Missed opportunities? An observational study of vital sign measurements

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ABSTRACT

Objective: To determine the frequency of monitoring of patient vital signs in two wards of a tertiary hospital.
Methods: A retrospective observational study of patient charts from two wards was conducted for a 48-hour period (Sunday and Monday, 23 and 24 October 2005). All vital sign readings from all patient charts were collected.
Results: 1597 unique vital signs were recorded in 62 patients. Frequency of documentation was significantly lower for respiratory rate than for all other vital sign measurements: respiratory rate, 1.0 reading/day, versus blood pressure, 5.0 readings/day; heart rate, 4.4 readings/day; and temperature, 4.2 readings/day ($P < 0.001$ for all comparisons). Comparisons between blood pressure, heart rate and temperature frequency measurements showed no statistical differences, but there were significant differences in overall collection frequency between the medical and the surgical ward (3.0 v 5.0 readings/day, $P < 0.001$).
Conclusion: Blood pressure, heart rate and temperature were the most diligently recorded vital signs, but documentation of respiratory rate was poor. Failure to perform vital sign measurements may underpin the failure to recognise patients in general wards whose condition is deteriorating.

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Modern medicine possesses a multitude of tools to assess patients and their illnesses. Among these, monitoring of vital signs provides a basic insight into the patient's overall condition and its stability or deterioration. A body of literature reveals an alarmingly high incidence of vital sign abnormalities before unplanned ICU admission and cardiorespiratory arrest,[1-5] and a proportion of hospital deaths are preceded by potentially correctable disease processes indicated by abnormal vital signs.[6,7]

Before a derangement of vital signs can be recognised, the signs need to be reliably and accurately recorded.[8] Hence, an appropriate frequency of vital-sign readings is critical for triggering a response to patients whose condition is deteriorating, and thereby avoiding unplanned ICU admissions and unexpected hospital deaths.[8] In addition, the degree of derangement of vital signs may help determine patient risk. Early warning systems, such as the Modified Early Warning Score (MEWS),[9,10] use physiological variables and their degree of derangement to assess the stability or deterioration of a patient's condition. MEWS is used in some health care settings[10,11] to determine whether further review or action is warranted.

This study aimed to establish the frequency of vital sign measurements in a medical ward and a surgical ward in a tertiary hospital, and to determine whether the frequency of measurement differed between specific vital signs.

Methods

This was a retrospective observational study conducted in two wards — a medical ward (Ward A) and a surgical ward (Ward B) — in an Australian tertiary, university-affiliated teaching hospital. The wards were chosen based on their consistently high levels of activity.

Vital sign audit

All patients residing in the two wards during a 48-hour study period were considered eligible for the study. The period chosen was 00:01 on Sunday 23 October to 23:59 Monday 24 October 2005 to obtain a continuous range of monitoring that represented an inclusive snapshot of a "slow" and a "busy" day. Staff were unaware of this retrospective audit to prevent bias in documentation of vital signs. The local jurisdictional human research ethics committee waived the need for informed consent.

Data collection

Data were collected from all patient observation charts. They comprised all measurements of blood pressure, heart rate, respiratory rate and temperature in the data collection period, the type of observation chart used for the recording, the patient's admission demographic data, admission diagnosis and hospital length of stay. Oxygen saturation was not collected because the general observation chart did not have a pro forma location for recording this measurement. Data were entered into a custom database (Office Access 2003, Microsoft, Seattle, Wash, USA) and were checked for inconsistencies and logical errors on entry.

MEWS measurements

Scoring criteria from the MEWS[9,10] were applied to each vital sign at each measurement time to determine whether

Table 1. Characteristics of patients included in the study

	Combined	Ward A	Ward B
No. of patients	62	31 (50%)	31 (50%)
Age (years): median (IQR)	67 (46–77)	57 (37–76)	70 (60–78)
No. of men	33 (53%)	21 (68%)	12 (39%)
Hospital length of stay (days): median (IQR)	6.8 (3.8–15.3)	5.0 (2.6–14.8)	8.4 (4.0–16.3)
Study observation time (days)			
Median time per patient (IQR)	2.0 (1.2–2.0)	1.9 (0.5–2.0)	2.0 (1.5–2.0)
Total time	97	44.3	52.7
General diagnostic categories			
Cardiovascular	12 (19%)	10 (32%)	2 (6%)
Other	11 (18%)	2 (6%)	9 (29%)
Other respiratory	8 (13%)	0	8 (26%)
Trauma	6 (10%)	5 (16%)	1 (3%)
Pneumonia	6 (10%)	1 (3%)	5 (16%)
Gastrointestinal	6 (10%)	5 (16%)	1 (3%)
Malignancy	5 (8%)	5 (16%)	0
Sepsis	4 (6%)	0	4 (13%)
Renal	4 (6%)	3 (10%)	1 (3%)

IQR = interquartile range.

the patient was at risk of deterioration. The score for each vital sign was determined using the criteria set out by Pittard.[9] A vital sign with a MEWS value ≥ 1 was considered deranged. When data for the MEWS calculation were missing, no assumptions were made about the missing data.

Statistical analysis and frequency calculations

Numerical data are presented as medians and interquartile ranges (IQRs), and categorical data as counts and percentages. Data were analysed using JMPIN 4.0.4 for Windows (SAS Institute, Cary, NC, USA, 2001). Numerical differences between vital sign types and wards were assessed using the Kruskal–Wallis test.

Frequency of vital-sign readings was calculated by dividing the number of vital sign recordings by the total minutes observed, yielding a frequency per minute per patient for each vital sign. Medians were scaled to units of readings per day. The total number of minutes that each patient was studied was determined from the individual's admission and discharge times, with a maximum study period of 2880 minutes (corresponding to 48 hours). All observation charts used for patients and vital sign patient progress notations were included in the frequency calculations. The usage of chart types per vital sign type was also tabulated to determine completion rate — how regularly a given vital sign was recorded for each discrete date and time entry.

Results

Patients

Sixty-five patients were eligible for the study (Ward A, 33; Ward B, 32), but three were excluded from the analysis (Ward A, 2; Ward B, 1) as their observation charts were not available. Of the 62 patients studied, 33 (53%) were men; casemix was varied, and the median length of hospital stay was 6.8 days (IQR, 3.8–15.3 days) (Table 1). All 62 patients survived to discharge, and there were no calls to the medical emergency team, unplanned ICU admissions or cardiac arrests. Vital sign measurements were located from five different types of observation charts.

Frequency of vital-sign readings

A total of 1597 unique vital-sign readings were collected: 681 (43%) from Ward A and 916 (57%) from Ward B. The frequency of documentation was significantly lower for respiratory rate than for all other vital signs: respiratory rate, 1.0 reading/day v blood pressure, 5.0 readings/day ($P<0.001$); v heart rate, 4.4 readings/day ($P<0.001$); and v temperature, 4.2 readings/day ($P<0.001$) (Table 2 and Table 3). However, there were no significant differences in the frequency of documentation of the other vital signs: blood pressure v heart rate, 5.0 v 4.4 ($P=0.46$), blood pressure v temperature, 5.0 v 4.2 ($P=0.19$), and heart rate v temperature, 4.4 v 4.2 ($P=0.59$)] (Table 2 and Table 3). Ward B (surgical) had a higher frequency of documentation of vital

Table 2. Total number and frequency of measurement of vital signs

	Combined	Ward A	Ward B
No. of measurements			
Total	1597 (100%)	681 (43%)	916 (57%)
Blood pressure	528 (33%)	226 (33%)	302 (33%)
Heart rate	493 (31%)	201 (30%)	292 (32%)
Respiratory rate	148 (9%)	71 (10%)	77 (8%)
Temperature	428 (27%)	183 (27%)	245 (27%)
Frequency (readings/day) (IQR)			
All vital signs	4.0 (2.0–5.4)	3.0 (1.9–4.0)†	5.0 (3.1–5.6)
Blood pressure	5.0 (3.4–5.8)	3.8 (2.0–5.5)*	5.5 (4.5–7.2)
Heart rate	4.4 (3.0–5.6)	3.8 (2.5–4.8)†	5.0 (4.0–7.2)
Respiratory rate	1.0 (0. 0–1.9)	1.3 (1.0–1.9)*	0.5 (0.0–2.0)
Temperature	4.2 (3.0–5.5)	3.0 (2.5–4.0)†	5.0 (4.5–5.9)

IQR = interquartile range.
* $P<0.01$, † $P<0.001$ for difference between Ward A and Ward B.

Table 3. Comparison of median frequency of readings between vital sign types

Comparison	Median frequency (readings/day)	*P*
Blood pressure versus		
Heart rate	5.0 v 4.4	0.46
Respiratory rate	5.0 v 1.0	< 0.001
Temperature	5.0 v 4.2	0.19
Heart rate versus		
Respiratory rate	4.4 v 1.0	< 0.001
Temperature	4.4 v 4.2	0.59
Respiratory rate versus		
Temperature	1.0 v 4.2	< 0.001

signs than Ward A (medical) (5.0 [3.1–5.6] v 3.0 [1.9–4.0], $P<0.001$) (Table 2).

Observation chart usage

Vital signs were collected from five distinct types of observation chart (Table 4). Recordings taken from patient progress notes (total, 123) were excluded from the determination of observation chart usage. Completion rates varied from 66% (42/64) to 81% (97/120) per chart type. The general observation chart was the most used chart type, with 1273 readings; its completion rate was 75% overall (1273/1688) and 24% for respiratory rate (101/422). The post-procedural observation chart had the highest completion rate, at 81% overall (97/120) and 73% (22/30) for respiratory rate.

Discussion

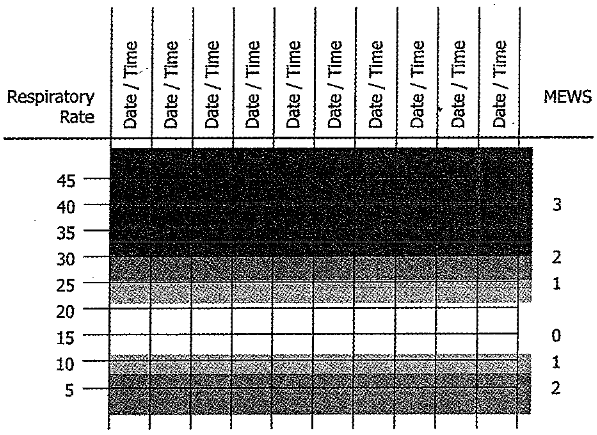
Patients whose condition is deteriorating have deranged vital signs, often hours before a significant event such as unplanned ICU admission, cardiac arrest or death.[1,2,6,7,12] A component of a systematic approach to managing the deteriorating patient may be a recognition system that uses vital signs to launch an appropriate response.[1,4,13] This recognition system involves reliably communicating the patient's condition to either the next shift or a medical assistance team.[13] The cornerstone of this system is to initially recognise the deterioration, which relies on measuring and charting vital signs.[13] Missing vital-sign measurements undermine the objective basis of determining patient status and any recognition system.

Our finding that respiratory rate is recorded at a low frequency is consistent with the results of others.[2,4,14,15] It is disappointing given that derangement of respiratory rate is a common antecedent to an unplanned ICU admission.[1,4,6] Hillman et al reported that increased respiratory rate is the second most common 8-hour antecedent to ICU admission from the ward, after the generalised category of "worry".[1] They also found that tachypnoea (specifically respiratory rate

Table 4. Observation chart usage and completion rates

Type of observation chart	No. of readings: Total taken	No. of readings: Maximum possible	Completion rate	Blood pressure	Heart rate	Respiratory rate	Temperature
Coronary care unit	42	64	66%	16 (100%)	16 (100%)	0	10 (63%)
General	1273	1688	75%	412 (98%)	392 (93%)	101 (24%)	368 (87%)
Neurological	11	16	69%	4 (100%)	4 (100%)	0	3 (75%)
Post-anaesthetic	51	68	75%	15 (88%)	16 (94%)	16 (94%)	4 (24%)
Post-procedural	97	120	81%	29 (97%)	26 (87%)	22 (73%)	20 (67%)
Patient progress	123	–	–	–	–	–	–

Figure 1. Prototype general observation chart section



Suggested shading of Modified Early Warning Score (MEWS) bands to facilitate immediate recognition of deranged vital signs (respiratory rate depicted).

greater than 36 breaths per min) is the second most common antecedent to preventable hospital deaths, after hypotension.[6] Others have also suggested that respiratory rate is an early, sensitive indicator for patient deterioration.[12,16,17] Our results suggest a significant mismatch between the relative importance of respiratory rate and its collection frequency. This is a concern as haphazard bedside readings may contribute to sudden changes being missed in the critically ill.[18]

An important determinant of recognising or missing patient deterioration is accurate interpretation of abnormal vital sign readings. However, as no unexpected deaths or unplanned ICU admissions and few derangements of vital signs occurred in our study, its power was inadequate to assess monitoring adjustments to vital sign derangements. Larger studies are required to determine whether nurses appropriately interpret and respond to abnormal vital sign measurements before the patient's condition deteriorates.

Our study found a median monitoring frequency for all vital signs of 3.0 readings/day (1.9–4.0 readings/day) in Ward A, and 5.0 readings/day (3.1–5.6 readings/day) in Ward B. Although our study was intrinsically limited by investigating only two wards over 2 days, these rates of measurement were similar to the results of Adam and Odell.[4] They found that blood pressure was monitored most often, and respiratory rate least often. The greater frequency of measurement on the surgical ward (Ward B) in our study was not unexpected, as the only hospital policy on vital sign measurement deals with postoperative measurement.[19] Although the precise cause of the difference in frequency between the medical and surgical wards is not certain, the difference is of concern given that more unplanned ICU admissions and higher mortality rates originate from the medical wards than from emergency departments and operating theatres.[1] Failure to monitor medical patients adequately may contribute to their poorer outcomes.

A limitation of our study was its inability to distinguish monitoring and recording of vital signs. Our data reflected only measurements recorded on patient charts, and it is possible that nursing staff monitored vital signs without annotating the charts. Although this may be common practice, the absence of recorded vital signs prevents other staff noticing trends in a patient's condition, thereby contributing to deterioration being missed.[18] A further limitation of our study was its conduct in a single centre, limiting its generalisability to other institutions. In addition, resource constraints prevented analysis of a full week of data. In light of this, we sampled a weekend day and a weekday to minimise bias. The success of this strategy is supported by the similarity between our results and those of Adam and Odell.[4]

We found evidence of inappropriate chart use, such as use of a coronary care chart in a general ward. Although we did not detect an overlap of individual recordings between charts, the appropriateness of using multiple chart types to record the same information and the potential for confusion has yet to be determined. Failure to recognise patient deterioration or a delay in this recognition arising from the use of multiple observation charts is a distinct possibility.

Our data also suggest an association between chart type and frequency of observations, but this did not reach statistical significance. The post-anaesthetic and post-procedural observation charts had high completion rates for respiratory rate and listed this vital sign alongside the other vital signs. In contrast, the general observation chart had a poorer completion rate for respiratory rate. It listed this sign towards the bottom of the chart, separate from the other vital signs and adjacent to entries such as bowel sounds. Hence, the design of the observation chart may have influenced the completion rate for respiratory rate.[20] However, another contributing factor to the difference in completion rate may be the critical care culture of postoperative and post-anaesthesia monitoring, which aims to detect respiratory depression.

Other possible reasons for the difference in respiratory rate collection frequencies may include a reliance on pulse oximetry and the general lack of a respiratory rate measuring device. Medical staff may view pulse oximetry as obviating the need for respiratory rate monitoring.[4] It is performed by an electronic device which provides relatively fast readings, like the devices for measuring heart rate, temperature and blood pressure. Outside the ICU and other close-monitoring environments, there is no common electronic device for measuring respiratory rate. More research is required to ascertain if this has a direct impact on its rate of collection.

Recognition of physiological abnormalities can be improved by measures focused on documenting vital signs, including appropriate education[21] and improved chart design.[20,22] Continuing education programs in the hospital might include subthemes about capturing and documenting all vital signs, especially respiratory rate. These programs can also dispel the myths regarding pulse oximetry as a respiratory rate substitute.[4] Equally important to improving the recording of vital sign measurements are user-friendly charts[8] that display all vital signs with equal prominence.

Transforming vital sign charting beyond a perfunctory task into a monitor for patient deterioration might be furthered by adding MEWS bands[22] to the general observation chart (Figure 1). Adding lightly coloured areas representing MEWS scores can immediately inform both the charter and the reader about current and historical patient status for any vital sign. Placing respiratory rate in a more prominent position on this newly designed chart would also emphasise its importance and decrease the likelihood of its being overlooked.[22]

Conclusions

Blood pressure, heart rate and temperature were the most diligently recorded vital signs, and respiratory rate was poorly documented. As systems are most effective and reliable when they are consistent and reproducible, a system of recognising patient deterioration relies on regular monitoring of vital signs in all patients and increasing frequency of monitoring for sick patients. By regularly neglecting to record respiratory rate, ward staff may be discarding a useful, proven and readily available monitor of deterioration, and consequently undermining the reliability of the recognition system. Simple measures, such as chart design and staff education, might improve monitoring frequency of all essential physiological variables and the detection of patients on the ward whose condition is deteriorating. Both measures require further study before wider adoption.

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