



Clinical paper

A review of rapid response team activation parameters in New Zealand hospitals[☆]Alex Psirides^{a,*}, Jennifer Hill^b, Sally Hurford^c^a Intensive Care Specialist, Intensive Care Unit, Wellington Regional Hospital, Wellington, New Zealand^b Australian Commission on Safety and Quality in Health Care, GPO Box 5480, Sydney, NSW 2001, Australia^c Intensive Care Unit, Wellington Regional Hospital, Wellington, New Zealand

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ABSTRACT

Objective: To review current systems for recognising and responding to clinically deteriorating patients in all New Zealand public hospitals.

Design: A cross-sectional study of recognition and response systems in all New Zealand public hospitals was conducted in October 2011. Copies of all current vital sign charts and/or relevant policies were requested. These were examined for vital sign based recognition and response systems. The charts or policies were also used to determine the type of system in use and the vital sign parameters and trigger thresholds that provoke a call to the rapid response team.

Setting: All New Zealand District Health Boards (DHBs).

Main outcome measures: Physiological parameters used to trigger rapid response, the weighting of any early warning score assigned to them, type of system used, values of physiological derangement that trigger maximal system response.

Results: All DHBs use aggregate scoring systems to assess deterioration and respond. A total of 9 different physiological parameters were scored with most charts (21%) scoring 6 different parameters. All scored respiratory rate, heart rate, systolic blood pressure and conscious level. 86% scored oliguria, 14% polyuria, 33% oxygen saturation and 24% oxygen administration. All systems used either aggregate scores or a single extreme parameter to elicit a maximal system response. The extremes of physiological derangement to which scores were assigned varied greatly with bradypnoea having the greatest range for what was considered grossly abnormal.

Conclusion: A large variance exists in the criteria used to detect deteriorating patients within New Zealand hospitals. Standardising both the vital signs chart and escalation criteria is likely to be of significant benefit in the early detection of and response to patient deterioration.

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1. Introduction

Serious adverse events in hospitalised patients may occur because severe clinical deterioration is not recognised or responded to.^{1–4} Several papers have highlighted the fact that vital sign derangements may be seen many hours before these events occur,⁵ and several systems have been developed with a view to promoting early recognition and response to clinical deterioration.^{6,7} One key aspect of these systems has been the development of processes where derangements in vital sign values are used to trigger escalation of care and a pre-determined clinical response.

There are a number of models for recognition and response systems in use internationally. These vary in the vital sign parameters and trigger thresholds that are used, as well as in the composition of the response team. Some systems, for example the medical emergency team (MET) model developed in Australia,⁸ use derangement in a single vital sign parameter to trigger escalation of care. Other systems, such as the early warning score (EWS) model originally developed in the United Kingdom, use an aggregate of scores assigned to multiple vital sign parameters which are scored according to their deviation from the norm.⁹ Combination systems use both single parameter and aggregate scores to trigger escalation of care.¹⁰

Some systems trigger an escalating series of graded responses to increasing levels of vital sign derangement whilst others trigger a single emergency response to patients with severe physiological abnormality. This latter response is commonly provided by a team of medical and/or nursing staff with advanced life support training.¹¹ The introduction of early warning score based rapid response systems in New Zealand hospitals became widespread

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following their increased adoption in the United Kingdom and Australia.^{12,13} While both Australia and the United Kingdom have centralised bodies providing national guidance on this work (the National Institute for Clinical Excellence (NICE) in the United Kingdom and the Australian Commission on Safety and Quality in Healthcare (ACSQHC) in Australia), New Zealand currently does not. Standardisation of clinical processes is a useful component of many patient safety initiatives. Internationally there are several calls for a unified approach to the development of recognition and response systems. Work is currently underway in the United Kingdom to develop a national EWS^{14,15} and ACSQHC have produced several publications outlining a national approach to the implementation of systems for recognising and responding to clinical deterioration.^{16–18}

The relatively small numbers of public hospitals in New Zealand may enable a unified strategy to be adopted to address the problem of delayed or inadequate responses to clinical deterioration. To inform this process, we surveyed the rapid response systems in place in all New Zealand public hospitals. A recent survey of recognition and response systems in use in Australian hospitals was conducted by the ACSQHC which provides a useful dataset with which New Zealand practice can be compared.¹⁹

2. Methods

A cross-sectional study of rapid responses systems in all 20 New Zealand District Health Boards (DHBs) was performed. All staff members with a safety and quality portfolio were contacted by email in October 2011. They were asked to supply electronic or paper copies of current vital sign charts or policies referring to any rapid response system used in the care of adult in-patients (aged 18 years or older) within their institution. Documents were obtained from all DHBs and available for analysis from January 2012. Seven DHBs supplied only their current policy, seven supplied only their current vital signs chart, and six supplied both. Where a DHB provided only a single document, relevant data were able to be extracted to permit system analysis from this alone. A single DHB supplied two different scoring systems in use in different hospitals meaning 21 complete systems from 20 DHBs were available for analysis. All of the systems applied only to patients being cared for in general ward areas; critical care areas such as intensive care, emergency or post-anaesthetic care units were excluded. No individual or grouped patient data were requested or provided; as such the study was granted expedited ethical approval.

Each chart or policy was examined and the relevant data extracted and recorded using a Numbers spreadsheet template (Apple Incorporated, 2009; Apple, Cupertino, CA, USA). The charts and policies were analysed to determine the type of system in use (single parameter, aggregate score, or combined system). The data extracted included which vital sign parameters were assigned scores, how the score was weighted for increasing physiological derangement from the norm, and the range of the scoring system used within each institution. The total maximum score possible was calculated for each individual system. Rapid response call triggers were examined to determine whether a maximum system response (attendance of a MET for example) could be triggered from a single parameter or by aggregate score only.

Additional data collected included whether the chart permitted modification of the scoring system to allow for 'normalisation' of physiological abnormalities specific to that patient, and if this was possible, whether restrictions were placed upon which staff members were allowed to make such modifications. The final dataset was then analysed for similarities and disparities.

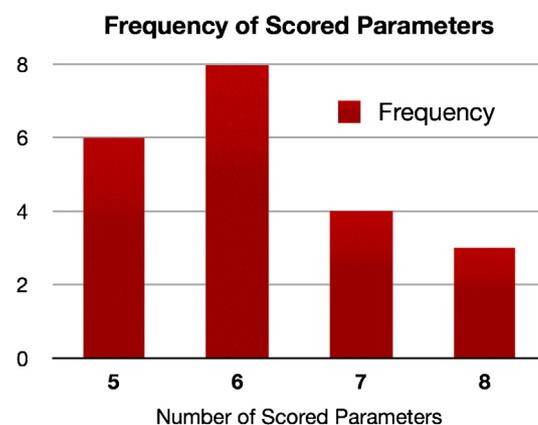


Fig. 1. Frequency distribution of the number of parameters assigned early warning scores on vital sign charts.

3. Results

All New Zealand DHBs utilise observation charts with inbuilt escalation systems based on the measurement of patients' vital signs. All of the systems used a combination model to trigger an escalation response, either when an aggregate EWS breached stated thresholds, or through extreme derangement of a single parameter. A maximal system response (i.e. a rapid response call to a MET or cardiac arrest team) could be triggered by either means in all twenty DHBs. Five systems assigned a single high score to an outlying vital sign in order to trigger a maximal system response. For example, four institutions where a total score of 5 initiated a MET call assigned a score of 5 to severe derangement in a single parameter.

3.1. Parameters assigned scores

A total of nine different physiological parameters were assigned scores across all 21 systems. These were respiratory rate, heart rate, systolic blood pressure, temperature, urine output, oxygen saturation, administered oxygen flow rate, level of consciousness and threatened airway. Of these nine, the total number of scored parameters on any single system ranged from five to eight, with eight systems assigning scores to six different parameters (see Fig. 1).

All 21 systems scored respiratory rate, heart rate, systolic blood pressure and level of consciousness. Eighteen (86%) scored oliguria with only three (14%) scoring polyuria. Only seven (33%) assigned any EWS to oxygen saturation with five (24%) scoring need for oxygen administration. All systems using these parameters allowed both saturation and oxygen administration to be scored independently of each other (i.e. hypoxia despite oxygen administration scores more than either being present alone). Where oxygen saturation was assigned an EWS, it was determined without consideration of supplied oxygen flow rate.

3.2. Extreme parameter values assigned maximal scores

Bradypnoea had the widest range of trigger values with nine systems (43%) assigning maximal score to a respiratory rate ≤ 8 and three (14%) not doing so until the rate was ≤ 4 . The variability for tachypnoea was less with 15 systems (71%) assigning maximal score to a respiratory rate ≥ 30 , one system ≥ 35 , and five systems (24%) requiring a rate of ≥ 40 before a maximal score was assigned. For tachycardia, the value most frequently assigned a maximum score was ≥ 130 (ten systems (48%)) followed by ≥ 140 (six systems (29%)). The lowest value assigned a maximum score for tachycardia was ≥ 120 (two systems (10%)). For the nine systems (43%) that

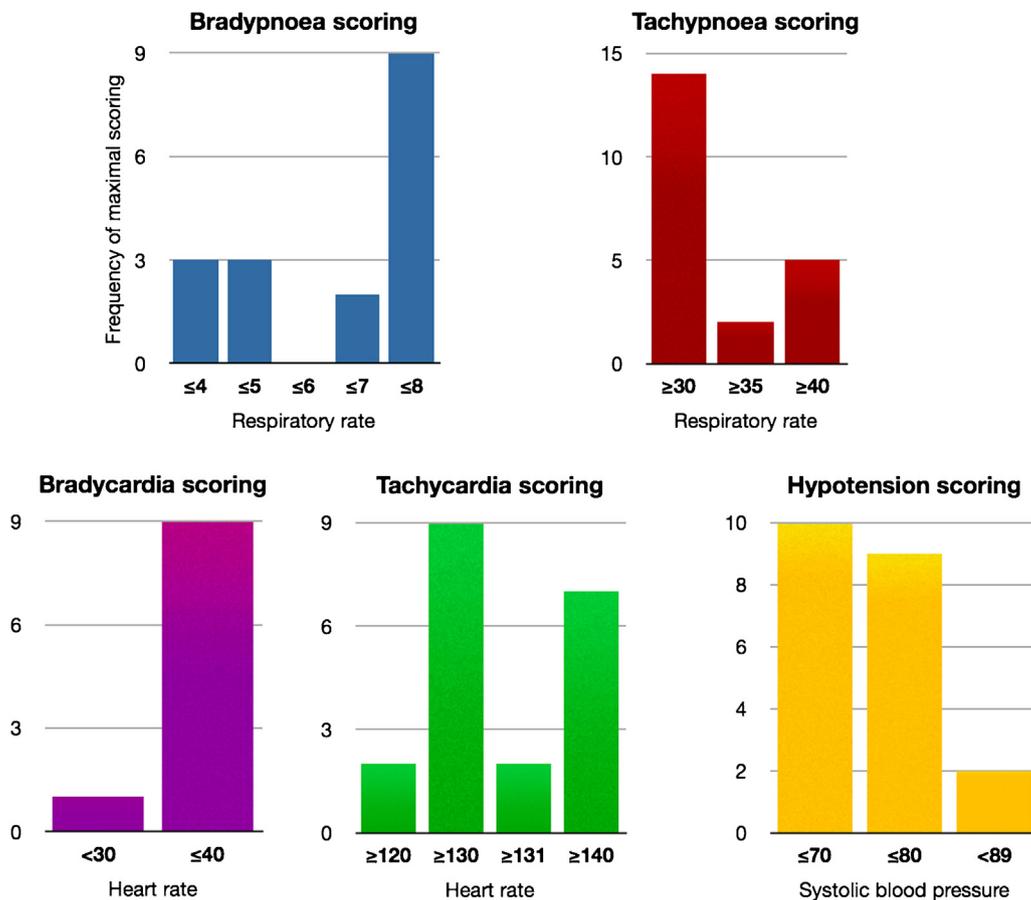


Fig. 2. Frequency of extreme vital sign parameters to which maximal early warning scores were assigned.

scored bradycardia maximally, nine used a heart rate ≤ 40 , with one not triggering a response until < 30 (see Fig. 2).

3.3. Score weightings

The most common range of scores assigned within each parameter (found in 14 institutions) was 0–3. In four of these institutions a maximum system response was triggered at a total EWS of ≥ 3 . At the other end of the spectrum, three DHBs required a total EWS ≥ 7 before a maximum system response occurred, however in all cases an emergency call was also triggered by extreme derangement in a single parameter.

All systems assigned a maximum score to hypotension, unconsciousness (defined as ‘unresponsive’ on the AVPU scale) and bradycardia. All but one system assigned a maximum score to tachycardia. Seventeen systems (76%) assigned a maximum score to bradypnoea with only 12 (57%) doing the same for bradycardia.

Five systems (24%) assigned a maximum score to hypothermia (defined as temperature $< \text{or } \leq 35^\circ\text{C}$) with four (19%) scoring the same for hyperthermia (defined as temperature $\geq 38.1\text{--}38.6^\circ\text{C}$). All hypotension was scored by systolic blood pressure only; no systems scored any diastolic measurement (but all vital sign charts recorded it).

The total maximum aggregate score possible (when all scored parameters were maximally deviated) ranged from 5 to 24. Where an aggregate score was able to trigger a maximal system response, the range of the minimum scores at which this was possible was 3–8. Expressing the latter score as a percentage of the former gave a range of 13–100%.

3.4. Alteration of scores, observation frequency and escalation

Of the 21 policies and vital sign charts provided, 16 of them allowed the EWS weighting to be altered. Of these 16, 12 specified such alterations were to be made only by medical staff with two specifying this was to be done only by a consultant. Two charts also allowed modification of parameters by the nurse practitioner or Patient At Risk (nurse) team. Of the remaining systems, three did not specify authority to change parameter weighting.

Thirteen of the 21 policies and charts provided specific instructions indicating the frequency with which patient observations should be performed. Frequency of vital sign measurements was increased as the EWS increased. The remaining systems included either non-specific statements such as ‘review frequency of observations’ or no suggestion that the frequency of subsequent observations should be changed if the score increased.

Nineteen of the 21 policies and charts provided information on the escalating series of graded responses for deranged physiology. Eight (42%) of these had four graded levels of escalation, ten (48%) had three levels. A single chart had two levels of escalation; this was from the institution that provided two charts and was the system in use at the smaller hospital within that DHB.

4. Discussion

This is the first cross-sectional study to describe the national variance in systems used to detect clinical deterioration in adult patients. Its main strength is the 100% response rate allowing a complete comparison of national practice at a single point in time.

Limitations of our study are that the systems analysis is based entirely on supplied documentation that may not accurately reflect actual practice. Compliance with such systems may be variable. As such our findings only relate to the intent of individual DHBs rather than what may actually occur within them.

The finding that all New Zealand DHBs utilise EWS systems is comparable to a 100% use in acute medical admissions reported in a survey of 48 United Kingdom institutions.¹⁴ In a similar survey of 220 Australian hospitals only 35% of respondents reported that such a system was in use.¹⁹ All New Zealand DHBs used a track and trigger system that requires calculation of a score; the Australian survey reported infrequent use of score-based systems except in larger or metropolitan hospitals where it was more common. This compares to the 48% of surveyed centres in the United Kingdom who reported using weighted scoring systems. Only 5 of the New Zealand charts surveyed contained explicit instructions that rapid response systems could be activated if the staff were 'worried' despite some evidence that in MET hospitals, this was the most frequent reason for escalation.²⁰

The considerable variation in the parameters used and the weighting of assigned scores is of interest. Given that geographical variation in abnormal physiology would seem to be unlikely, this reflects the lack of agreement or evidence of the 'ideal' system. This has been commented on previously.²¹ The ACSQHC guidelines specify a minimum physiological observation dataset (respiratory rate, oxygen saturation, heart rate, blood pressure, temperature and level of consciousness) with which all New Zealand DHBs complied.¹⁶ Level of consciousness was scored in 100% of New Zealand systems but in only 85% of United Kingdom systems.¹⁴ The scoring of oxygen saturation in 33% of New Zealand systems compares to 65% of United Kingdom systems. Only respiratory rate, heart rate and systolic blood pressure were scored in all of the United Kingdom systems surveyed. Beyond identification of a core observation set, neither ACSQHC nor NICE make specific recommendations about which parameters should be included as triggers for escalation in a recognition and response system, though ACSQHC state that from a human factors point of view there should be a maximum of nine parameters included on an observation and response chart (any number of which may have scores assigned). All New Zealand systems complied with this recommendation. A variety of parameters based on investigations (pH, base deficit, blood sugar, abnormal electro-cardiogram) rather than vital signs have been described as rapid response triggers in Australian systems¹²; no investigation-based triggers were present in any New Zealand system.

Two DHBs indicated that variants in systems existed for different hospitals within their organisation. Both these variants were for smaller hospitals without intensive care units; one system used lower thresholds for escalation whereas the other used the same thresholds as their larger affiliated hospital but escalated the seniority of the responder sooner (i.e. consultant notification rather than registrar). Both charts contained an aggregate score trigger that prompted referral to their larger affiliated hospital.

Given variety in the size, staffing levels and skill-mix within New Zealand DHBs, this would seem to be an appropriate adaptation and an innovative use of scoring systems. Larger DHBs tended to have more escalation stages in their graded response, often including an 'Outreach' or 'Patient At Risk' nursing service early on. Smaller hospitals are often medically staffed solely by house surgeons (first or second year junior doctors) and consultants so the scope for escalating between these extremes is limited. Although the rapid response team composition was not investigated, only five of the 20 DHBs have tertiary intensive care from units where registrars would be available to provide 24h cover for medical emergency teams or their local equivalent.

None of the systems surveyed included any form of patient or family activation although internationally these systems have been described.²²

The vital sign thresholds at which escalation occurs are markedly variable and are comparable to those seen in a recent Australian review.¹² Whilst several authors have investigated the sensitivity and specificity of specific calling criteria,^{15,23,24} the largest dataset currently available to guide escalation parameters is a longitudinal analysis of 1.15 million vital signs in 27,722 patients.²⁵ This formidable series allows stratification of vital signs for mortality. Applying the criteria in this paper to the vital sign thresholds most frequently used to trigger a rapid response call in New Zealand hospitals suggests a 10% in-hospital mortality rate for patients who breach a single threshold for bradypnoea (≤ 8), tachypnoea (≥ 30), tachycardia (≥ 130) or hypotension (systolic ≤ 70). Five (24%) New Zealand systems trigger a rapid response with a level of tachypnoea (≥ 40) associated with a 25% in-hospital mortality rate. All New Zealand systems trigger maximally for a patient with a neurological status of 'unresponsive,' also associated with a 20% in-hospital mortality rate in this series. This high mortality suggests there may be benefit in initiating a rapid response earlier although comparison between institutions even within a single country is difficult given the range of responder expertise. A highly specialised team with several response levels may give equally good or better treatment at a lower response level than a general ward in which a maximal response is elicited. It may also be that in an effort to avoid 'over-calling' the deteriorating patient, emergency systems activation parameters may be set too high in some institutions. Earlier activation is supported by Jones et al²⁶ in a paper citing in-hospital mortality rates of 14.6% for patients with abnormal vital signs and approximately 25% for patients who require MET calls. Both these mortality rates are higher than the 6.5% quoted for almost 270,000 patients admitted to Australasian intensive care units.²⁷

Several authors have called for a national standardised approach to early warning scores^{14,15} and rapid response systems with, for example, the new Australian National Safety and Quality Health Service Standards including the establishment of these systems in acute health facilities as a mandatory requirement for hospital accreditation from 2013. In contrast, the development of recognition and response systems in New Zealand public hospitals remains ad hoc and mostly driven by individuals.

5. Conclusions

A large variance exists in the criteria used to detect deteriorating adult patients within New Zealand public hospitals. The development of a national EWS and observation and response chart could potentially provide a number of patient safety and operational benefits. A single system would enable teaching at the undergraduate level, ensure staff familiarity when moving between hospitals, be better able to represent expert opinion and include human factors expertise in chart graphic design, allow national rather than regional promotion of the system, and greatly simplify data collection and reporting, with inter-DHB outcomes being more comparable. It would also address many of the disparities we have identified. While a great deal of initial work would be required to reach consensus and validate any such system, by ensuring that the patients who deteriorate in our hospitals receive appropriate and timely care we are likely to save both lives and money.

Conflict of interest statement

No conflicts of interest to declare.

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