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Clinical paper

Changes and their prognostic implications in the abbreviated Vitalpac™ early warning score (ViEWS) after admission to hospital of 18,853 acutely ill medical patients☆

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ABSTRACT

Background: The best performing early warning score is Vitalpac™ Early Warning Score (ViEWS). However, it is not known how often, to what extent and over what time frame any early warning scores change, and what the implications of these changes are.
Setting: Thunder Bay Regional Health Sciences Center, Ontario, Canada.
Methods: The changes in the first three complete sets of the six variables required to retrospectively calculate the abbreviated version of ViEWS (that did not include mental status) after admission to hospital of 18,853 acutely ill medical patients, and their relationship to subsequent in-hospital mortality were examined.
Results: In the 10.4 SD 20.1 (median 5.0) hours between admission and the second recording the score changed in only 5.9% of patients and these changes were of no prognostic value. By the time of the third recording 34.9 SD 21.7 (median 30.0) hours after admission a change in score was clearly associated with a corresponding change in in-hospital mortality (e.g. for patients with an initial score of 5 an increase between the first and third recording of ≥4 points was associated with an increased mortality (OR 6.5 95% CI 2.3–15.9, $p < 0.00001$), whereas a reduction of ≤−4 points was associated with a reduced mortality (OR 0.4 95% CI 0.2–0.9, p 0.03)).
Conclusion: After a median interval of 30 h both the initial abbreviated ViEWS recording and subsequent changes in it both predict clinical outcome. It remains to be determined what interventions during this time frame will improve patient outcomes.

1. Introduction

In 1997 Morgan and colleagues described the first early warning score system, designed to alert clinicians to deteriorating patients using aggregate weighted scoring of vital signs.[1] Many variations have since been published.[2] Tarassenko et al.[3] have suggested that "normal" patients will probably have vital signs close to the normal range (i.e. low early warning score), whereas unsalvageable patients will have extremely abnormal vital signs (i.e. very high early warning score), and those of deteriorating but salvageable patients will have vital signs somewhere between. This intuition implies that seriously ill patients are more likely to deteriorate and less likely to improve than those with mild illness. This, however, may not be the case as at some point in the evolution of all serious illness the patient would have appeared to be only mildly ill. Only in retrospect can the significance of the initially mild signs and/or symptoms be appreciated. The Simple Clinical Score (SCS) is a reliable independently validated instrument that objectively assesses and measures severity of illness.[4–7] We recently reported that approximately12% of patients increase their SCS 24 h after admission to hospital. Patients with low scores were just as likely to increase their SCS as high scores, and regardless of the initial score an increased SCS was associated with a 5 fold increase in in-hospital mortality compared to patients with an unchanged SCS and a 20 fold increase in mortality compared to those with a decreased SCS.[8] This, however, was a small study of only 1000 hospital admissions, and has yet to be confirmed by others.

Despite evidence that physiological instability precedes critical clinical deterioration[9–12] early warning score systems have not

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been shown to improve patient outcomes.[2,13,14] The obvious explanation of this failure to demonstrate benefit is lack of any evidence based consensus on how to respond to elevated and/or changing early warning scores. At present it is not known how often, to what extent and over what time frame early warning scores change, and what the implications of these changes are. Without this information it is impossible to develop rational treatment protocols on how to respond to them.

At the present time the best performing early warning score is Vitalpac™ Early Warning Score (ViEWS).[15] The score's discrimination and calibration has been internally and externally validated, and so far it appears to be universally applicable. As a result, a slightly modified version of ViEWS has been proposed as a National Early Warning Score by the Royal College of Physicians in the UK.[16] We recently reported validation of an abbreviated version of ViEWS that did not include changes in mental function.[17] This study confirmed that patients with a high score on admission are more likely to die. We hypothesized that a subsequent change in the score would also correlate with outcome. This present study reports changes in the first three recordings of the abbreviated ViEWS after admission to hospital of acutely ill medical patients, and their relationship to subsequent in-hospital mortality.

2. Methods

2.1. Setting

Thunder Bay Regional Health Sciences Center (TBRHSC) is a 375 bed hospital that is the major regional referral center for north western Ontario, an area of 526,000 thousand square kilometers between Hudson Bay and the north shore of Lake Superior with a population of 250,000.

2.2. Study design

This was a retrospective observational study with prospectively collected data. Since 2005 all patients admitted to TBRHSC have had their demographic details, vital signs on admission and subsequent clinical outcomes (e.g. length of stay, in-hospital mortality, etc.) routinely entered into the hospital's MediTech computer system. The system also routinely collects each patients oxygen saturation and whether or not they are on supplemental oxygen, but does not record patients' mental status. Data can be entered into the MediTech system at any time by nursing and other clinical staff. Vital signs are collected according to perceived clinical need, usually at 6–12 hourly intervals.

The MediTech database was used to retrospectively calculate an abbreviated ViEWS (which does not include mental status) for each patient at the time of their admission. The original ViEWS attributes up to 3 points to seven variables (i.e. temperature, systolic blood pressure, oxygen saturation, the use of supplemental oxygen, mental status, and pulse and breathing rate) and, hence, has a maximum value of 21 points. Since the abbreviated ViEWS does not include mental status its maximum value is 18 points (i.e. it attributes up to 3 points to six variables).

The anonymized age, vital signs, oxygen saturation, use of supplemental oxygen, length of stay and mortality of every patient over 15 years age admitted to TBRHSC from 1st January 2005 and 30th June 2011 was extracted from the hospital's MediTech system. The outcome of each medical patient's last recorded hospital admission was related to changes in the first three complete abbreviated ViEWS recorded after hospitalization. Although different vital signs may well have been recorded frequently after admission the abbreviated ViEWS could only be calculated when all six variables required to calculate the score were recorded. The last recorded admission was chosen to ensure that all the deaths that occurred were examined.

2.3. Statistical methods

Descriptive statistics were calculated including means/standard deviations (SD), medians, or percentages and statistical significance was tested using Student's *t*-test. Statistical significance difference between two categorical variables was determined by Chi-square analysis that applied Yates continuity correction provided all expected cell frequencies were equal to or greater than five. Otherwise the two-tailed Fisher exact probability test was used. The p value for statistical significance was < 0.05.

Ethical approval of the study was obtained from the Research Ethics Board for Thunder Bay Regional Health Sciences Center.

3. Results

3.1. Patient cohort

Between 1st January 2005 and 30th June 2011 there were 86,594 admissions of 38,698 patients (i.e. an average of 2.3 admissions per patient): 18,827 (48.7%) of these patients were admitted to surgery, 1018 (2.6%) to ICU and 18,853 (48.7%) to medicine. Almost all the 18,853 medical patients (99.6%) had a complete set of the six variables required to calculate the abbreviated ViEWS recorded at the time of admission, 82.0% for a second time and 65.6% for the third time.

The changes between the first, second and third abbreviated ViEWS recorded could not be examined in over 40% of patients because they had already died (36 patients) or they had been discharged (248 patients) or they never had three complete sets of the six required variables recorded (7717 patients). The remaining 10,852 patients had a mean age of 66.1 SD 18.5 (median 69.0) years and hospital length of stay of 10.3 SD 18.1 (median 6.0) days – the 805 (7.4%) patients who died were older (76.6 SD 12.6 versus 65.2 SD 18.6 years, $p < 0.00001$), had a longer length of stay (15.5 SD 24.5 versus 9.9 SD 17.4 days, $p < 0.00001$), and a higher abbreviated ViEWS on admission (4.5 SD 3.0 versus 2.2 SD 2.3, $p < 0.00001$). Although the mean initial abbreviated ViEWS recorded was 2.3 SD 2.4 with a median value of 2.0 only 508 (4.7%) patients had a score greater or equal to 8 – these patients, therefore, had to be combined in order to provide enough data for statistical analysis.

The second abbreviated ViEWS was recorded 10.4 SD 20.1 h (median 5.0, range 0–549, 99% were within 60 h), and the third recorded 34.9 SD 21.7 h (median 30.0, range 3–578, 99% within 84 h) after admission – there were no significant differences in these timings between patients who died and those who survived, and patients with high initial abbreviated ViEWS did not have a second or third abbreviated ViEWS recorded sooner or later than those with lower scores.

3.2. Outcome by changes between the first and second abbreviated ViEWS recording

In the median five hour interval between the first and second recording of the abbreviated ViEWS it only increased in 2.1% and decreased in 3.8% of patients. Paradoxically those patients with reduced scores and not those with increased scores were statistically more likely to die in hospital (Table 1). However, when examined according to the initial abbreviated ViEWS recorded there was no statistically significant change in in-hospital mortality associated with either an increase or decrease in abbreviated ViEWS. Although, the number of patients was small, and in many cases insufficient for statistical analysis, some patients with decreased scores soon after admission had a higher in-hospital