Developing a Vital Sign Alert System

An automated program that reduces critical events as well as nursing workload.

OVERVIEW: This article describes the implementation of a nurse-designed, automated system for enhancing patient monitoring on medical–surgical and step-down nursing units. The system, which is not derived from any of the early warning scoring systems described in nursing literature, was developed and put into place at a large tertiary hospital in eastern Virginia and found to substantially reduce out-of-unit codes without increasing nurses' workload.

Keywords: automated alert systems, early warning scoring systems, physiologic monitoring, vital signs

Hospitalized patients often exhibit signs of deterioration several hours before experiencing cardiopulmonary arrest. These early warning signs frequently go unrecognized by nurses on medical–surgical units, who tend to have large caseloads.[1, 2] Over the past several years, the use of a rapid response team and an early warning scoring (EWS) system has been proposed as a possible solution to the problem.

A rapid response team is a designated group of clinicians with intensive care expertise, who can quickly assemble at a patient's bedside to institute immediate diagnostic and treatment measures in accordance with hospital protocol. Unfortunately, rapid response teams tend to be activated only after a patient's condition has deteriorated and destabilized to the point that emergency transfer to an ICU is required.

EWS systems are based on the premise that a decline in a patient's condition can be detected early through the assessment of an aggregate set of critical physiologic variables. Whereas a single abnormality among these variables may not signal a need for intervention, a combination of two or more irregularities, occurring together, may alert the nurse to a potentially dangerous change in the patient's condition.

Theoretically, an EWS system facilitates early detection of life-threatening changes, giving the nurse time to confer with a physician and institute corrective measures to stabilize the patient's condition. Literature reviews conducted over the past decade, however, have found little evidence that EWS systems are effective in reducing adverse events.[1, 3-5] Furthermore, there is little evidence that such instruments are reliable or valid.[6, 7] EWS systems have been criticized for being too labor intensive and complex for practical use on medical–surgical units. It's been suggested that the increased nursing workload associated with such systems, as well as general misunderstandings concerning their use and the significance of patients' scores, may explain the failure of nurses to use them correctly and consistently.[8, 9]

This article describes an automated vital sign alert (VSA) system that was developed and implemented by nurses at Sentara Norfolk General Hospital in Norfolk, Virginia, a 525-bed teaching hospital and level I trauma center within the Sentara Healthcare system, which operates 10 acute care hospitals in Virginia and northeastern North Carolina. The VSA system, which replaced an ineffective EWS system, was designed specifically to enhance patient monitoring on medical–surgical and step-down nursing units without increasing the nurse's workload. The VSA system described in this article was not based on any of the EWS systems described elsewhere, but was a unique creation.

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Vital Sign Alert Scoring Chart

Score	2	1	No Score (in range)	1	2
Pulse Rate	≤ 49	50–59	60–100	101–119	≥ 120
Respiratory Rate	≤ 10	11–15	16–20	21–29	≥ 30
Systolic BP	≤ 89	90–99	100–140	141–180	≥ 181
SpO_2	≤ 89%	90%–94%	95%–100% (COPD 90%–100%)		

Pulse: Take apical pulse for one minute if irregular.
Respiratory Rate: Count for one minute if irregular or patient is dyspneic.

Figure 1. The color-coded vital sign alert scoring chart indicates which vital sign values represent a safe target range (green), which alert practitioners to exercise caution (yellow), and which signify instability requiring immediate action (red). BP = blood pressure; COPD = chronic obstructive pulmonary disease; SpO_2 = oxygen saturation.

EXPERIENCE WITH AN EWS SYSTEM

In 2007, consistent with health care initiatives directed at reducing out-of-unit codes (cardiopulmonary arrest events occurring on general medical–surgical or step-down units), our hospital developed a paper-based EWS system, similar to others described in nursing literature, and implemented it on three nursing units—one medical, one surgical, and one step-down unit. The system relied on seven critical variables:

- temperature
- pulse
- respiratory rate
- blood pressure
- oxygen saturation level
- level of consciousness
- urinary output

Each variable was assessed and scored according to established ranges, three deviations above and below identified normal ranges. Level of consciousness was given greater weight than the other six variables because it was considered more indicative of deteriorating health.

Once the system was in use, our nurses found that level of consciousness and urinary output scores varied widely among practitioners. For example, level of consciousness fluctuated with medication administration and such environmental factors as unfamiliar surroundings and routines, especially in elderly patients. This variable was particularly difficult to assess in patients with cognitive issues related to delirium, stroke, or dementia. Urinary output couldn't be measured in patients who were incontinent, used the bathroom without measuring urine, or were assisted by family members who didn't save urine for measurement. Patients receiving dialysis presented other scoring problems. Initially, they were assigned no "warning" points for the absence of urinary output and were scored as if they had normal renal function. Later, this practice was changed, when our hospital data indicated that these patients had a higher incidence of out-of-unit codes.

As a clinical nurse specialist, I observed on daily rounds that many of our nurses saw no value in the EWS system and considered it nothing more than a documentation requirement. When asked, few knew or understood the significance of their patients' scores. Many had no clear understanding of how to respond to high scores because the system neither stratified severity levels for total scores nor identified nursing interventions to be taken with deviations from normal.

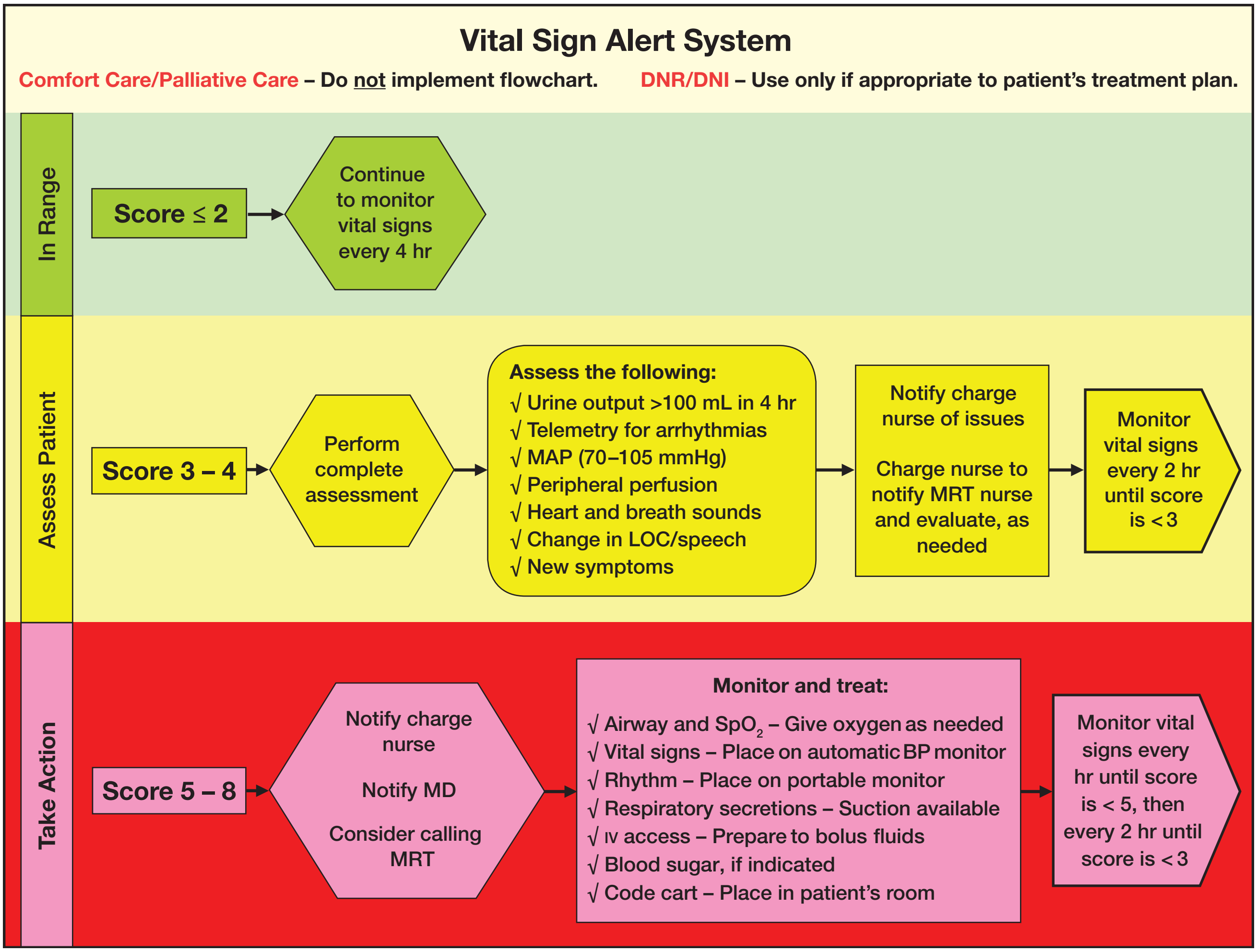

Figure 2. The vital sign alert (VSA) algorithm identifies nursing action based on a patient's aggregate VSA score. BP = blood pressure; DNI = do not intubate; DNR = do not resuscitate; LOC = level of consciousness; MAP = mean arterial pressure; MRT = medical response team; SpO_2 = oxygen saturation.

A review of patient records revealed that the EWS tool was not completed consistently or in a timely manner. Nurses explained that it consumed a great deal of their time and added no value to their practice. Some nurses waited until the end of their shift to complete scoring requirements on assigned patients, negating the intended effect of EWS as a warning system.

To determine the amount of time nurses spent completing the EWS tool, I randomly observed the collection and scoring of data. The nurses were to complete the EWS tool six times daily on each of their assigned patients. Conservatively, completion required an average of two minutes per patient, or 12 minutes per patient daily. On a unit with 36 beds filled to capacity, this accounted for a total of 7.2 nursing hours daily, or 2,628 nursing hours annually—the equivalent of one full-time nurse.

TECHNOLOGICAL ASSISTANCE

In 2009, the EWS system was incorporated into our hospital's electronic medical record (EMR). With computerization, the system could calculate a total score from data the nurse entered manually into the electronic flow sheet, but this did little to reduce the nurse's workload or to alleviate problems related to the collection of required data or use of the tool. At the end of the year, recognizing that patients on our medical–surgical and step-down units were particularly vulnerable—as a result of large nurse caseloads, a high percentage of new nurses on staff, and higher levels of patient acuity owing to frequent shortages of critical care beds—the hospital's nursing administration established a technology-assisted critical thinking (TACT) committee to explore monitoring technologies that could help nurses on these units. (At the time, little technology was available to them other than continuous telemetry monitoring.)

A director of nursing chaired the TACT committee. Members included nurse leaders and nursing staff from several units. An information technology (IT) nurse attended committee meetings to provide the membership with guidance regarding computer capabilities, build programs to produce desired products, and resolve issues related to project implementation.

Initially, the TACT committee focused on the development of a screen saver that automatically displayed vital patient information from the patient's EMR to desktop computers at each nurses' station. Based on nurse recommendations, the following data were considered most important to monitor and include on the screen savers: code status, vital signs, blood sugar level, hemoglobin level (if low), potassium level (if low), fall risk score, and stat physician orders. In conjunction with the development of the screen savers, the TACT committee tasked me with revising the EWS system and gave me the freedom to do whatever I deemed necessary to make the system work. I decided to retire the EWS system altogether and design something entirely new, for the following reasons:

- The system's continued use was not supported by evidenced-based practice.
- The system was too complex and labor intensive for practical use on medical–surgical and step-down nursing units.
- It was important to overcome negative staff attitudes related to the use of an alert system.

The goal of the VSA system is to get the patient's total score into the green zone and keep it there.

REVIEWING THE EVIDENCE

A literature review suggested that the best indicators of cardiopulmonary arrest, unplanned ICU admission, and unexpected death were vital signs and oxygen saturation level. Many studies attempted to identify criteria that could be used for activation of rapid response teams. Most explored whether abnormal physiologic findings preceding cardiopulmonary arrest, unplanned ICU admission, or unexpected death could be identified and quantified.

A 2009, four-month, prospective, observational cohort study conducted at a university-affiliated U.S. Department of Veterans Affairs (VA) hospital examined the vital sign thresholds used on medical and surgical units as criteria for calling the hospital's medical emergency team.[10] The most commonly recorded of these were:

- systolic blood pressure of less than 90 mmHg
- pulse rate of less than 40 or more than 110 beats per minute
- respiratory rate of less than 8 or more than 26 breaths per minute
- arterial oxygen saturation level of less than 90%

Prospective analysis indicated that more than one-third of the patients meeting a single vital sign criterion experienced a critical event, defined in this study as transfer to a higher level of care, cardiopulmonary arrest, or death. Of the patients meeting two or more criteria, 75% experienced a critical event. The relationship between meeting vital sign criteria and ICU transfer was the same for both medical and surgical patients, and the median length of stay for patients meeting vital sign criteria was twice that of patients with normal vital signs. The researchers concluded that vital signs could be used to predict critical events in medical and surgical patients.

A retrospective cross-sectional study of 3,160 adult admissions to general units in five Australian hospitals identified the following as the top early indications of developing critical conditions[11]:

- oxygen saturation levels between 90% and 95%
- systolic blood pressure between 80 and 100 mmHg or between 181 and 240 mmHg
- pulse rate between 40 and 49 beats per minute or between 121 and 140 beats per minute
- "other," a category including 43 signs, the most frequent of which were shortness of breath, temperature above 38°C (100.4°F), symptoms or signs of orthostatic hypotension, and hemoglobin level below 80 g/L

Oxygen saturation values below 90%, a pulse rate below 40 beats per minute or above 140 beats per minute, systolic blood pressure below 80 mmHg, Glasgow Coma Scale scores of 8 or below, and unresponsiveness to verbal commands were classified as late signs of deterioration.

A prospective study of 1,695 acute medical admissions to a British hospital investigated the effect of using modified early warning (MEW) scores to predict ICU admission, cardiopulmonary arrest, and death by collecting physiologic data from patients prior to these critical events.[12] The MEW scores of patients in the study group did not differ significantly from those of patients in the control group (participants in an observational study performed on the same unit the previous year, before introduction of the MEW score). Patients who died, suffered cardiopulmonary arrest, or were admitted to the ICU, however, had significantly lower blood pressure and temperature and significantly higher pulse and respiratory rates than all other patients in the study. Data analysis revealed that respiratory rate was the best predictor of high risk.

A prospective study of 6,303 patients admitted to a medical, surgical, or orthopedic unit in an Australian hospital evaluated 10 clinical abnormalities as predictors of in-hospital death[13]:

- oxygen saturation values below 90% (whether or not receiving oxygen therapy)
- systolic blood pressure above 200 mmHg
- systolic blood pressure below 90 mmHg
- pulse rate above 130 beats per minute
- pulse rate below 50 beats per minute
- respiratory rate above 30 breaths per minute
- respiratory rate below six breaths per minute
- Glasgow Coma Scale score of 3 or lower
- level of consciousness reduced by more than two Glasgow Coma Scale points
- seizure

Of the 1,598 clinical abnormalities observed in 564 (9%) of the patients during the study period, the two most common were oxygen saturation values below 90% (51% of all abnormalities) and systolic blood pressure below 90 mmHg (17% of all abnormalities).

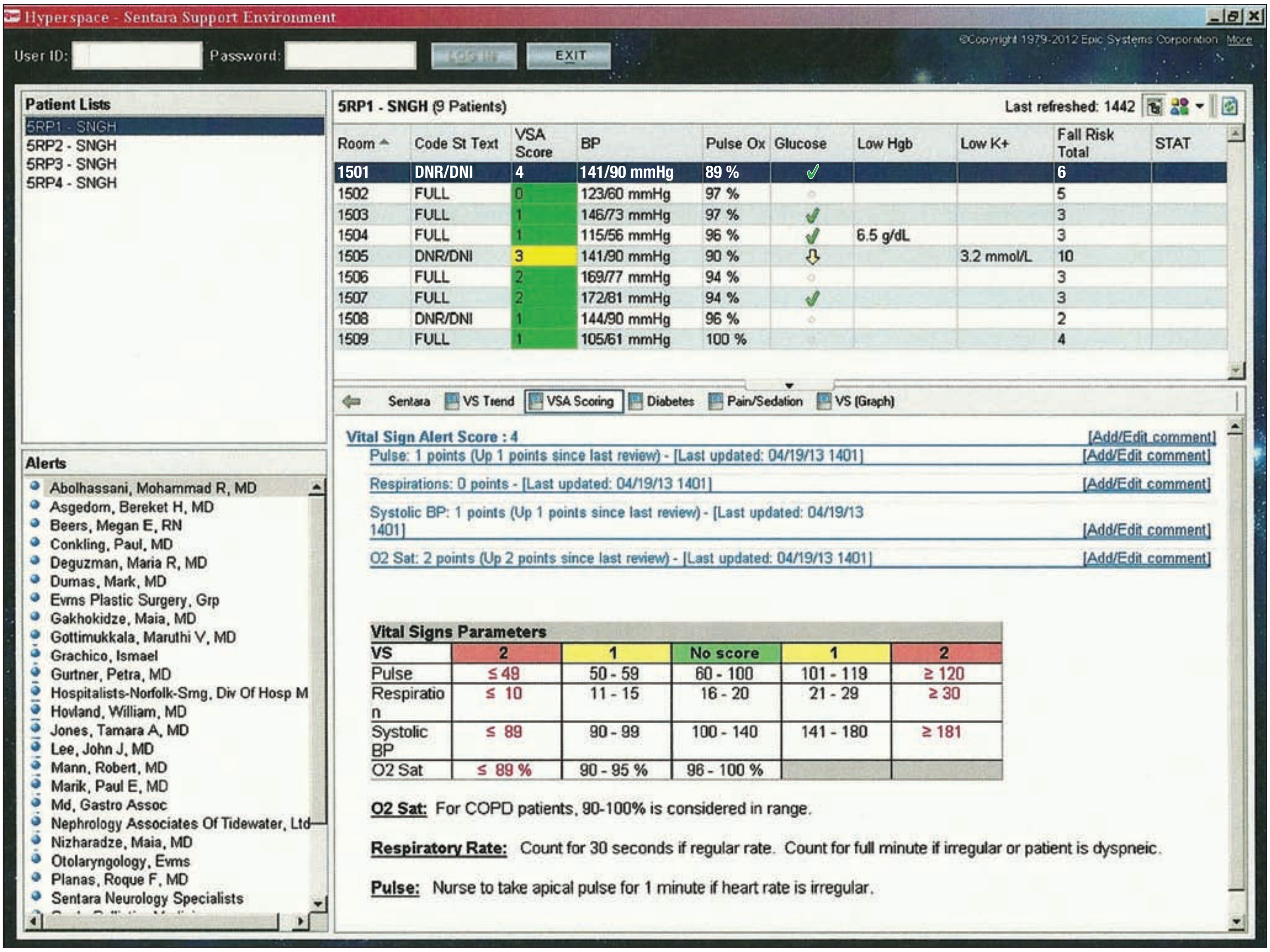

Figure 3. This vital sign alert (VSA) scoring screen indicates that the patient in room 1501 has a DNR/DNI code status, a VSA score of 4, a BP of 141/90 mmHg, and an oxygen saturation level of 89%, as measured by pulse oximetry. Because vital signs and VSA scores are highlighted when a particular patient is selected, the yellow code color of this patient's VSA score is not visible in this view, although VSA score color coding is visible for all other patients within the pod. The middle section of the screen shows that the patient's VSA score of 4 is based on 1 point for pulse, 1 point for systolic BP, and 2 points for oxygen saturation. The patient's vital signs were entered into the electronic medical record on April 19, 2013, at 1401 hours. BP = blood pressure; DNI = do not intubate; DNR = do not resuscitate.

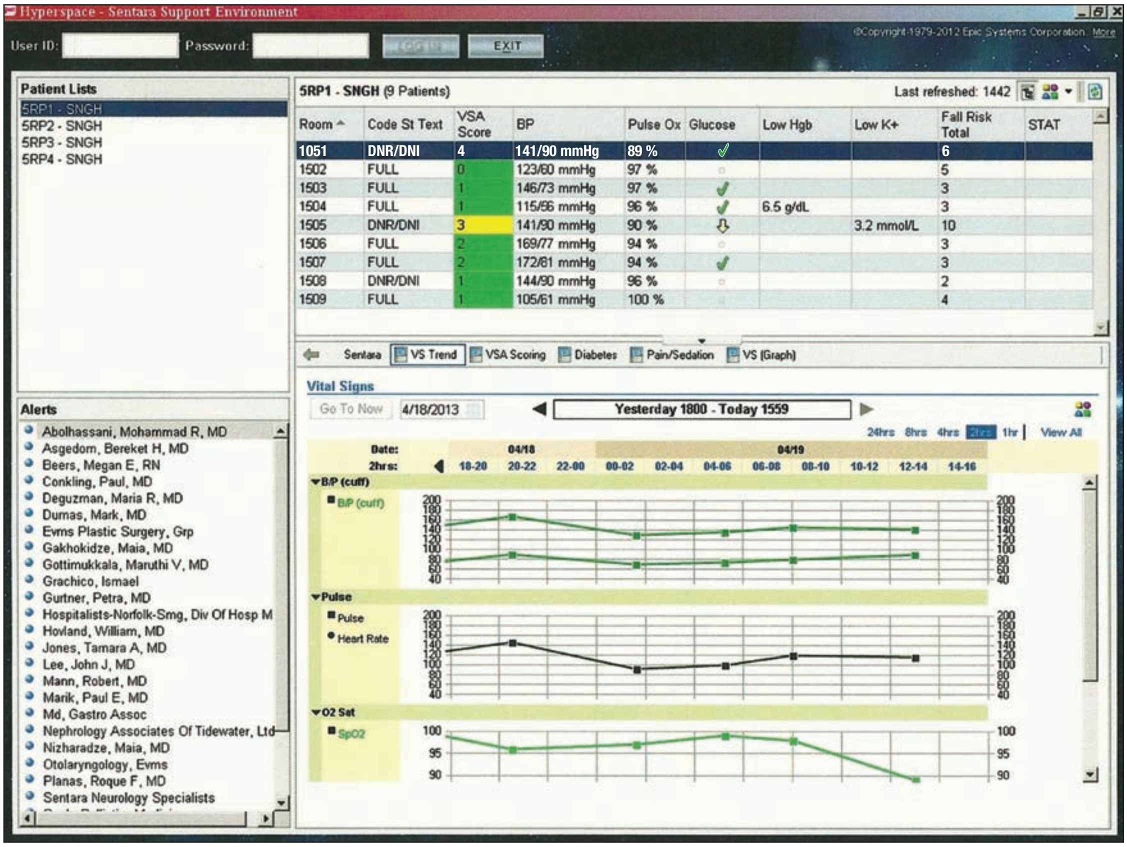

Figure 4. The vital sign trend screen allows nurses to access more detailed information about a selected patient's vital sign trends over time.

A pulse rate greater than 130 beats per minute, a respiratory rate greater than 30 breaths per minute, and systolic blood pressure greater than 200 mmHg collectively accounted for 23% of all observed abnormalities. Of the 564 patients who exhibited clinical abnormalities, 146 (26%) died. The greater the number of clinical abnormalities observed in a patient, the higher the patient's risk of death.

The literature review reinforced my belief in the value of vital signs, which have been used successfully for decades to assess patients and determine the urgency and effectiveness of treatment. Vital signs apply to all patients and all diagnoses. They are essential to nursing practice. While individual vital sign measurements provide important information, sudden variations in one vital sign usually cause compensatory variations in others, and it's the cumulative variation from normal that is most indicative of an unstable condition.

DEVELOPING THE VSA SYSTEM

The new system I designed was a simple, color-coded VSA scoring chart that used green to indicate the values within a safe target range and yellow and red to indicate caution and danger, respectively, depending on the degree of deviation from the target range (see Figure 1). For example, the normal pulse rate—between 60 and 100 beats per minute—is within the target green zone. The heart can safely tolerate for a sustained period some deviation from this range (scores within the yellow zone), although extreme variations (scores within the red zone) represent instability and should be addressed immediately.

The goal of the VSA system is to get the patient's total score into the green zone and keep it there. A green VSA score doesn't necessarily mean that the patient's vital signs are normal, just that treatment measures are effective in keeping values within a safe range. If the VSA score doesn't enter the green zone within the expected time frame, or if it reverts to yellow or turns red after having been in the green zone for a period of time, this may indicate treatment failure or complications.

To reinforce appropriate nursing action based on the patient's total VSA score, I developed a VSA algorithm (see Figure 2). A green VSA score requires no additional nursing action; vital signs continue to be monitored every four hours. Because hospitalized patients typically display some variation in vital signs related to their acute condition, the algorithm allows a two-point variation from the green target range before recommending nursing action. When a patient's score is abnormal, the VSA algorithm prompts three key nursing actions:

- Perform a complete patient assessment to determine possible causes for the abnormal score.
- Confer with the charge nurse to validate findings and determine an appropriate plan of action.
- Designate the patient a "patient of focus" so that she or he receives more frequent monitoring or treatment until stabilized or transferred to a higher level of care.

In prompting the nurse to perform a complete assessment and confer with the charge nurse when the score is in the yellow zone, the algorithm takes into account that, at this point, the nurse relies on clinical expertise to personalize care. For example, a patient with pneumonia admitted to the hospital through the ED may have a yellow VSA score on admission because of hypoxia, increased respirations, and tachycardia, but would be expected to achieve a green VSA score within 48 hours following the administration of IV antibiotics, oxygen, and other treatments. Likewise, although oxygen saturation levels below 90% are usually considered critical and requiring of action, they are often baseline values in patients with chronic lung disease. Similarly, in an athlete who may have low baseline respiratory and resting pulse rates, a yellow score would not indicate a need for intensive monitoring.

Well-developed critical thinking skills and self-confidence are two key characteristics of an effective nursing staff. The VSA system neither hinders the development of these traits—attempting to "think for" the nurse—nor prescribes specific nursing interventions based on the type of physiologic dysfunction displayed. It is simply an alerting tool that makes the nurse aware of changes in the patient's condition that may require nursing action to prevent further deterioration.

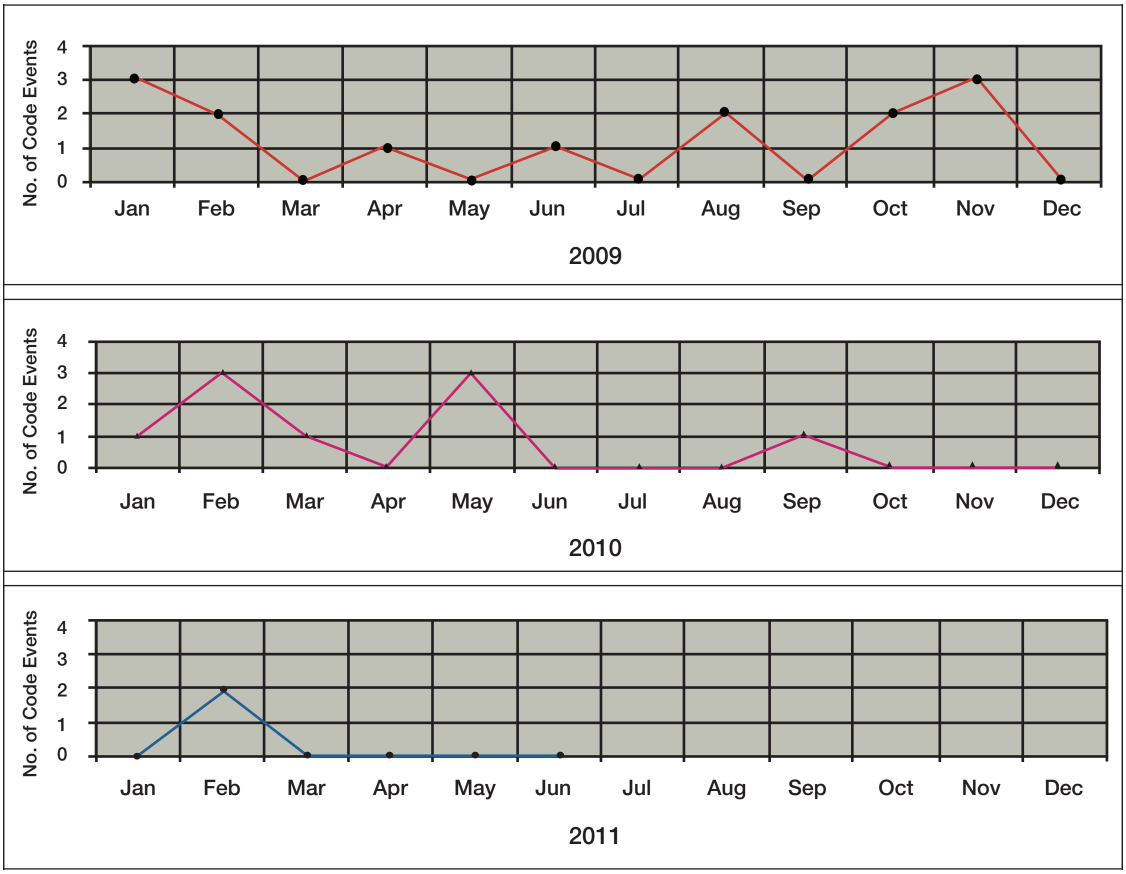

Figure 5. The number of out-of-unit codes (cardiopulmonary arrest events) that occurred on the pilot unit between January 2009 and June 2011. In the year before the June 2010 implementation of the VSA system (June 2009 to May 2010), 16 out-of-unit codes occurred on the unit. Over the next year (June 2010 to May 2011), out-of-unit codes were reduced to three.

Determining vital sign thresholds. For pulse rate, respiratory rate, and oxygen saturation as measured by pulse oximetry, I incorporated normal values for adults that were derived from published studies and found in many nursing textbooks: a pulse rate of 60 to 100 beats per minute, a respiratory rate of 16 to 20 breaths per minute, and an oxygen saturation level of 95% to 100%. The Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure defines normal adult systolic blood pressure as below 120 mmHg, prehypertension as 120 to 139 mmHg, stage 1 hypertension as 140 to 159 mmHg, and stage 2 hypertension as 160 mmHg or greater.[14] Keeping in mind that hospital patients may exhibit artificially high systolic blood pressures because of such factors as anxiety, pain, or IV fluid administration, and that preadmission antihypertensive drug dosages are not typically adjusted until the patient's condition has stabilized, I identified an acceptable systolic blood pressure range for this population as between 100 and 140 mmHg. Having defined the target (green) values for these indicators, I determined what would constitute dangerous (red) values, and then filled the gap between them with caution (yellow) values.

The VSA system neither attempts to "think for" the nurse—nor prescribes specific nursing interventions based on the physiologic dysfunction displayed. It is simply an alerting tool.

Automating the system. The IT nurse on the TACT committee programmed the VSA system into our EMR as a fully automated program, capable of calculating patients' VSA scores from the most recent vital sign data in their EMRs, applying the appropriate color coding to each, and displaying the color-coded scores on the screen savers of the desktop computers at each nurses' station. The program was designed to scan each patient's EMR every 60 seconds, recalculating scores whenever new vital sign data were available. Color-coded VSA scores were also added to the nurses' patient lists, so they were readily available to nurses using mobile computers at the bedside. Double-clicking on a patient's VSA score opened the VSA algorithm, prompting timely nursing action when a score was out of the target range.

The display of color-coded scores on the screen savers provided the charge nurse with a readily accessible tool for continuously monitoring all patients on the unit. Two buttons located in the center of the screen saver and labeled "VSA Scoring" and "VS Trend" allow the nurse to view either scoring information or vital sign trends for a selected patient (see Figures 3 and 4).

THE PILOT PROGRAM

The VSA system was initially rolled out on a 36-bed step-down medical unit that is physically divided into four distinct pods, each containing nine beds. Over each 12-hour shift, the unit is staffed by 11 to 12 nurses (including the charge nurse) plus two assistive personnel. All nursing staff attended a one-hour education session prior to VSA implementation. Our nurse executive participated in every education session to show support for the staff and the project.

Problems identified. Nurses on the pilot unit noted long delays in vital sign data entry. Delays were attributed to the fact that assistive personnel took vital signs on a large number of patients before entering the data in the computer, kept vital sign recordings on their clipboards until they had time to enter them in the computer, and often had to compete with other health care team members for access to desktop computers at the nurses' station. Since the effectiveness of the VSA system depended on the timely entry of vital sign data, we conducted sequential trials of two different types of handheld mobile computers frequently used in health care systems to enter patient data into EMRs: the Dolphin 9900 by Honeywell Scanning and Mobility (Norcross, Georgia) and the MC9500 by Motorola Solutions (Schaumburg, Illinois). Both manufacturers supplied computers for the trial free of charge. Our assistive personnel found that the Honeywell Dolphin 9900 lost patient data because it couldn't maintain a connection to the hospital's wireless network, although multiple access points were located throughout the unit. Our hospital purchased the Motorola MC9500 because we found it to be consistently reliable in maintaining connectivity for immediate transfer of data from the patient's bedside to the EMR.

Originally, temperature was included on the VSA scoring chart. This vital sign was problematic, however, because normal and abnormal ranges for patients with specific conditions, such as hypothermia related to shock, are not easily identified in nursing literature. During the pilot program, nurses reported a large number of false alerts caused by abnormally low temperature readings that couldn't be correlated with physiologic changes in the patient's condition. Patients frequently had low temperature readings from environmental factors and measurement errors, not from physiologic shock. The nursing staff suggested that temperature be removed from the scoring system because it skewed the results. They noted that they could review the patient's record and take the patient's temperature if they suspected fever, that it was established practice for assistive personnel to report all temperature readings above 100.4°F, and that peripheral perfusion and skin temperature were included as routine assessments in patients with abnormal VSA scores. As a result of this nursing input, temperature was removed from the VSA system and, subsequently, false alerts were drastically reduced.

The VSA system was implemented on the pilot unit of our hospital in June 2010. Over the following year, the pilot unit effectively reduced the number of out-of-unit codes from 16 to three (see Figure 5). Because VSA scoring was fully automated once data were entered into the EMR by assistive personnel, the VSA system added nothing to the nurses' normal workload. An informal survey of nurses on the pilot unit indicated that nurse satisfaction increased with the use of the VSA system, which eliminated excessive manual data entry required by the EWS system. Nurses reported that they felt the VSA system allowed them to monitor large numbers of patients quickly and easily. In 2011, nursing research conducted on a comparable 39-bed unit at a sister community hospital within the Sentara Healthcare system produced similar positive results.

FINDING EFFECTIVE NURSING TOOLS

Nurses are frequently asked to incorporate screening tools into their daily practice. Some provide valuable information and have the potential to improve patient care; but before widespread implementation, each should be carefully evaluated for ease of use and effect on both workload and patient outcomes. Nursing committees responsible for practice change should include IT representatives who can assess the feasibility of using automation to facilitate proposed changes.

Although computers can be used to perform calculations and manipulate and display data, their ability to improve patient care depends on nurses' ability to design effective systems for their practice. In our hospital, work completed by nurses resulted in the adoption of screen savers, an effective VSA system, and subsequently, the availability of handheld computers throughout the hospital. These technological advances—and the resultant improvements in patient care and nurse satisfaction—were made possible by

- an innovative staff that's dedicated to improving nursing practice and the quality of patient care.
- a shared belief among clinicians and administrators that nurses have the ability to effect practice change.
- visible support from hospital leadership in an environment that fosters personal growth and nursing excellence.

All three innovations have since been incorporated into executive plans for implementation across our multihospital health care system. ▼

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REFERENCES

1. McArthur-Rouse F. Critical care outreach services and early warning scoring systems: a review of the literature. *J Adv Nurs* 2001;36(5):696-704.
2. National Patient Safety Agency. *Recognising and responding appropriately to early signs of deterioration in hospitalised patients*. London: National Health Service; 2007 Nov. ref. no. 0683. http://www.nrls.npsa.nhs.uk/resources/?entryid45=59834.
3. Esmonde L, et al. Investigating the effectiveness of critical care outreach services: a systematic review. *Intensive Care Med* 2006;32(11):1713-21.
4. Kyriacos U, et al. Monitoring vital signs using early warning scoring systems: a review of the literature. *J Nurs Manag* 2011;19(3):311-30.
5. McGaughey J, et al. Outreach and early warning systems (EWS) for the prevention of intensive care admission and death of critically ill adult patients on general hospital wards. *Cochrane Database Syst Rev* 2007(3):CD005529.
6. Gao H, et al. Systematic review and evaluation of physiological track and trigger warning systems for identifying at-risk patients on the ward. *Intensive Care Med* 2007;33(4):667-79.
7. Subbe CP, et al. Reproducibility of physiological track-and-trigger warning systems for identifying at-risk patients on the ward. *Intensive Care Med* 2007;33(4):619-24.
8. Morris A, Davies K. Early warning scoring systems: observation of care in practice. *Br J Nurs* 2010;19(18):1180-4.
9. Oakey RJ, Slade V. Physiological observation track and trigger system. *Nurs Stand* 2006;20(27):48-54.
10. Lighthall GK, et al. Abnormal vital signs are associated with an increased risk for critical events in US veteran inpatients. *Resuscitation* 2009;80(11):1264-9.
11. Harrison GA, et al. The prevalence of recordings of the signs of critical conditions and emergency responses in hospital wards—the SOCCER study. *Resuscitation* 2005;65(2):149-57.
12. Subbe CP, et al. Effect of introducing the modified early warning score on clinical outcomes, cardio-pulmonary arrests and intensive care utilisation in acute medical admissions. *Anaesthesia* 2003;58(8):797-802.
13. Buist M, et al. Association between clinically abnormal observations and subsequent in-hospital mortality: a prospective study. *Resuscitation* 2004;62(2):137-41.
14. National High Blood Pressure Education Program. *The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*. Bethesda, MD: National Institutes of Health, National Heart, Lung, and Blood Institute; 2004 Aug. No. 04-5230. http://www.nhlbi.nih.gov/guidelines/hypertension/jnc7full.htm.