A Prospective Study of Nighttime Vital Sign Monitoring Frequency and Risk of Clinical Deterioration

The routine practice of collecting vital signs every 4 hours in hospitalized ward patients has been perpetuated since as early as 1893, but little evidence supports this tradition.1 Although vital signs can be indicative of impending clinical deterioration, routine nighttime vital sign monitoring adds to the already fragmented sleep of inpatients. Sleep disruptions are prevalent among ward patients and are associated with several negative health outcomes, including elevated blood pressure and delirium.2,3 Overnight vital sign checks not only are an especially bothersome disrupter but also can deplete crucial health care resources. Track and trigger systems, such as the Modified Early Warning Score (MEWS), have been used to identify high-risk patients for critical interventions.4 The present study investigated whether the MEWS could identify low-risk patients who might forgo overnight vital sign monitoring.

Methods | We conducted a prospective cohort study of consecutive adult inpatients at a 550-bed academic institution between November 4, 2008, and August 31, 2011. All vital signs were extracted from the electronic medical record (Epic; Epic Systems Corporation), and a MEWS was calculated for each data set obtained on the general floors, with forward imputation used for incomplete sets. The MEWS most closely preceding 11 PM each evening was used to stratify patients. The number of nighttime (11 PM to 6 AM) disruptions for vital sign monitoring and the occurrence of adverse events, defined as intensive care unit transfers or cardiac arrests in the next 24 hours (11 PM to 11 PM), were compared across all MEWS categories.

Results | In total, 54,096 patients were included in the study, accounting for 182,828 patient-days on the wards and 1699 adverse events. The patient sample was 43.0% male and had a median age of 56 years (interquartile range, 40-68 years). The median evening MEWS was 2 (interquartile range, 1-2). The adverse event rate increased with higher evening MEWS, from a rate of 5.0 per 1000 patient-days (when the MEWS was ≤1) to 157.3 per 1000 patient-days (when the MEWS was ≥7) (P = .003 for trend) (Figure). However, the frequency of vital sign disruptions was unchanged, with a median of 2 vital sign checks per patient per night and at least 1 disruption from vital sign collection 99.3% of the nights regardless of MEWS category. Almost half of all nighttime vital sign disruptions (45.0%) occurred in patients with a MEWS of 1 or less.

Discussion | To our knowledge, this is the first study to critically examine the practice of vital sign collection on medical wards. Our study found that overnight vital signs are collected frequently among ward patients regardless of their risk of clinical deterioration. The evening MEWS identified a low-risk subset of patients who had significantly fewer adverse events but had overnight vital signs taken at a similar rate as high-risk patients. This suggests that the nighttime frequency of vital sign monitoring for low-risk medical inpatients might be reduced. Such a reduction could have dramatic benefits to patient sleep, considering that vital sign checks have been shown to be the environmental factor most disruptive to patient sleep.5 In addition to being linked to negative health outcomes and patient distress during inpatient care,
sleep deprivation may be an important factor in the posthospitalization syndrome that has recently been implicated as a cause for 30-day readmissions.6

Given that half of all nighttime vital sign checks are for low-risk patients, this reduction could also have significant health care resource implications. With fewer vital sign collections required for most patients, overnight nurse staffing could be moderated. This would represent a significant cost savings, considering that nursing wages account for one-quarter to one-third of a hospital's operating budget.7 A tailored approach would also enable a reallocation of resources away from the sleep-deprived, low-risk patients to more careful monitoring of high-risk patients. Evidence suggests that this reallocation could improve patient safety. For example, investigations have shown that adverse events on the medical wards are often closely preceded by vital sign changes, indicating that some of them may be predicted and prevented with individualized increases in monitoring.8

Although the cohort is large, this study is limited to a single institution. In addition, the MEWS only represents vital sign data and does not incorporate more nuanced markers of clinical status. As such, further prospective study of the safety and benefit of personalized vital sign collection is warranted. There is also promise in using new wireless sensor technology and machine-learning algorithms to individualize the frequency, reporting, and interpretation of vital signs and their trends. Routine current practice is the reflexive and inflexible collection of vital signs every 4 hours both day and night, without consideration of a patient's risk of deterioration. Given these findings, further study of approaches to tailor vital sign collection based on risk of clinical deterioration is warranted and may help improve patient experience and safety in hospitals.

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Invited Commentary
No Rest for the Weary...or the Sick

Sleep disruption and deprivation are commonly experienced by hospitalized patients. About half report significant insomnia, excessive daytime somnolence, or both, and health care professionals are often unaware of a patient’s sleep problems.1 Sleep deprivation is associated with elevated levels of cortisol and other stress response hormones, as well as impaired wound healing, weakened cellular immunity, worsened cognitive functioning, decreased ventilatory drive, hypertension, impaired glucose tolerance, and increased mortality.2-4 Cognitive dysfunction with sleep deprivation includes delirium, impaired attention, longer reaction time, poor short-term and working memory, increased errors, reduced learning, cognitive slowing and deterioration, and decreased motivation to task.3,4

The environmental factor that is most disruptive to sleep is wakening patients up to measure vital signs at night.5 In this issue, Yoder and colleagues6 provide a critical examination of measuring vital signs every 4 hours for hospitalized patients, a practice that has been in place since at least 1893. Frequent measurement of vital signs has long been viewed as providing an early warning of impending clinical deterioration. Yoder et al used the Modified Early Warning Score to classify 54,096 patients according to their risk of clinical deteriora-