Is the New Zealand Early Warning Score useful following cardiac surgery?

Kevin Niall Peek, Michael Gillham

ABSTRACT

AIMS: The rate of medical emergency team (MET) calling among post-cardiac surgery patients is unknown. We set out to determine what the call frequency would be if MET activation occurred in every instance that the early warning score (EWS) breached our local threshold, what the outcome was for these patients and what the calling rate might be if the proposed New Zealand EWS (NZEWS) system was implemented with 100% adherence.

METHODS: The clinical records of 400 consecutive post-cardiac surgery patients were examined. The number of times a patient's EWS reached the threshold which mandated a call to the MET was determined, as was the actual rate of calling, the occurrence of inpatient death and re-admission to the intensive care unit (ICU). The rate of calling was then determined using the NZEWS, and with a routine modification to the heart rate score.

RESULTS: There were 73 occasions (MET events) where the EWS reached the MET calling threshold. The MET was only called twice. There were no inpatient deaths and 12 ICU re-admissions in the study cohort. Nine ICU re-admissions were preceded by a MET event, two by cardiac arrest and one had neither. Re-scoring with NZEWS yielded 53 events. Eight of the 12 ICU admissions were preceded by a NZEWS event.

CONCLUSIONS: The rate of MET triggering EWS in patients post-cardiac surgery is high at 182/1,000 admissions. Using NZEWS could reduce the MET calling rate without significant risk to patient safety.

An early warning score (EWS) is a tool used by medical providers to identify those patients who are at risk of developing organ dysfunction and/or death. These scores are based on a set of physiological observations (parameters). In general, respiratory rate, heart rate, systolic blood pressure, temperature and level of consciousness are measured. But variation exists and some scores include peripheral pulse oximetry and volume of urine passed. Deviation from the reference range in each parameter contributes to an overall aggregate score. In many hospitals within New Zealand, when the EWS meets a threshold, a call for review by a medical emergency team (MET) or an experienced senior nurse is either recommended or mandated.1-4

In a survey of district health boards in New Zealand a large variance was found, between which parameters were used to compose the EWS, the weighting and thresholds of each parameter and the response to an elevated score.5 The Auckland District Health Board's current EWS was developed as a composite of a pre-existing mandatory “Criteria for Code Red Call” and the Physiologically Unstable Patient (PUP) score.6-7 There is currently considerable focus on developing a national New Zealand Early Warning Score (NZEWS) similar to those systems developed in the UK.6-9

In general hospital cohorts, patients who trigger a MET review are at high risk of morbidity and death. However, there are little data concerning the use of an EWS in post-operative cardiac surgery patients.10 Post-operative cardiac surgery patients have a high rate of primary, rapid atrial fibrillation and are often being treated for heart failure with vasodilators such as angiotensin converting enzyme inhibitors.11 Tachycardia and hypotension are frequent and can often be adequately managed by the ward staff without activation of the MET. Frequent MET activation in the absence of specific
adequate funding for this service may have adverse effects on care delivery to patients within the intensive care unit.¹²

We set out to determine what the call frequency would be if MET activation occurred in every instance that the EWS breached our local threshold, what the outcome was for these patients and further, what the calling rate might be if the proposed NZEWS system was implemented with 100% adherence. As there have been no studies performed on this group of patients we decided to study a moderate number of (400) patients in the first instance.

Figure 1: Auckland District Health Board Adult Observations Chart.

Each parameter is scored according to EWS scoring key and the total score for each set of observations tallied at the bottom of the page. A score of 5 or greater mandates a MET call (“code red”).

Methods

Four hundred consecutive post-cardiac surgery patients who were discharged from the ICU to the cardiothoracic ward were identified retrospectively from our ICU database. Procedure and demographic information for each patient were collected from the clinical records. All physical observation charts from the time of admission to the cardiothoracic ward until discharge from hospital were examined by the principal investigator. Each set of observations was scored according to the hospital EWS criteria (Figure 1). Scores of 5 or higher, which...
should trigger a MET call, were considered ‘MET events’. For each MET event, the parameter(s) that was deranged, leading to the elevated score, was recorded. In order for more than one event to be recorded for an individual patient, the EWS must have fallen below 5 for at least one set of observations between MET events. The compliance with correctly recording the EWS after each set of observations was also determined in the first 100 patients.

The following outcomes were determined for each MET event: compliance with alerting the MET, review by the ICU team, readmission to ICU and inpatient mortality. The outcomes were determined by examining the clinical records including doctors’ and nurses’ notes, the electronic record system, admission and discharge records from ICU and the patient’s final hospital discharge summaries.

Finally, the physical observation charts for each MET event were examined again and re-scored using two alternative systems. First, using the proposed NZEWS criteria (Figure 2) and second, using the current EWS criteria but increasing the upper limit of heart rate as a single parameter MET trigger from 140 to 150 beats per minute (bpm). An analysis of the effect of these changes to the scoring criteria was performed.

This investigation (A+ 7186) was approved by the Auckland DHB Research Review Committee.

The draft NZEWS chart includes oxygen saturation and supplemental oxygen use in its parameters. A MET call is mandated for any parameter in the ‘blue’ zone or a total EWS of 10 or more. Therefore, respiratory rate above 35 or below 5 bpm, a systolic blood pressure below 70 mmHg, a heart rate above 140 or below 40 bpm and unresponsiveness all mandate a MET call.
Table 1: MET Events—parameters that led to an EWS of 5 or higher.

<table>
<thead>
<tr>
<th>MET Events</th>
<th>73</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate &gt;140bpm</td>
<td>30</td>
</tr>
<tr>
<td>Heart rate &gt;150bpm</td>
<td>5</td>
</tr>
<tr>
<td>Heart rate &lt;40bpm</td>
<td>6</td>
</tr>
<tr>
<td>Systolic blood pressure &lt;80mmHg</td>
<td>18</td>
</tr>
<tr>
<td>Combination</td>
<td>19</td>
</tr>
</tbody>
</table>

Table 2: Primary outcomes of MET events.

<table>
<thead>
<tr>
<th>Events</th>
<th>73</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET calls (%)</td>
<td>2  (3%)</td>
</tr>
<tr>
<td>Referred to ICU independent of a MET call (%)</td>
<td>11 (15%)</td>
</tr>
<tr>
<td>Re-admitted to ICU (%)</td>
<td>9  (12%)</td>
</tr>
<tr>
<td>Inpatient deaths</td>
<td>0</td>
</tr>
</tbody>
</table>

Results

In 400 consecutive patients (274 males, 126 females) discharged from the ICU to the cardiothoracic ward, 43 patients had a total of 73 MET events of EWS 5 or more. Two additional patients also had unheralded cardiac arrest. Thirty MET events were for isolated heart rate (HR) >140bpm, six for isolated HR <40bpm, 18 for isolated systolic blood pressure <80mmHg and 19 for a combination of deranged observations (Table 1).

Among the 73 MET events which mandated a MET call, there were only two MET calls made. The remaining 71 MET events were managed without alerting the MET (Table 2). The EWS was not recorded or recorded incorrectly in 1,462 of 4,480 sets of observations or 33% of the time.

In total, 12 patients in the 400 patient cohort were re-admitted to the ICU. Three patients had no preceding MET event. Two of these followed unheralded cardiac arrest and one was referred back and re-admitted without having a MET event. This patient had concerning hypoxia. Nine patients were re-admitted following a MET event, with only one having a MET call made and the other eight being referred to ICU independent of a MET call. There were no inpatient deaths.

When the MET events were re-scored using the proposed NZEWS chart, there were only 53 which mandated a MET call. There was one additional patient that did not meet MET criteria on the NZEWS chart who was subsequently re-admitted to ICU.

Re-scoring MET events with an increased upper limit of heart rate as a single parameter MET trigger from 140–150bpm as a modification to the current EWS resulted in 48 in which a MET call was required. This re-scoring led to one additional patient being missed who was subsequently re-admitted to ICU following a heart rate between 140–150bpm. Applying the same heart rate modification to NZEWS resulted in 28 MET calls and three patients missed who were re-admitted to the ICU (Table 3).

Discussion

We observed a high rate of deranged observations in this cohort of 400 post-cardiac surgery patients. There was poor adherence to alerting the MET to patients who breached the calling criteria at 3%. With complete adherence to the EWS system a MET activation rate of approximately 182 per 1,000 admissions can be expected. This rate is much larger than the typical rate of 20–40 per 1,000 admissions seen in general hospital cohorts.13 We have found that the most commonly deranged parameter mandating a MET call was isolated tachycardia (41%), and in most cases the rate was between 140–150bpm. This contrasts with general hospital cohorts

Table 3: Results of re-scoring MET events using the proposed NZEWS chart.

<table>
<thead>
<tr>
<th>Re-scoring MET events using the proposed NZEWS chart</th>
<th>53</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET calls (%)</td>
<td>2  (3%)</td>
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<td>9  (12%)</td>
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<tr>
<td>Inpatient deaths</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 3: Frequency of MET events using current EWS, NZEWS and allowing isolated HR up to 150bpm.

<table>
<thead>
<tr>
<th>Events</th>
<th>Event rate (per 1,000 admissions)</th>
<th>ICU re-admissions without MET event</th>
<th>Reason for re-admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using current EWS</td>
<td>73 182</td>
<td>1</td>
<td>Hypoxia</td>
</tr>
<tr>
<td>Current EWS but allowing isolated HR up to 150bpm</td>
<td>48 120</td>
<td>2</td>
<td>Hypoxia, HR 140–150</td>
</tr>
<tr>
<td>Using NZEWS</td>
<td>53 133</td>
<td>2</td>
<td>Hypoxia, SBP &lt;80</td>
</tr>
<tr>
<td>Using NZEWS and allowing isolated HR up to 150bpm</td>
<td>28 70</td>
<td>3</td>
<td>Hypoxia, HR 140–150, SBP &lt;80</td>
</tr>
</tbody>
</table>

in whom the most common cause for MET activation is hypoxia.13

One of the principal aims of an EWS system is to identify those patients who are at risk of deteriorating to cardiac arrest and/or death. None of the 43 patients in our study with an EWS of 5 or higher progressed to either of these outcomes, and less than one-quarter (9/43) of these patients were re-admitted to the ICU.

A substantial increase in the number of MET calls can be expected should adherence to the current EWS system be absolute in post cardiac-surgery patients. Relaxing the threshold for isolated tachycardia as a single MET calling criterion from 140–150bpm may safely allow the initial investigation and management of fast atrial fibrillation to occur without involvement of the MET. If our current system were replaced by the proposed NZEWS, the calling rate would be lower but still high. It is unlikely that many significantly deteriorating patients would escape detection if the threshold for heart rate in isolation activating the MET were elevated to 150bpm. Patients who were causing significant concern can still be referred to the MET without attaining the requisite point score.

Our data indicates that calling rates in post-operative cardiac surgery patients will be high if the NZEWS system is introduced. This group of patients has very low in-patient mortality. Modification of the heart rate parameter to allow rates up to 150bpm before calling the MET will attenuate this to a degree but may result in more patients re-admitted to the ICU being ‘missed’ by the system. Hospital METs will need to be appropriately resourced to deal with the demand.

**Competing interests:**
Nil.

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