to fulfil MET call criteria compared with surgical patients (18% versus 11%,

respectively; *P* = 0.03). Although not statistically significant, more female than male patients fulfilled MET call criteria (16.8% versus 11.9%; *P* = 0.121). The mean ages for patients who did and did not fulfil MET call criteria were similar (61.5 years versus 60.8 years; *P* = 0.782).

### Alternative escalation processes in the absence of an MET review

When an MET was not activated in response to aberrant vital signs, the primary nurse escalated care in 36/79 cases (46%). Of those 36, a nurse-initiated response occurred for 23 patients (64%) and, when an intervention outside the nursing scope of practice was required, a referral to the patient's treating doctor was made in 13 cases (36%). Subsequently, treatment was ordered for 12 of the 13 patients (92%) (Figure 2).

The four study parameters (blood pressure, heart rate, respiratory rate and oxygen saturation) were grouped to ascertain the overall proportion that fulfilled MET criteria and resolved in less than 1 hour. Notably, we found 37 patients (45%) demonstrated clinical improvement within 1 hour and no longer fulfilled MET criteria. Of that proportion, 26 (70%) had documentation indicating that the aberrant measurement was recognised and that a subsequent intervention had taken place. Most instances were responded to by the nurse initiating treatment (21; 81%) and, in five patients (19%), the nurse referred the patient to medical staff (Figure 3). Nursing interventions included administering or increasing supplemental oxygen supply in response to hypoxia, and patients who were hypotensive

**Figure 2. Nurse response to aberrant vital signs (N = 82)**

received repositioning and an increased frequency of blood pressure measurements. In response to tachycardia a 12-lead electrocardiogram (ECG) was recorded, and the treating doctor was asked to review the patient. In all cases, the nurse reassessed the patient's vital signs and condition to ensure clinical stability was achieved after the intervention.

No documentation indicated that aberrant vital sign measurements were only reported to the nurse in charge. Typically, the doctor and nurse in charge were simultaneously notified of a problem, and the documentation reflected the treating doctor's assessment and orders.

### Vital sign parameters fulfilling MET criteria

For the 82 patients who fulfilled the MET criteria, the most common vital signs documented as meeting the criteria were, in descending order: systolic blood pressure (42; 51%), oxygen saturation (27; 33%), heart rate (11; 13%) and respiratory rate (2; 2%).

Of the 42 patients whose blood pressure was the trigger for an MET activation, 33 patients (79%) had a systolic blood pressure < 90 mmHg and no documentation indicating recognition or escalation to senior nursing or medical staff (Figure 4). For five patients (12%) who were hypotensive, the primary nurse intervened by placing the patient in the Trendelenburg position and increased the frequency of blood pressure measurements until clinical stability was assured. A further five patients (12%) were referred to medical staff and in response received intravenous fluid therapy.

Documentation showed nursing staff were most responsive to low oxygen saturations. Of the 27 patients whose

oxygen saturation was the trigger for an MET activation, 17 patients (63%) had a nurse who responded immediately by administering or increasing supplemental oxygen, and made frequent assessments to ensure the patient responded appropriately. In all 17 patients, oxygen saturations increased within 1 hour. Another five patients (19%) with documented hypoxia were referred to medical staff for review. All these patients were administered bronchodilators and attended medical imaging for a chest x-ray to further investigate their condition.

Of the 11 patients with documented tachyarrhythmia, two (18%) were referred to and reviewed by a doctor. In response, an ECG was recorded and antiarrhythmic agents were administered to treat the diagnosed clinical condition. For these patients, clinical stability was achieved in less than 3 hours. A further six patients who satisfied MET criteria for an aberrant heart rate did not have documentation indicating that nursing or medical staff had been

alerted or that an intervention took place. Reasons for this remain unknown.

Two patients fulfilled MET criteria with tachypnoea, and neither had any documentation suggesting this was responded to.

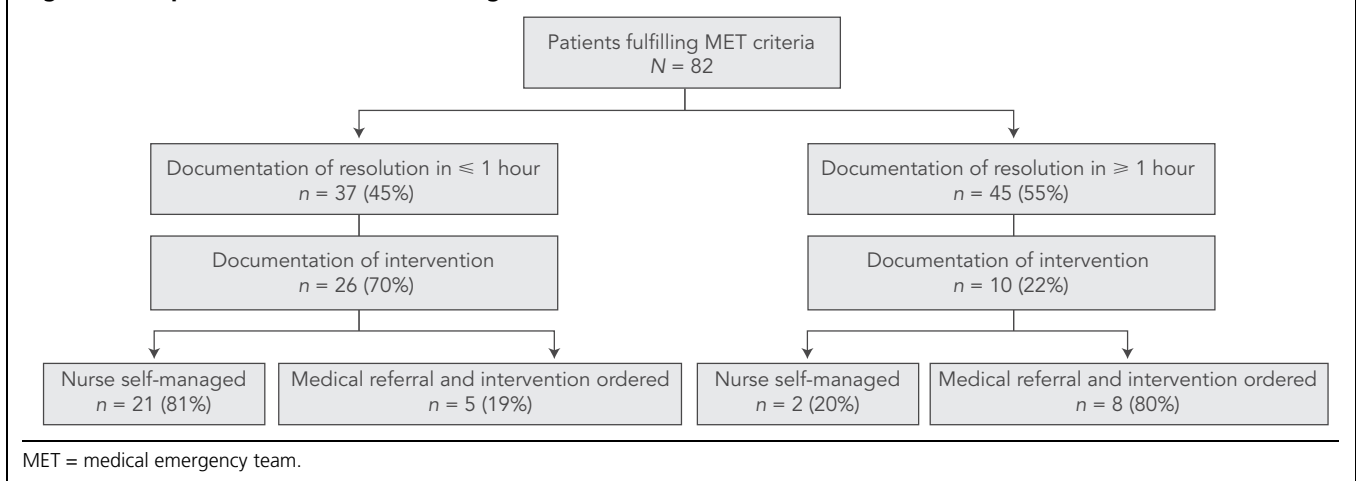
## Discussion

### Major findings

We conducted a retrospective observational study to determine the incidence and outcomes of patients fulfilling MET criteria during their entire hospital admission. We found that one in seven patients (14%) had vital signs that fulfilled one or more MET call criteria. Only three patients received an MET review. Despite the low MET activation rate, aberrant vital signs were still responded to in 46% of the cohort. During the study period, two patients died in hospital. Significantly, hospital LOS for patients who fulfilled MET criteria was double that of patients who did not.

### Comparison with previous studies

Our findings add to previous research reporting that 3%–27% of patients had vital signs fulfilling MET criteria.<sup>9,11–13</sup> In a single-centre study in Sweden and Denmark, the point prevalence of MET criteria being met was 4.5% and 18%, respectively. The study of Casamento and colleagues prospectively examined the prevalence of patients who fulfilled hospital-specific criteria for MET action, and reported that 3.26% of the 1688 patients had vital signs sufficient to warrant an MET review.<sup>7</sup> A study by Vetro and

**Figure 3. Proportion of aberrant vital signs documented to have resolved in less than 1 hour (N = 82)**

colleagues revealed that of 22 patients who had a cardiac arrest, six patients (27%) had had vital signs fulfilling MET criteria in the preceding 6 hours but none had had an MET call.<sup>14</sup>

Differences in these reported incidences may relate to differences in MET criteria thresholds and patient demographics. The studies reporting MET incidence reviewed only a proportion of patient vital signs taken at their admission. Similarly to our study, Buist and colleagues prospectively assessed patients' vital signs from five general wards for their entire admission duration.<sup>10</sup> He reported that 8.9% of the cohort had had abnormal bedside observations, of which 67% spontaneously resolved and 21.6% were brought back to normal with treatment on the ward. The higher proportion of patients with abnormal vital signs and the proportion that spontaneously resolved could be attributed to the larger sample size, institutional variances and a longer study period.

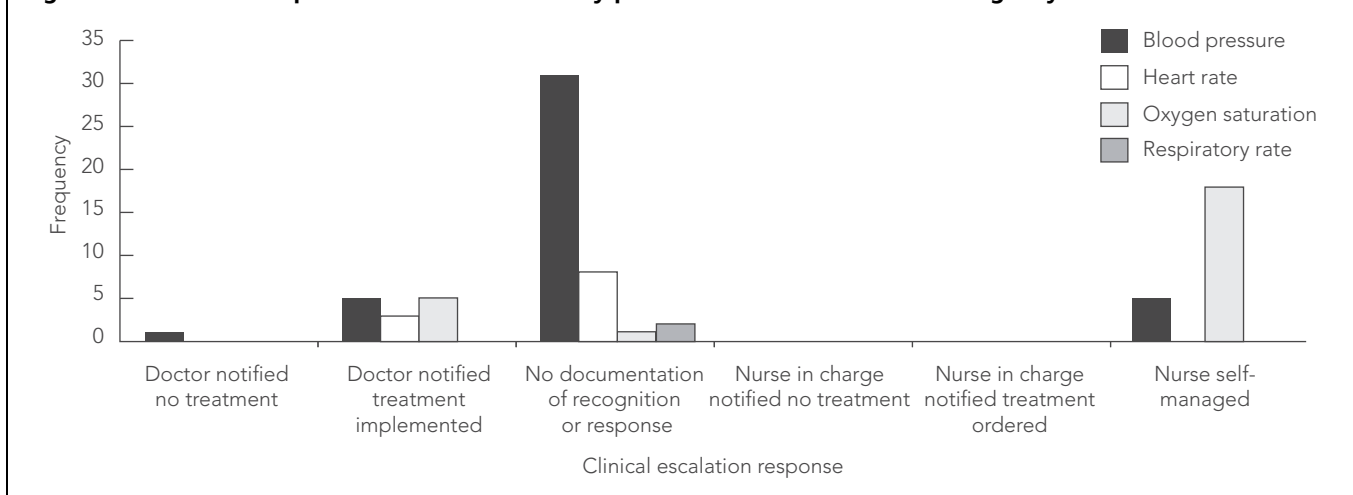
### Implications

We found that one in seven patients fulfilled one or more MET criteria during their hospital admission. Therefore, the likelihood of nurses encountering patients who may deteriorate during a routine shift is high. In addition, patients with vital signs fulfilling MET criteria had an associated LOS that was double that of patients who did not. Similarly, Fuhrmann and colleagues reported a significant association between patients with abnormal vital signs and hospital LOS (median difference, 7 days;  $P < 0.0001$ ).<sup>9</sup> An increased LOS has implications for patient morbidity, hospital resources and bed availabilities. Both these findings emphasise the importance of nurses recognising signs of clinical deterioration and valuing the importance of early escalation and intervention.

We found that MET activation occurred in a minority of patients fulfilling MET criteria, which initially suggested that nurses may not consistently recognise the clinical significance of or urgency in responding to aberrant vital signs. It was encouraging that half of patients had documentation indicating that nurses interpreted the meaning behind aberrant vital sign measurements and escalated care in ways other than activating an MET. Nurses mostly responded within their scope of practice or referred patients to medical staff for review and treatment orders. Importantly, in many patients, MET criteria resolved in less than 1 hour. This indicates that clinicians felt confident managing certain clinical situations without activating an MET. Nurses at the study institution favoured a multitiered response, as proposed by the Australian Commission on Safety and Quality in Health Care.<sup>15</sup> Similarly, Kansal and Havill reported an increase of 50% in escalation of care with the implementation of a two-tiered rapid-response system (along with new observation charts and MET calling criteria) for patients who were at risk of deteriorating.<sup>16</sup>

We found that hypotension and hypoxia were the most common parameters which fulfilled MET criteria. This finding was also reported in Buist's study, in which decreased oxygen saturation comprised 51% of all events and hypotension accounted for 17.3%.<sup>10</sup> Only two patients in our study had a documented respiratory rate fulfilling MET criteria for tachypnoea. Despite a large body of evidence indicating that an abnormal respiratory rate is an important predictor of serious adverse events,<sup>17-20</sup> neither of these patients had documentation indicating responsiveness in terms of therapeutic management or further investigation of causes.

We found that respiratory rate was infrequently documented and often missing as part of a full set of vital sign

**Figure 4. Escalation responses to individual study parameters when medical emergency team activation failed**

measurements. It is unknown if this represents infrequent assessment or poor documentation, both of which have been reported in previous studies.<sup>20-23</sup> Incomplete vital sign measurement undermines the objective basis of ascertaining the clinical status of a patient and the value associated with a response system.<sup>24</sup> Medical students and clinicians should be taught that respiratory rate is the most useful marker for identifying patients at risk of serious adverse events, and therefore warrants frequent assessment and documentation.

#### Further research

Further research is needed to understand the decision-making processes of nurses when they are faced with clinical deterioration of a patient. Other factors that need investigating are those influencing which clinicians summon an MET call immediately compared with those who do not. Insight into the routine documentation practices of clinicians would be useful, to ascertain the intervention, referral and management decisions that are formally documented and those that are not.

Research to inform the optimal frequency of vital sign measurement to ensure clinical deterioration does not go unrecognised and to prevent associated complications would be beneficial. Understanding the factors that contribute to a doubling of LOS would benefit patient management and outcome decisions.

#### Strengths and limitations

To our knowledge, our study is the first to review the incidence and outcomes of patients fulfilling MET criteria for their entire hospital LOS in a private population. The private setting may have restricted our ability to generalise our findings, but the study institution represents a typical

large metropolitan private hospital in a developed country. Therefore, the results and study methodology may be relevant to other institutions with similar characteristics. We cannot comment on the proportion of objective concerns that were not escalated.

Our results further contribute to existing MET literature by investigating the trajectory of care provided in the absence of an MET review. Our CRF had predefined questions to efficiently capture information so that we could meet our research aims and make data collection consistent. Clinicians were not aware of the study taking place, so their decision making was not altered by the presence of researchers.

Documentation bias is a potential limitation of our study. Data obtained from this chart review relied on accurate measurement and documentation of vital signs, escalation procedures and interventions implemented by clinicians. While this documentation is a legal requirement for nurses, we recognise that it may not always occur accurately and completely. The data collection period occurred during 1 week in October, therefore seasonal and institutional variations cannot be accounted for. We had limited information on admission and presence of baseline comorbidities. We cannot comment on whether intervention by the MET would have resulted in a reduction in the increased LOS observed.

#### Conclusions

The MET is a major component of the modern health care system. Recognising the significance of altered physiological observations and responding appropriately is a highly complex process, and involves nurses integrating knowledge with clinical experience. Patients fulfilling MET criteria had twice the hospital LOS. Further research is needed to

assess nurse decision making in the context of abnormal vital signs, and the actions taken in the absence of MET review.

### Competing interests

None declared.

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