Use of medical emergency call data as a marker of quality of emergency department care in the post-National Emergency Access Target era

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Abstract

Objectives. Any new model of care should always be accompanied by rigorous monitoring to ensure that there are no negative consequences, especially any that impact upon patient safety. In 2013, ‘THERMoSTAT’ (Two-Hour Evaluation and Referral Model for Shorter Turnaround Times), an emergency department model of care developed by Royal Brisbane and Women’s Hospital staff was launched to gain efficiencies and improve hospital National Emergency Access Target (NEAT) compliance. The aim of this study was to trial the use of medical emergency call data as a novel marker of the quality of care delivered by our emergency department.

Methods. Incidence of medical emergency calls for hospital emergency admission patients for the 2 years pre- and 1 year post-THERMoSTAT were compared after standardising for overall hospital activity.

Results. During the study period, hospital activity increased 10%, and the emergency department experienced a total of 222 645 presentations, 68 000 (30.5%) of which converted into an admission. THERMoSTAT improved NEAT compliance by 17% (from 57.7% to 74.9%) with no change in any patient-safety indicators. A total of 8432 medical emergency calls were made on 5930 patients, 2831 of whom were emergency admissions. After adjusting for hospital activity, there was no change in the average number of patients per week who triggered a medical emergency call after the introduction of THERMoSTAT. These results were reproduced when data was analysed for: total number of inpatients triggering calls; emergency admission patients; and emergency admission patients within the first 24 h or first 4 h of admission.

Conclusions. This is the first report to investigate the correlation between inpatient medical emergency call incidence and emergency department model of care. Medical emergency call data showed significant promise as a measure of morbidity and as a more direct, objective, simple, quantitative and meaningful measure of patient safety.

What is known about the topic? It is well established that extended emergency department lengths of stay are associated with poorer patient outcomes. The corollary of this is not always true however; shorter emergency department length of stay does not automatically translate into better care. Although the underlying philosophy of NEAT is to enhance patient care, there is a risk of negative consequences if NEAT is seen as an end in itself. Many of the commonly used emergency department key performance indicators focus on the timeliness of care and there is a scarcity of easily quantifiable markers that reliably reflect the quality of that care.

What does this paper add? This study builds on the concept of medical emergency call incidence as a marker of safety and quality. It explores the utility of using the number of medical emergency calls made in the first few hours of an emergency admission as an indicator of the quality of care delivered by the emergency department. This is significant because it introduces a measure that has a focus that embraces more than the timeliness of care only.

What are the implications for practitioners? If medical emergency call incidence in early emergency admissions can be proven to accurately reflect emergency department quality of care then it would provide an easily monitored, objective, quantitative and prompt measure that evaluates dimensions other than timeliness.
Introduction
The Royal Brisbane and Women’s Hospital (RBWH) is a 929-bed quaternary and tertiary referral teaching hospital in the heart of metropolitan Brisbane. The introduction of the National Emergency Access Target (NEAT) catalysed a critical evaluation of how hospital services were delivered at the hospital. As part of this evaluation, the hospital emergency department (ED) developed a novel model of care, Two-Hour Evaluation and Referral Model for Shorter Turnaround Times (THERMoSTAT), which uses a two-phase team approach, combining clinical streaming and early senior consultation to gain efficiencies, enable early referral, reduce ED length of stay and improve NEAT compliance. This model is described in greater detail by Burke et al.

The introduction of ED targets has prompted multiple commentaries. Although the rationale for the Australian NEAT was to help address issues of hospital ED overcrowding and its associated poor outcomes for patients, mandated targets do carry a risk of unintended negative consequences. The Federal policy document is clear that NEAT is not meant to override clinical judgement; however the value of ED targets has been questioned in the literature and the Francis Inquiry into the poor clinical performance of Mid Staffordshire NHS Foundation Trust Hospitals graphically exemplified how targets can have adverse impacts on healthcare delivery when care of patients becomes ‘secondary to achieving targets and minimising breaches’.

Although it is clear that the underlying philosophy of NEAT, which is to improve patient safety and enhance quality of care, is laudable, the literature provides valuable insights into how it can be unsafe and destructive when the focus is on a target as an end in itself and promptness of action takes precedence over quality of care, rather than the target being an indicator of quality. This highlights the challenge of how to measure quality of care, and in particular how to measure it directly, simply, objectively and in real-time so that care can be responsive. The initial trigger for the Francis Inquiry was concern about the Trust Hospitals’ high mortality rate, however mortality data is well-recognised as being non-specific, insensitive and a late marker of quality of care. Many of the other frequently employed ED performance indicators, median length of ED stay, time to clinical assessment, and time to commencement of treatment are surrogate markers that merely track the distribution of time that patients spend within the ED. Although there is a well-established general association between ED length of stay and patient outcomes, timeliness should not be the sole criterion for assessing quality of care.

When THERMoSTAT commenced, it was closely monitored using a suite of efficiency and patient-safety indicators to ensure that the new model of care did not gain efficiencies at the expense of the quality of care provided, however as outlined above, it was considered that many of the established indicators focused on timeliness of care and were limited in their applicability to reflect the quality of care.

One non-temporal indicator of patient safety that RBWH monitors within the general hospital is the medical emergency (ME) call rate. Research has shown that the rate of ME calls in a hospital is inversely related to cardiac arrest and respiratory arrest calls. In hospitals with a strong culture of recognising and making ME calls, this increased sensitivity to deteriorating patients is considered a positive safety and quality feature, with some proposing the concept of a ME ‘dose’ (ME events per 1000 admissions) as an indicator of safety and quality.

We propose to build upon the concept of ‘ME dose’ and apply it to emergency admission patients. Patients whose ED presentation generates an admission to the main hospital are in general more unwell, and are therefore more likely to have a compromised physiological reserve and be more challenging to manage, especially within a stringent timeframe. We hypothesised that this group of patients were likely to be the most sensitive responders to changes in the level of care, which would in turn influence the number of ME calls triggered for this cohort. Since the effects of the emergency part of any patient episode will dilute over time, these effects will be more prevalent in the early part of an admission.

The aim of this study was to trial the use of hospital ME call data as a marker of the quality of care delivered by the ED, and ascertain whether it has promise as a more direct, objective, quantitative and responsive way of measuring the quality of ED care, which would be simpler, quicker and more relevant than many of the current key performance indicators (KPIs).

Methods
Data acquisition
THERMoSTAT commenced on 7 February 2013. Weekly data was collected retrospectively from 3 January 2011 to 6 February 2013, and prospectively from the 7 February 2013 to 1st February 2014. This represented 109 weeks pre- and 51 weeks post-THERMoSTAT. Two years of pre-intervention data was analysed to ensure that we had an established, robust and consistent culture of escalation and triggering of ME calls. Analysis of prospective post-intervention data was ceased after clear statistical trends were well substantiated.

ED attendance data including number of presentations, NEAT compliance, ED median length of stay, and the number of presentations that converted to a full hospital admission (excluding admissions to the emergency short-stay unit) were collected from the Queensland Government Health Services Information Agency ED Information System database. The total number of hospital admissions and the number derived from an ED presentation were collected from the Queensland Health Hospital-Based Corporate Information System database. This data was cross-referenced with ME call data collated from the Metro North Hospital and Health Service Safety and Quality Database. ME test calls, cancelled calls, and calls to staff, visitors or others who were not hospital inpatients were excluded. Information was collected about each call and used to...
calculate the number of patients who triggered at least one ME call, their admission source, date and time of admission, date and time of the ME call, and elapsed admission time before each ME call.

All ME call records were individually examined and cross-referenced with hospital departmental records if required to ensure accuracy. This eliminated possible confounding effects, for example, if information systems misallocated changes in the episode of care as a new admission (which would affect admission time before ME call) or if bed or ward relocation of a patient had not been recognised.

Data analysis

Standard statistical analyses were conducted. Data for total number of admissions per week, total number of admissions per week with an admission source of ED, length of stay in ED, number of admissions per week, total number of admissions Standard statistical analyses were conducted. Data for total time before ME call) or if bed or ward relocation of a patient had

Ethics approval and site-specific approval to conduct this study were granted by the RBWH Centre for the Advancement of Clinical Research (HREC/13/QRBW/428).

Results

Hospital activity

During the 160-week study period, the RBWH experienced a total of 222 645 ED presentations and 277 069 hospital admissions, exactly 68 000 (25%) of which were emergency admissions. Results presented in Table 1 show that overall hospital activity increased nearly 10% from a weekly median of 1705 to 1860 (P < 0.001) when comparing before and after the introduction of THERMoSTAT. This increased admission rate was also observed in emergency admissions which showed a 12% increase from a weekly median of 408 to 455 (P < 0.001).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-THERMoSTAT</th>
<th>Post-THERMoSTAT</th>
<th>P-value</th>
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<tbody>
<tr>
<td>Total number of admissions</td>
<td>1705 (1625, 1779)</td>
<td>1860 (1809, 1899)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Emergency admissions</td>
<td>408 (396, 423)</td>
<td>455 (445, 473)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ED LOS (min)</td>
<td>270.6 (274.4, 290.0)</td>
<td>192.4 (182.2, 203.0)</td>
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<td>NEAT compliance (%)</td>
<td>57.7 (54.8, 60.3)</td>
<td>74.9 (72.8, 77.6)</td>
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NEAT compliance

THERMoSTAT resulted in an immediate, dramatic and sustained improvement in NEAT compliance. Average weekly NEAT compliance improved 17%, from 57.7% to 74.9% (P < 0.001), and this improvement was also reflected in a decrease in the median ED length of stay from 270.6 min to 192.4 min (P < 0.001). These results are described in more detail elsewhere by Burke et al.1

ME calls

There was a total of 8488 valid ME calls made during the 160-week study period. Of these, 56 records could not be analysed due to insufficient information. The remaining 8432 ME calls were triggered by a total of 5930 patients. The actual number of ME calls did increase over time for all investigated cohorts (all inpatients, emergency admission patients, emergency admission patients within the first 24 h of admission, and emergency admission patients within the first 4 h of admission; see Fig. 1), but all increases were proportional to the increase in hospital activity. The proportion of all inpatients who triggered a ME call at some stage during their admission did not change and averaged 2.2% for the entire 160 weeks of the study. Similarly, the proportion of all emergency admission patients who triggered a ME call at some time throughout their admission remained stable and averaged 4.2% (data not shown).

Results presented in Table 2 show that before THERMoSTAT the mean number of patients who triggered a ME call per week was 35.3 and after THERMoSTAT the mean was 40.3. Although these figures appear to show a significant increase, when they were adjusted to account for the general increase in hospital activity that occurred over this time, there was no statistically significant increase in the number of patients who triggered ME calls after the commencement of THERMoSTAT (P = 0.200).

Similar trends were seen when the ME call data was analysed for emergency admissions. Of the 5930 patients, 2831 (48%) were emergency admissions and adjusted weekly ME call data showed no significant change after the introduction of THERMoSTAT (pre-THERMoSTAT adjusted mean 41.9, post-THERMoSTAT adjusted mean 41.6, P = 0.910). Likewise, of the 1406 patients who triggered one or more ME calls within the first 24 h of their admission, 813 were emergency admissions and the pre- and post-THERMoSTAT means of 4.7 and 5.9 patients per week were not statistically significant when they were adjusted to rates per 1000 admissions (pre-THERMoSTAT adjusted mean 11.5, post-THERMoSTAT adjusted mean 13.0, P = 0.150). Data was also analysed for the number of patients who triggered ME calls early in their admission (within 4 h), however neither unadjusted nor

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adjusted data showed any significant differences, possibly due to the very small numbers of patients in these groups. These results of all of the emergency admission ME call data is summarised in Table 3.

Discussion
The philosophy underpinning NEAT is to enhance patient care, but this begets the challenge of how to best measure quality of care. To date, most published literature has relied on surrogate quality-of-care markers that have in part been chosen for their ease of measurement and this has resulted in suites of KPIs that largely reflect the speed of patient care. Although timely care is an important aspect of quality of care, it should not form the sole basis for judging quality of care. A rapid ED journey without proper management is unlikely to constitute high-quality care, although measuring ‘proper management’ is not straightforward.

![Figure 1](https://example.com/figure1.png)

**Fig. 1.** Plot of the actual weekly incidence of patients who triggered medical emergency (ME) calls from 3 January 2011 to 1 February 2014. The red line indicates when THERMoSTAT (Two-Hour Evaluation and Referral Model for Shorter Turnaround Times) commenced.

<table>
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<tr>
<th>Table 2. Weekly unadjusted and adjusted averages for the number of patients triggering medical emergency (ME) calls before and after THERMoSTAT</th>
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<tbody>
<tr>
<td><strong>Pre THERMoSTAT</strong></td>
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<tr>
<td>Mean (95% CI)</td>
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<tr>
<td>Number of patients triggering ME calls</td>
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<tr>
<td>Adjusted mean</td>
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Adjusted mean is calculated as the number of patients per 1000 admitted patients per week.

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<td>No. of ME calls</td>
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<tr>
<td>Calls able to be analysed</td>
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<tr>
<td>No. of patients</td>
</tr>
<tr>
<td>Patients who triggered calls</td>
</tr>
<tr>
<td>≤24 hrs</td>
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<tr>
<td>≤4 hrs</td>
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</table>

Adjusted data is calculated per 1000 admitted patients per week.

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To include some element of assessment of patient morbidity into the assessment of ED performance, we chose to investigate ME call data in conjunction with a suite of more conventional KPIs. Our study proposed the hypothesis that inferior ED management would result in increased levels of physiological instability among emergency-admitted inpatients, which would in turn manifest as increased numbers of ME calls to these patients in the hours after they were transferred out of the ED and admitted into the general hospital. We hypothesised that the reduced physiological reserve of these patients would make them especially sensitive to changes in quality of care and, when utilised appropriately, ME calls could act as a more direct and sensitive indicator of patient morbidity, thereby providing a measure of quality of care that did not reflect solely timeliness.

It is well accepted that patients who are admitted from ED are in general more unwell, and this was reflected in our data. Emergency-admitted patients were almost twice as likely (4.2%) to trigger a ME call at some time during their admission than the total hospital inpatient cohort (2.2%) and nearly three times as likely as their non-emergency-admission counterparts (1.5%). In fact, emergency-admitted patients constituted 48% of all ME calls despite representing only 25% of all hospital admissions. These figures are consistent with other published studies.

THERMoSTAT did markedly improve the hospital’s NEAT compliance and during a time of significant growth in overall hospital activity. Throughout the entire study period, there was no change in the proportionate number of inpatients who triggered a ME call. This indicates that there was no change in the culture of calling MEs during this time. In this context, the lack of an increase in the number of emergency admission inpatients who triggered a ME call suggests that THERMoSTAT did not result in any increased levels of physiological instability among ED-admitted patients and hence it indicates that it did not compromise patient safety or quality of care.

We particularly sought evidence of changes in ME call incidence that occurred early in the emergency admission period (within either 4 or 24 h of admission) when the impact of how a patient was managed in the ED would be at its greatest and before inpatient ward management could modify any of the effects of the recent ED management (or mismanagement). We discerned no change in the number of emergency admission inpatients who triggered a ME call within either the first 4 h or the first 24 h of their transfer out of the ED.

The ME call data was corroborated by the other KPIs that were also monitored with the introduction of THERMoSTAT. The THERMoSTAT model of care and its KPIs have been described in greater detail elsewhere, but of note here, there was no evidence that THERMoSTAT resulted in any inappropriate or premature discharge of patients from ED (THERMoSTAT was not associated with any change in the rate of patients who re-presented to ED within 48 h of discharge from ED), nor any evidence that THERMoSTAT resulted in inappropriate allocations among admitted patients (as demonstrated by no change in the percentage of patients who were transferred across divisions within 24 h of their emergency admission), and only a minor increase (equivalent to approximately one additional patient per day) occurred in the number of emergency admissions that were discharged within 24 h (excluding emergency short-stay admissions), which may suggest a mildly more conservative attitude towards admission. All of these results are consistent with the ME call data, which suggests that the general physiological stability of emergency admission patients transferred to the general hospital wards was also unchanged post-THERMoSTAT.

Further studies are required to validate the utility of ME call data as a measure of quality of ED care. However if this study hypothesis is substantiated, then ME calls may prove to be a more direct, simple and objective means to monitor changes in the safety of patients. It may be sensitive enough to detect subtle changes and should be able to provide rapid feedback that would facilitate earlier intervention if concerns are identified.

**Limitations**

The results in this study are reliant on appropriate activation of ME calls. Like all measures, ME call data is subject to both under- and over-reporting. Recognising and responding to deteriorating patients is a key focus for our facility. In the 2 years preceding the commencement of this study, the hospital had invested heavily in staff education and training in recognising and responding to the deteriorating patient and management were confident that a robust culture around appropriate triggering of ME calls had been established.

**Conclusions**

The ED model of care, 'THERMoSTAT', which was introduced in the RBWH ED in February 2013 has safely and efficiently resulted in substantial improvements in the hospital’s NEAT compliance, as previously described. In an effort to identify KPIs that reflect the quality of care using metrics other than only timeliness, ME call data was analysed. ME call data was chosen because the ME call rate has been shown to be a measure of morbidity and to therefore reflect patient safety and quality of care. THERMoSTAT did not result in any increase in the number of emergency admission patients who triggered ME calls, including calls triggered in the hours immediately after transfer from the ED. These results were consistent with all other monitored ED KPIs, and indicate that ME call incidence among emergency admission patients has promise as an objective measure of quality of ED care, and one which has a focus more broad than only the timeliness of care.

These findings are significant because this is the first report to investigate the correlation between inpatient ME call incidence and ED quality of care. We suggest that further testing of the utility of ME call incidence is warranted, since it may prove to be an easily measured and more direct, meaningful and sensitive measure of quality of care than many of the currently used indicators.

**Competing interests**

The authors declare there are no competing interests.

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