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Clinical paper

Changes and their prognostic implications in the abbreviated VitalPAC™ Early Warning Score (ViEWS) after admission to hospital of 18,827 surgical patients☆

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ABSTRACT

Background: It is not known how often, to what extent and over what time frame any early warning scores change in surgical patients, and what the implications of these changes are.
Setting: Thunder Bay Regional Health Sciences Centre, Ontario, Canada.
Methods: The changes in the first three recordings of the abbreviated version of the VitalPAC™ Early Warning Score (ViEWS) after admission to hospital of 18,827 surgical patients, and their relationship to subsequent in-hospital mortality were examined.
Results: In the 2.0 SD 2.4 h between admission and the second recording the score changed in 12.6% of patients. If the initial abbreviated ViEWS was ≤2 points (78% of all patients) the in-hospital mortality was 0.5%, and not significantly different in the 3.7% of patients that either increased or decreased their score. Patients who had an initial score ≥3 had a significantly higher overall in-hospital mortality (odds ratio 5.48, Chi-square 120.72, $p < 0.0001$). Of these patients, those with a lower second score (42.3% of patients) had a significantly lower in-hospital mortality than those with an unchanged second score (i.e. 1.5% versus 3.3%, odds ratio 0.43, Chi-square 11.08, $p < 0.001$).
Conclusion: The abbreviated ViEWS score measured on admission identifies the majority of surgical patients who are at low risk of in-hospital death. Patients with an initial abbreviated ViEWS ≥3 who do not reduce their score within 2–3 h of admission have a further significantly increased mortality.

1. Introduction

In 1997 Morgan and colleagues described the first early warning score system (EWS), designed to alert clinicians to deteriorating patients using aggregate weighted scoring of vital signs.[1] Stenhouse et al. evaluated a modified form of this score in 206 surgical patients over 9 months.[2] At the present time the EWS that predicts mortality within 24 h best is the internally and externally validated VitalPAC™ Early Warning Score (ViEWS)[3–5] on which the National Early Warning Score of the United Kingdom and the Republic of Ireland is based.[6]

Despite evidence that physiological instability proceeds critical clinical deterioration[7–10] early warning score systems alone cannot be expected to improve patient outcomes as there is no consensus on how to respond to elevation and/or changes in any of these 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.

An abbreviated version of ViEWS that does not include changes in mental function has a similar discrimination and performance to ViEWS.[5] We recently reported that there were no changes in the abbreviated ViEWS in the vast majority of acutely ill medical patients during the first few hours after their admission to hospital and that if changes did occur these changes carried little or no prognostic information.[11] It was not until the third abbreviated ViEWS recording that a change in score was clearly associated with a corresponding change in in-hospital mortality. In this study we have examined a large cohort of surgical patients to determine if changes in their abbreviated ViEWS after admission are similar to

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those of medical patients, and if they carry the same prognostic significance.

2. Methods

2.1. Setting

Thunder Bay Regional Health Sciences Centre (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 adult patient (i.e. 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 surgical patient's last recorded hospital admission was related to changes in the first three complete abbreviated ViEWS recorded after hospitalization. The surgical services offered by TBRHSC are general, neurosurgical, orthopedics, ear, nose and throat, gynecological, plastic, oral and dental, ophthalmology, thoracic, vascular and urology. However, the MediTech system only separately identifies orthopedic surgery, neurosurgery and major life threatening trauma surgery from all other (general) surgery performed.

During the study period 18,209,676 vital signs were entered into the MediTech system – and average of 27 vital signs per patient per day. However, the abbreviated ViEWS could only be calculated when all six variables required to calculate the score were recorded at the same time. Only one admission was chosen to ensure that a patient could only be included once in the study, thus eliminating the bias of unusual patients that might survive repeated episodes of severe illness, such as a multiple sclerosis patient with recurrent urinary sepsis. The last recorded admission was selected 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. Trend analysis was performed as described by Schlesselman.[12] 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 and approximately one-third were admitted electively. Of these patients 16,049 (85.4%) were classified in the MediTech system as general surgical, 1537 (8.2%) as orthopedic, 1136 (6.0%) as neurosurgical and 78 (0.4%) as major trauma patients. None of the 1018 patients admitted to ICU were included in this study.

Almost all the surgical patients (99.6%) had a complete set of the six variables required to calculate the abbreviated ViEWS recorded at the time of admission and 15,230 patients (81.0%) for a second time within 24 h of admission (mean 2.0 SD 2.4, median 1.0 h, range 0–24 h). The changes between the first and second abbreviated ViEWS recorded could not be examined in the remaining 18.5% patients because they had already died (6 patients) or they had been discharged (777 patients) or they never had a second abbreviated ViEWS recorded (2702 patients) or more than 24 h elapsed before the second score was recorded (143 patients). Only 13,097 (69.6%) of patients had a third abbreviated ViEWS recorded within 48 h of admission (mean 25.6 SD 3.4, median 25.0, range 0–48 h).

The 15,230 patients who had a second score recorded had a mean age of 55.8 SD 18.7 years and hospital length of stay of 5.1 SD 6.1 days, and 146 of them (1.0%) died in hospital. No orthopedic or trauma patients died in hospital, and there was no difference in the mortality rates between general surgical and neuro-surgical patients (i.e. 1.1% versus 0.8%, p 0.60). The patients who died were older (80.1 SD 10.5 versus 55.5 SD 18.6 years, $p < 0.00001$), had a longer length of stay (13.0 SD 12.8 versus 5.0 SD 5.9 days, $p < 0.00001$), and a higher abbreviated ViEWS on admission (3.5 SD 2.6, median 3.0, IQR 1.0–5.0 versus 1.4 SD 1.7, median 1.0, IQR 0–2, $p < 0.00001$).

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

Between the first and second recording of the abbreviated ViEWS it decreased in 10.8% and increased in 1.8% of patients (Fig. 1). Even when examined according to the initial abbreviated ViEWS there was no statistically significant change in in-hospital

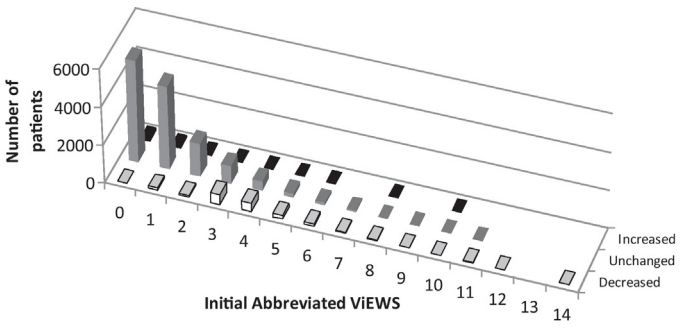

Fig. 1. Number of patients with increased, unchanged and decreased second abbreviated ViEWS according to the initial score.