ISQua®

International Journal for Quality in Health Care, 2015, 27(3), 207–213
doi: 10.1093/intqhc/mzv019
Advance Access Publication Date: 17 April 2015
Article

OXFORD

Article

Attitudes towards vital signs monitoring in the detection of clinical deterioration: scale development and survey of ward nurses

WENQI MOK[1], WENRU WANG[2], SIMON COOPER[3,4,5], EMILY NEO KIM ANG[2], and SOK YING LIAW[2]

[1]Khoo Teck Puat Hospital, Singapore 768828, Singapore, [2]Alice Lee Centre for Nursing Studies, Yong Loo Lin School of Medicine, National University of Singapore, Singapore 117597, Singapore, [3]School of Nursing, Midwifery and Healthcare, Federation University Australia, Ballarat VIC 3353, Australia, [4]School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong, and [5]School of Nursing and Midwifery, University of Brighton, Brighton BN1 9PH, United Kingdom

Address reprint requests to: Sok Ying Liaw, Alice Lee Centre for Nursing Studies, Yong Loo Lin School of Medicine, National University of Singapore. Level 2, Clinical Research Centre, Block MD11 10 Medical Drive, Singapore 117597, Singapore. Tel: +65-65167451; E-mail: nurliaw@nus.edu.sg

Accepted 8 March 2015

Abstract

Objective: To develop and determine the psychometrics properties of an instrument (V-scale) and to explore nurses' attitudes towards vital signs monitoring in the detection of clinical deterioration in general wards.
Design: Scale development with psychometric testing and a descriptive quantitative survey.
Setting: Tertiary acute care hospital.
Participants: A total of 614 general ward nurses.
Findings: Principal component analysis revealed a 16-item instrument in a five-factor solution (key indicators, knowledge, communication, workload and technology) that explained 56.27% of the variance. The internal consistency was sufficient with Cronbach's alpha of 0.71 and strong item subscale correlations (0.56–0.89). The test–retest reliability was adequate with an Intraclass Correlation Coefficient (ICC) of 0.85. Many nurses (56.9%) erroneously perceived blood pressure changes as the first indicator of deterioration, and 46% agreed that an altered respiratory rate was the least important indicator. Most nurses (59.8%) also reported relying on oxygen saturation to evaluate respiratory dysfunction, and 27.4% indicated that they make quick estimates of the respiratory rate. Current practices for vital signs monitoring were considered to be time consuming (21.0%) and overwhelming (35.3%). Nurses' attitudes were most significantly influenced by whether they had a degree qualification followed by whether they worked in a general ward with a specialty and had >5 years of experience.
Conclusions: This exploratory study provides evidence for the psychometric properties of the V-scale. It reveals a need for continuous professional development to improve ward nurses' attitudes towards vital signs monitoring. Vital signs monitoring needs to be prioritized in workload planning.

Key words: attitude, deterioration, monitoring, nurses, vital signs, instrument development, validity, reliability

Introduction

The majority of adverse events are preceded by a period of abnormal vital signs (minutes to hours), which could be identified through consistent and accurate monitoring [1, 2]. Close monitoring of vital signs is essential to detect and act upon deterioration with the potential to reduce adverse events, such as cardiopulmonary arrest [3, 4]. Despite this, several studies have indicated that vital signs are not consistently measured, recorded or reported [5, 6]. The failure to undertake timely monitoring of vital signs has a significant impact on the effectiveness of the rapid response system (RRS) [2]. The rapid response team, commonly called the efferent limb of the RRS, is heavily dependent on the timely detection of deterioration—a process commonly called the efferent arm [7].

Vital signs monitoring is fundamental to nursing. In some settings, non-registered nursing staff monitor patients and are overseen by qualified staff who interpret the data and report abnormal values. Nurses' failure to reliably assess, document and interpret vital signs has not been adequately studied [8]. In a qualitative study that explored front line nurses' experiences with deteriorating patients, consistent concerns about monitoring and reporting of vital signs were raised. These issues included workload issues and failure to recognize critical vital signs (particularly respiratory rates) [9].

Nurses are perceived to be neglecting vital signs monitoring or do not regard it as a priority [2, 7] which could affect how well they carry out this task [10]. To date, nurses' attitudes towards vital signs monitoring has not been explored due to lack of a reliable and valid tool. A study to explore attitudes towards vital signs monitoring could lead to evidence-based strategies to promote nurses' role in detecting and reporting deterioration. Therefore, the aim of this study is 2-fold: to develop and determine the psychometric properties of an attitudinal measure and to explore nurses' attitudes toward vital signs monitoring to detect and report deterioration among patients in general ward settings.

Methods

Design of the instrument

A comprehensive literature search was conducted using electronic databases (CINAHL, ScienceDirect, PubMed and Scopus) and limited to journals published between 1990 and November 2012. A combination of various keywords included vital signs, physiologic signs, cardinal signs, physiological parameter, patient observation, deterioration, general ward patients, inpatients, ward patients and hospital patients. This search identified 719 citations. After a full review of the papers, 17 articles were included in the final review. Six themes were identified relating to vital signs monitoring to detect clinical deterioration: abnormal vital signs, knowledge, reporting of deteriorating vital signs, role and responsibilities, workload, technology and observational chart design. Twenty-seven individual interviews were conducted with 15 general ward nurses—each lasted between 45 and 60 min—to explore their experiences in detecting physiological deterioration. Consistent themes that arose were as follows: key indicators of changes in vital signs, interpretation of the vital signs, reporting of abnormal vital signs and the effect of excessive workload on vital signs monitoring.

The literature review and interview data led to the development of six emergent themes that were identified as the instrument's subscales: (i) knowledge, perceived ability to interpret vital signs; (ii) key indicators, key vital signs indicating deterioration; (iii) communication, reporting deteriorating vital signs; (iv) workload, time and effort to record vital signs; (v) technology, impact of electronic vital signs monitoring on respiratory rates counting; (vi) role and responsibility, staff responsibility in detecting and reporting vital sign abnormalities.

A pool of items was initially generated, through a broad literature review, to cover the six themes. Eight to 10 statements on a four-point Likert rating scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree) were formulated to cover each theme. The resulting initial 50-item V-scale was reviewed by a panel of nursing experts with extensive clinical experience. The content validity index (CVI) was computed. One item with a low CVI of 0.45 was removed from the instrument. The wording was revised on items with a CVI of <0.80 based on the experts' suggestions. The revised V-scale was sent for further content validation which yielded a CVI of at least 0.80 for each item and a CVI of 0.97 for the overall scale.

Study setting and population

The study was conducted at an acute care tertiary hospital in Singapore with ~990 inpatient beds. The target population was registered nurses (RNs) and enrolled nurses (ENs) employed on the general care units. A staff mix of RNs and ENs is typical for teams providing nursing care in Singapore with RNs serving as team leaders and delegating tasks to the ENs who have basic nursing education with emphasis on technical skills.

For the purpose of psychometric testing, the instruments were administered to 300 RNs and ENs. The sample size determination was based on Dixon's recommendation of 5 to 10 respondents per questionnaire item to ensure stable test parameters [11]. A total of 234 questionnaires (a 78% response rate) were completed. Thirty participants were approached to complete the same instrument after 1 week to establish its stability.

The sample size for this exploratory survey was determined by the number of participants required to maintain statistical power for the statistical tests employed [12]. Using multiple linear regression analysis, we anticipated seven key variables that would affect nurses' attitudes towards vital signs monitoring in detecting clinical deterioration. To achieve a medium effect size, with 80% power at a 0.05 significance level, a minimum of 102 participants was needed [13]. To increase the generalizability of the results and the power of this study, 380 nurses from 20 general wards were recruited via convenience sampling.

Data collection

Data collection took place after approval by the University Institutional Review Board. The data collection for psychometric testing of the newly developed scale took place in October 2013. After establishing the psychometric properties of the V-scale, it was used for the exploratory survey in December 2013. The process of data collection for the two periods was similar. The researcher told potential participants about the purpose and nature of the study. The questionnaires and a participant information sheet were distributed to the nurses during their breaks or off-shift time in order not to disrupt normal work flow. Copies of the questionnaire and participant information sheet were also made available in each ward along with sealed box for collection of completed questionnaires. Anonymity and data confidentiality were assured. The return of a completed questionnaire was seen as consent to participate in the study.

Data analysis

Descriptive statistics were computed for demographic variables and the participants' responses to each item of the V-scale. Exploratory factor analysis (EFA) using principal component analysis and varimax rotation were used to examine the factor construct of the instrument. Internal consistency was evaluated using Cronbach's alpha and item-to-total correlation. Test–retest reliability was assessed using

ICC. Univariate analysis, namely an independent *t*-test, was used to examine any significant differences in the mean scores between RNs and ENs, as well as demographic subgroups. Multiple linear regression analysis was then incorporated to identify the most influential demographic factors that predict nurses' attitudes.

Results

Construct validity

The construct validity of the developed instrument was examined using EFA. Bartlett's test of sphericity was statically significant (x^2 (1176) = 4178.85, $P = 0.000$), and the calculated Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.74, indicating that the sample was large enough to perform factor analysis. Table 1 summarizes the result of the factor analysis which indicates the weight or loading of each item in the instrument on the underlying variable. A large factor loading indicates a strong relationship between the variable to the items [13]. Five factors had eigenvalues of >1 which explained 56.27% of total variance. Using the loading criteria of 0.40 [12], 16 items demonstrated strong factor loadings as shown in Table 1. Factor 1, technology, consisted of four items with factor loadings of 0.59–0.73 and accounted for 21.14% of the variance. Factor 2, communication, consisted of two items, both with both factor loadings of 0.79 and accounted for 10.68% of the variance. Factor 3, workload, was composed of four items with factor loadings of 0.61–0.75 and accounted for 8.80% of the variance. Factor 4, key indicators, consisted of three items with factor loadings of 0.59–0.76 and accounted for 8.41% of the variance. Factor 5, knowledge, consisted of three items with factor loadings of 0.53–0.79 and accounted for 7.24% of the variance. These five-factor solutions represented the core subscales of the instrument.

Reliability

The internal consistency of Cronbach's alpha was 0.71 for the 16-item V-scale. The correlation coefficients between items and their respective subscales ranged between 0.56 and 0.89. The overall ICC was 0.85 (95% CI = 0.760–0.917, $P < 0.01$).

Survey findings

The demographic characteristics of the participants who participated in the exploratory survey are presented in Table 2. The majority of participants were <30 years of age (72.4%), female (95.5%), RNs (70.3%), with a Bachelor degree (54.5%) and >5 years of working

Table 1 Factorial structure of the V-scale by using EFA ($n = 234$)

No	Items in the V-scale	Factor loading[a]				
		1	2	3	4	5
Factor 1: Technology						
1	Respiratory rate value is usually estimated for stable patients during routine vital signs monitoring.	0.586	0.102	−0.386	0.363	0.276
2	Electronic vitals monitoring results in casual monitoring (i.e. counting) of respiratory rate.	−0.727	0.110	0.063	0.030	−0.076
3	The use of pulse oximetry to monitor SpO_2 will reduce the need to count respiratory rates.	0.617	0.233	−0.196	0.398	0.372
4	I usually record respiratory rate as standard rate between 12 and 20/min if SpO_2 is within normal range.	0.623	0.156	−0.362	0.401	0.245
Factor 2: Communication						
5	I am confident to report deteriorating vital signs in a way that will get a team doctor/RN in-charge to review the patient.	−0.015	0.789	−0.077	−0.054	0.117
6	I will repeatedly inform the team doctor/RN in-charge of vital sign changes if no prompt actions are acted on.	−0.028	0.792	−0.054	0.012	0.101
Factor 3: Workload						
7	It is time consuming to perform vital signs monitoring.	0.038	0.060	−0.700	0.192	0.057
8	Vital signs monitoring is a boring task.	0.101	0.244	−0.751	0.163	0.037
9	Complete and accurate vital signs monitoring is neglected due to time constraints.	0.300	0.082	−0.605	−0.056	0.273
10	I feel overwhelmed trying to complete the different frequency of vital signs collection (i.e. hourly, 2 hourly, 4 hourly, etc.) of my patients.	0.174	−0.175	−0.714	0.135	0.295
Factor 4: Key indicators						
11	SpO_2 is a more reliable indicator in reflecting early signs of respiratory dysfunction than respiratory rate.	0.117	0.050	−0.036	0.704	−0.077
12	Blood pressure is often the first parameter that reflects abnormality when a patient deteriorates.	0.053	−0.176	−0.165	0.762	0.081
13	Respiratory rate value is the least important sign of deterioration.	0.194	0.079	−0.200	0.585	0.253
Factor 5: Knowledge						
14	I can relate vital signs readings to physiology and pathophysiology of presenting diseases.	−0.387	0.300	−0.126	0.126	0.525
15	My knowledge in interpreting vital signs to identify clinical deterioration is limited.	0.183	0.195	−0.265	0.259	0.702
16	Changes in vital signs were not interpreted accurately by nurses (i.e. absence or delay of appropriate nursing actions).	0.259	−0.018	−0.081	−0.091	0.793
Eigen values		3.382	1.710	1.407	1.345	1.158
Per cent of variance explained (total: 56.27%)		21.14	10.68	8.80	8.41	7.24

[a]Principal component analysis with varimax rotation and factor loading ≥0.40.

Table 2 Demographic data of study sample in the exploratory study ($n = 380$)

Demographic	*n* (%)
Age (years)	
≤30	275 (72.4)
31–40	77 (20.3)
>40	28 (7.4)
Gender	
Male	17 (4.5)
Female	363 (95.5)
Ethnic group	
Chinese	131 (34.5)
Malay	43 (11.3)
Indian	42 (11.1)
Others (e.g. Filippinos, Burmese)	164 (43.2)
Highest nursing education	
National Institute of Technical Education (NITEC) Certificate	22 (5.8)
Diploma/Advanced Diploma in Nursing	121 (31.8)
Degree	207 (54.5)
Others	22 (5.8)
Missing data	8 (2.1)
Length of working experience as a nurse (years)	
0–3	128 (33.7)
3–5	98 (25.8)
>5	154 (40.5)
Current nursing designation	
Registered nurse	268 (70.3)
Enrolled nurse	112 (29.4)
Type of ward	
Medical surgical	137 (36.1)
Ward with a specialty (e.g. Orthopedics, Cardiology)	243 (63.9)

experience (40.5%). Most (63.9%) were working in a general ward with a specialty (e.g. cardiology, renal or neurology ward).

Five demographic variables including age, ethnic group, highest nursing qualification attained, length of work experience and ward specialty were found to have a significant impact on the overall attitude score towards vital signs monitoring to detect and report deterioration. These five variables were included in the multiple linear regression analysis which identified three significant demographic predictors (Table 3). A degree qualification, having >5-year work experience and working in a general ward with a specialty are predictors of higher attitudes scores, which accounted for 56.27% of variance. The higher attitude scores indicate more positive attitudes and vice versa. Among these, degree qualification had the most significant influence on the attitudes ($\beta = 0.201$, $P < 0.001$), followed by working in a general ward with a specialty ($\beta = 0.130$, $P < 0.01$), and >5 years of working experience ($\beta = 0.128$, $P < 0.05$).

As shown in Table 4, no significant difference was found between the RNs and ENs for the subscale scores on technology, communication, workload and key indicators. However, the RNs reported a significantly higher score ($P < 0.01$) on the knowledge subscale than the ENs.

The participants' responses to each item were presented in Table 5 and reported descriptively within the subscales.

Key indicators

More than half of the respondents (59.8%) erroneously agreed or strongly agreed with the statement that 'SpO_2 is a more reliable indicator in reflecting early signs of respiratory dysfunction than respiratory rate'. Similarly, the majority of the respondents (56.9%) erroneously agreed or strongly agreed that 'Blood pressure is often the first parameter that reflects abnormality when a patient deteriorates'.

Knowledge

The majority of respondents agreed or strongly agreed (76.6%) that they 'can relate vital signs readings to physiology and pathophysiology of presenting diseases'. Most of them (62.6%) disagreed or strongly disagreed with the statement 'My knowledge in interpreting vital signs to identify clinical deterioration is limited'. In addition, most of them (61.8%) disagreed or strongly disagreed with 'Changes in vital signs are not interpreted accurately by nurses'.

Technology

There is an almost equal balance between respondents who disagreed (24.8%) and those who agreed (24.2%) with the statement 'Electronic vital signs monitoring results in casual monitoring (i.e. counting) of respiratory rate'. While the majority of the respondents (63.4%) disagreed or strongly disagreed with the statement 'The use of pulse oximetry to monitor SpO_2 will reduce the need to count respiratory rates', more than a quarter of the respondents agreed or strongly agreed that 'Respiratory rate value is usually estimated for stable patients during routine vital signs monitoring'. More than one-fifth (20.2%) of the respondents agreed or strongly agreed with the statement 'I usually record respiratory rate as standard rate between 12–20/min if SpO_2 is within normal range'.

Workload

Although the majority of respondents (67.1%) disagreed or strongly disagreed with the statement 'Vital signs monitoring is a boring task', more than one-fifth (21.0%) of respondents agreed or strongly agree with the statement 'It is time-consuming to perform vital signs monitoring'. Almost one-quarter (23.9%) of the nurses agreed that 'Complete and accurate vital signs monitoring is neglected due to time constraints'. More agreed (35.3%) than disagreed (32.1%) with the statement 'I feel overwhelmed trying to complete the different frequency of vital signs collection of my patient.'

Communication

The majority of the nurses responded positively to the statements contained in the subscale. More than three-quarter (89.0%) were 'Confident to report deteriorating vital signs in a way that will get team doctor/RN in-charge to review the patient'. Most (89.3%) also agreed or strongly agreed with the statement 'I will repeatedly inform the team doctor/RN in-charge on vital sign changes if prompt action is not taken'.

Discussion

A comprehensive methodology involving a literature review, interviews and validation by 11 experts led to the development and validation of the V- scale which yielded an excellent CVI. Construct validity indicated an accepted fit for the 16-item five-factor model after the removal of items and one factor from the V-scale. This model was chosen over the initial tool as the content was more meaningful and the items less alike. The overall V-scale demonstrated sufficient internal consistency as reflected by the acceptable Cronbach's alpha of 0.71 for the final instrument and the high correlation between the items

Table 3 Multiple linear regression

Demographics	Standardized β coefficients	t	P-value
Age vs. ≤30			
31–40	0.063	1.151	0.251
>40	0.017	0.324	0.746
Ethnic group vs. Indians			
Chinese	−0.030	0.575	0.565
Malay	0.033	0.641	0.522
Others (e.g. Filipinos, Burmese)	0.058	1.023	0.307
Highest nursing education vs. NITEC			
Dip/Adv. Dip	0.099	1.322	0.187
Degree	**0.201**	4.006	<0.001
Others (e.g. School of Nursing)	−0.026	0.508	0.612
Length of working experience vs. 0–3			
3–5	0.000	0.004	0.997
>5	**0.128**	2.551	<0.05
Ward specialty	**0.130**	2.626	<0.01

Adjusted $R^2 = 0.342$.

Table 4 Comparison of scores between RNs and ENs

	RN ($n = 268$) Mean (SD)	EN ($n = 15$) Mean (SD)	T-statistic	P-value
Subscales				
Key indicators	8.8 (2.1)	8.4 (1.8)	1.561	0.119
Knowledge	11.3 (1.9)	10.7 (1.8)	2.840	**0.005**
Technology	13.6 (2.8)	13.1 (2.7)	1.469	0.143
Workload	13.6 (3.4)	13.7 (2.9)	−0.228	0.097
Communication	8.4 (1.2)	8.1 (1.5)	1.630	0.104
Overall	55.6 (7.7)	54.1 (6.9)	1.87	0.062

with their respective subscales. The ICC indicated that the V-scale yielded consistent responses at different times, supporting the stability of the instrument.

Our survey findings indicated that the nurses had limited understanding of the key indicators of deterioration. For example, blood pressure is a relatively late sign of deterioration, because compensatory mechanisms normally first increase the heart and respiratory rates without significant changes in blood pressure [14]. However, most nurses in our study perceived blood pressure as the first sign of deterioration. They placed less importance of respiratory rate as a key predictor of a potentially serious clinical event—a misconception reported by others [6, 9]. A study by Van and Michell [6] reported that altered blood pressure was the most common cause for activation of a medical emergency team (MET), and the respiratory rate alone was never a trigger. Furthermore, respiratory rate is the vital sign least often recorded and most commonly omitted from hospital documentation [15, 16]. These misconceptions about low blood pressure as the first indicator of deterioration and respiratory rate as the least important needs to be addressed by highlighting the influence of compensatory mechanisms.

Misconceptions may be due to a lack of knowledge of pathophysiology and lack of understanding of physiological compensation. However, it appears from the finding that most nurses are unaware of their knowledge deficit. Future studies should test nurses' knowledge of vital sign interpretation in relation to physiological changes. The finding highlights the importance of educating nurses about aspects of a physical assessment such as the 'work of breathing' and accessory muscle use in addition to respiratory rate counting. Such education should begin with nurses' pre-registration curriculum and be reinforced throughout the post-registration education program. Besides testing knowledge, future studies could also examine the effectiveness of education intervention in improving nurses' attitudes towards vital signs monitoring.

Nurses in the study reported great reliance on the use of peripheral capillary oxygen saturation (SpO_2) to evaluate respiratory dysfunction and make quick estimates of the respiratory rate. Nearly a quarter of nurses agreed that pulse oximetry can be used to substitute respiratory rate monitoring. Like electronic devices for tracking heart rate, temperature and blood pressure, pulse oximetry monitors patients' oxygenation status. The increasing automation of monitoring vital signs and pulse oximetry may have led to nurses spending less time on visual observation and performing quick checks of the respiratory rate [17]. This finding supports previous studies [18, 19] that highlighted the need to dispel myths regarding pulse oximetry as a substitute for respiratory rate counting. Nurses need to understand that pulse oximetry and respiratory rate monitoring provide different information about the patient's status. Pulse oximetry measures SpO_2 but not ventilation, while measuring the respiratory rate reveals ventilation but not necessarily saturation levels. Further, SpO_2 has not been demonstrated to be a specific indicator of serious illness [20, 21] and may appear to be normal, during the early phase of deterioration, due to a rise in respiratory rate to compensate for the inadequacy of oxygen delivery. In addition to understanding the differences between pulse oximetry and respiratory rate, the importance of using sensory skills assessments to complement automated vital signs taking should be emphasized. Observation (e.g. a patient's skin colour), touch (e.g. a patient's clamminess and coldness) and listening (to what the patient is saying) are essential to detecting signs of a patient's deterioration [22]. For example, Cooper *et al.* [17] advocate using traditional approaches to measuring vital signs recording—including palpating a pulse for 30 s for rate and rhythm and observing a patient's respiratory rate for 30 s. Manual observation of vital signs, including taking blood pressure manually, was recommended in a study in improving the care of acutely unwell patients. The nurses reported that when taking blood pressure manually, the conventional touch and feel helps them to quickly detect any decline in the patient's condition [23].

Nurses in the study reported that current practices of vital signs monitoring are time consuming and overwhelming. Nearly a quarter agreed that complete and accurate vital signs monitoring is neglected due to time constraints. This is congruent with a previous qualitative study [8], which revealed that nurses feel overloaded when they are faced with many patients who need frequent vital signs monitoring. Excessive vital signs monitoring may affect nurses' prioritization of workload and compromise their ability to closely monitor more acutely ill patients [8, 24]. Similar to previous studies [2, 8], our study suggested that the current practice of vital signs monitoring, based on tradition rather than evidence, may place unrealistic demands on nurses. The frequency of vital signs monitoring should be determined based on a patient-centred approach to care [25, 26]. In the study hospital, there are guidelines for escalating care in response to abnormal vital signs changes, but there is not a standard policy for the frequency of measuring vital signs. Monitoring is undertaken at timed intervals determined by ward practices (e.g. every 4 hours for newly admitted patient) and doctor's orders (e.g. hourly observation for 24 h for postoperative patients). It is important for nurses and doctors to regularly review the frequency of vital signs monitoring, particularly for patients whose condition improves. While nurses in the study hospital can initiate more frequent assessment of vital signs based on the patient's

Table 5 Participants' attitude towards V-scale result ($n = 380$)

	SD[a] *n* (%)	D[b] *n* (%)	N[c] *n* (%)	A[d] *n* (%)	SA[e] *n* (%)
Subscale: Key indicators					
SpO_2 is a more reliable indicator in reflecting early signs of respiratory dysfunction than respiratory rate.	7 (1.8)	55 (14.5)	91 (23.9)	177 (46.6)	50 (13.2)
Blood pressure is often the first parameter that reflects abnormality when a patient deteriorates.	7 (1.8)	62 (16.3)	95 (25.0)	172 (45.3)	44 (11.6)
Respiratory rate value is the least important sign of deterioration.	77 (20.3)	168 (44.2)	89 (23.4)	37 (9.7)	9 (2.4)
Subscale: Knowledge					
I can relate vital signs readings to physiology and pathophysiology of presenting diseases.	1 (0.3)	17 (4.5)	71 (18.7)	222 (58.4)	69 (18.2)
My knowledge in interpreting vital signs to identify clinical deterioration is limited.	41 (10.8)	197 (51.8)	92 (24.2)	44 (11.6)	6 (1.6)
Changes in vital signs were not interpreted accurately by nurses (i.e. absence or delay of appropriate nursing actions).	48 (12.6)	187 (49.2)	105 (27.6)	34 (8.9)	6 (1.6)
Subscale: Technology					
Respiratory rate value is usually estimated for stable patients during routine vital signs monitoring.	45 (11.8)	118 (31.1)	113 (29.7)	96 (25.3)	8 (2.1)
Electronic vitals monitoring results in casual monitoring (i.e. counting) of respiratory rate.	12 (3.2)	82 (21.6)	194 (51.1)	86 (22.6)	6 (1.6)
The use of pulse oximetry to monitor SpO_2 will reduce the need to count respiratory rates.	57 (15.0)	184 (48.4)	77 (20.3)	58 (15.3)	4 (1.1)
I usually record respiratory rate as standard rate between 12 and 20/min if SpO_2 is within normal range.	76 (20.0)	147 (38.7)	80 (21.1)	72 (18.9)	5 (1.3)
Subscale: Workload					
It is time consuming to perform vital signs monitoring.	75 (19.7)	145 (38.2)	80 (21.1)	70 (18.4)	10 (2.6)
Vital signs monitoring is a boring task.	85 (22.4)	170 (44.7)	79 (20.8)	41 (10.8)	5 (1.3)
Complete and accurate vital signs monitoring is neglected due to time constraints.	53 (13.9)	144 (37.9)	92 (24.2)	70 (18.4)	21 (5.5)
I feel overwhelmed trying to complete the different frequency of vital signs collection (i.e. hourly, 2 hourly, 4 hourly, etc.) of my patients.	26 (6.8)	96 (25.3)	124 (32.6)	107 (28.2)	27 (7.1)
Subscale: Communication					
I am confident to report deteriorating vital signs in a way that will encourage a team doctor/RN in-charge to review the patient.	6 (1.6)	8 (2.1)	28 (7.4)	229 (60.3)	109 (28.7)
I will repeatedly inform the team doctor/RN in-charge of vital sign changes if prompt action is not taken.	3 (0.8)	7 (1.8)	31 (8.2)	213 (56.1)	126 (33.2)

[a]Strongly disagree.
[b]Disagree.
[c]Neutral.
[d]Agree.
[e]Strongly agree.

condition, they cannot reduce the frequency without a doctor's approval. This policy should be reviewed to allow qualified nurses to judge what is sufficient to assess and manage acute conditions. However, to prevent suboptimal monitoring of vital signs, a policy for frequency could be set at the minimum standard that meets the needs of the majority patients in the clinical setting [27].

With rising patient acuity in the general ward, it is expected that more patients may require frequent vital signs monitoring. To reduce the burden on nurses, general wards should be equipped with electronic systems that measure vital signs continuously [2, 28]. Although more research is needed to evaluate the impact of continuous monitoring on general ward patients, studies have revealed a significant decrease in total length of hospital stay as well as a lowering in the code blue [29] and mortality rates [30]. The sociotechnical factors, such as alert burden on ward staff, need to be considered to effectively implement this intervention in the complex healthcare environment [31].

In all, this study revealed the need for continuing education for ward nurses to improve their attitudes towards vital signs monitoring in clinical deterioration. Given that a degree qualification, experience and working in a general ward with a specialty were predictors of a positive attitude towards vital signs monitoring among respondents, those with lower educational qualifications, less experience and those working in a general medical surgical wards should receive further professional development. In addition, our study reported that, compared with the better educated RNs, the ENs were less able to interpret vital signs, suggesting that the RNs should be responsible for this role. Education should, therefore, focus on the development of clinical reasoning skills to enable both RNs and ENs to relate changes in vital sign to other patient information and apply their knowledge of physiology and pathophysiology to identify signs of deterioration early [32].

This study has limitations that warrant consideration. It is the first study to specifically develop an instrument to examine the attitudes of nurses towards vital signs monitoring to detect and report on clinical deterioration. Thus, there is a lack of established criterion in existing literature to test the concurrent validity of the V-scale. In addition, although the sample size was deemed adequate, it was conducted on a convenience sample of nurses from a single local hospital. Therefore, it might not be possible to apply the findings to hospital nurses outside Singapore. Finally, the study used a self-reported questionnaire. Given that the nurses appeared to be unaware of their knowledge deficit,

knowledge tests could be conducted in a future study. Future studies could also employ a mixed method exploratory design to provide a more comprehensive understanding of nurses' attitudes towards vital signs monitoring, particularly regarding poor respiratory rate monitoring.

Conclusion

A 16-item V-scale with evidence of content validity, construct validity, internal consistency reliability and stability was developed and implemented to explore general ward nurses' attitudes towards vital signs monitoring in detecting clinical deterioration. The survey findings indicated that nurses have limited understanding of the key indicators of deterioration and held misconceived views on the use of pulse oximetry as a substitute for monitoring respiratory rates. Developing knowledge of physiological compensatory mechanisms and the pathophysiology underpinning changes in vital signs changes is important to enhance nurses' clinical reasoning ability to interpret early signs of clinical deterioration. Nurses perceive the current practice of vital signs monitoring as time consuming and overwhelming. Future research studies are needed to identify the optimal method to enhance the clinical process of undertaking vital signs monitoring.

Acknowledgements

The authors thank Siti Zubaidah and the evidence-based nursing unit, as well as nurses of the National University Hospital for their assistance with this study. Lastly, we thank the NUHS Medical Publications Support Unit, Singapore, for providing editing services for this manuscript.

References

1. Fagan K, Sabel A, Mehler PS *et al.* Vital sign abnormalities, rapid response, and adverse outcomes in hospitalized patients. *Am J Med Qual* 2012;**27**:480–6.
2. Hands C, Reid E, Meredith P *et al.* The prevalence of recordings of the signs of critical conditions and emergency responses in hospital wards--the SOCCER study. *Resuscitation* 2005;**65**:149–57.
3. Jones DA, DeVita MA, Bellomo R. Rapid-response teams. *N Eng J Med* 2001;**365**:139–46.
4. Smith GB, Prytherch DR, Schmidt P *et al.* Hospital-wide physiological surveillance-a new approach to the early identification and management of the sick patient. *Resuscitation* 2006;**71**:19–28.
5. Chen J, Hillman K, Bellomo R *et al.* The impact of introducing medical emergency team system on the documentations of vital signs. *Resuscitation* 2009;**80**:35–43.
6. Van Leuvan CH, Mitchell I. Missed opportunities. An observational study of vital sign measurements. *Crit Care Resusc* 2008;**10**:111–5.
7. Moriarty JP, Schiebel NE, Johnson MG *et al.* Evaluating implementation of a rapid response team: considering alternative outcome measures. *Int J Qual Health Care* 2014;**26**:49–57.
8. Rose L, Clarke SP. Vital signs. *AJN* 2010;**110**:11.
9. Chua WL, Liaw SY, Mackey S *et al.* Front line nurses' experiences with deteriorating ward patients: a qualitative study. *Int Nurs Rev* 2013;**60**:501–9.
10. Moore C, Sanko L. Vital signs get no respect. *Kans Nurse* 2010;**85**:3–8.
11. Dixon JK. *Exploratory Factor Analysis. Statistical Methods for Health Care Research*. 5th ed. Philadelphia: Lippincott Williams & Wilkins, 2005,321–51.
12. Cohen J. A power primer. *Psychol Bull* 1992;**112**:155–9.
13. Polit DF, Beck CT. *Essentials of Nursing Research: Methods, Appraisal, and Utilization*. 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.
14. Soong JTY, Soni N. Circulatory shock. *Medicine* 2013;**41**:64–9.
15. De Meester K, Bogaert PV, Clarke SP *et al.* In-hospital mortality after serious adverse events on medical and surgical nursing units: a mixed methods study. *J Clin Nur* 2012;**22**:2308–17.
16. Ludikhuize J, Smorenburg SM, de Rooij SE *et al.* Identification of deteriorating patients on general wards; measurement of vital parameters and potential effectiveness of the Modified Early Warning Score. *J Crit Care* 2012;**27**:7–13.
17. Cooper S, Cant R, Sparkes L. Respiratory rate records: the repeated rate? *J Clin Nurs* 2014;**23**:1236–8.
18. Cretikos MA, Bellomo R, Hillman K *et al.* Respiratory rate: the neglected vital sign. *Med J Aust* 2008;**188**:657–9.
19. Adam S, Odell M. An acute problem? A report of the National Confidential Enquiry into Patient Outcome and Death. *Nurs Crit Care* 2005;**10**:225–7.
20. Hodgetts TJ, Kenward G, Vlachonikolis IG *et al.* The identification of risk factors for cardiac arrest and formulation of activation criteria to alert a medical emergency team. *Resuscitation* 2002;**54**:125–31.
21. Goldhill DR, McNarry AF. Physiological abnormalities in early warning scores are related to mortality in adult inpatients. *Br J Anaesth* 2004;**92**:882–4.
22. Cioffi J. Nurses' experiences of making decisions to call emergency assistance to their patients. *J Adv Nurs* 2000;**32**:108–14.
23. Turkington P, Power M, Hunt C *et al.* There is another way: empowering frontline staff caring for acutely unwell adults. *Int J Qual Health Care* 2014;**26**:71–8.
24. Beaumont K, Luettel D, Thomson R. Deterioration in hospital patients: early signs and appropriate actions. *Nurs Stand* 2008;**23**:43–8.
25. Zeitz K, McCutcheon H. Observations and vital signs: ritual or vital for the monitoring of postoperative patients. *Appl Nurs Res* 2006;**19**:204–11.
26. Storm-Versloot MN, Verweij L, Lucas C *et al.* Clinical relevance of routinely measured vital signs in hospitalized patients: a systematic review. *J Nurs Scholarsh* 2014;**46**:39–49.
27. Schulman CS, Staul L. Standards for frequency of measurement and documentation of vital signs and physical assessments. *Crit Care Nurse* 2010;**30**:74–6.
28. Bellomo R, Ackerman M, Bailey M *et al.* A controlled trial of electronic automated advisory vital signs monitoring in general hospital wards. *Crit Care Med* 2012;**40**:2349–61.
29. Brown H, Terrence J, Vasquez P *et al.* Continuous monitoring in an inpatient medical-surgical unit: a controlled clinical trial. *Am J Med* 2014;**127**:226–32.
30. Schmidt PE, Meredith P, Prytherch DR *et al.* Impact of introducing an electronic physiological surveillance system on hospital mortality. *BMJ Qual Saf* 2015;**24**:176–7.
31. Bates DW, Zimlichman E. Finding patients before they crash: the next major opportunity to improve patient safety. *BMJ Qual Saf* 2015;**24**:1–3.
32. Levett-Jones T, Hoffman K, Dempsey Y *et al.* The 'five rights' of clinical reasoning: an educational model to enhance nursing students' ability to identify and manage clinically 'at risk' patients. *Nurs Edu Today* 2010; **30**:515–20.