CLINICAL RESEARCH STUDY

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Continuous Monitoring in an Inpatient Medical-Surgical Unit: A Controlled Clinical Trial

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ABSTRACT

BACKGROUND: For hospitalized patients with unexpected clinical deterioration, delayed or suboptimal intervention is associated with increased morbidity and mortality. Lack of continuous monitoring for average-risk patients has been suggested as a contributing factor for unexpected in-hospital mortality. Our objective was to assess the effects of continuous heart rate and respiration rate monitoring in a medical-surgical unit on unplanned transfers and length of stay in the intensive care unit and length of stay in the medical-surgical unit.

METHODS: In a controlled study, we have compared a 33-bed medical-surgical unit (intervention unit) to a "sister" control unit for a 9-month preimplementation and a 9-month postimplementation period. Following the intervention, all beds in the intervention unit were equipped with monitors that allowed for continuous assessment of heart and respiration rate.

RESULTS: We reviewed 7643 patient charts: 2314 that were continuously monitored in the intervention arm and 5329 in the control arms. Comparing the average length of stay of patients hospitalized in the intervention unit following the implementation of the monitors to that before the implementation and to that in the control unit, we observed a significant decrease (from 4.0 to 3.6 and 3.6 days, respectively; $P < .05$). Total intensive care unit days were significantly lower in the intervention unit postimplementation (63.5 vs 120.1 and 85.36 days/1000 patients, respectively; $P = .04$). The rate of transfer to the intensive care unit did not change, comparing before and after implementation and to the control unit ($P = .19$). Rate of code blue events decreased following the intervention from 6.3 to 0.9 and 2.1, respectively, per 1000 patients ($P = .02$).

CONCLUSIONS: Continuous monitoring on a medical-surgical unit was associated with a significant decrease in total length of stay in the hospital and in intensive care unit days for transferred patients, as well as lower code blue rates.

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Adult patients hospitalized in acute care facilities who are critically ill requiring either ventilation or hemodynamic support or cardiac monitoring, are usually admitted to either an intensive care unit (ICU) or a telemetry unit. These patients benefit from frequent monitoring of vital signs and pulse oximetry, continuous electrocardiography monitoring, and higher nurse-to-patient ratios. Because non-ICU/telemetry beds usually constitute the majority of available beds in acute care hospitals and academic medical centers, most adult acute care patients are admitted to medical-surgical units where continuous monitoring is not available. Unfortunately, these patients can experience unexpected clinical deterioration that may go undetected if it occurs in the interval between routine vital sign measurements, commonly measured every 4 to 6 hours. McGloin et al[1] demonstrated that potentially avoidable deaths and ICU admissions were associated with physiological deteriorations that may be overlooked. Hravnak et al[2] showed that an integrated monitoring system using standard measurements of heart rate, blood pressure, respiratory rate, and pulse oximetry in a step-down unit was able to detect cardiorespiratory instability.

CLINICAL SIGNIFICANCE

- Continuous vital signs monitoring in a medical-surgical unit was found to be associated with a reduction in intensive care unit utilization for patients who require transfer due to clinical deterioration.
- Continuous vital signs monitoring in a medical-surgical unit also was found to be associated with a reduction in total time spent in the hospital.
- Results may support the hypothesis that continuous monitoring leads to earlier recognition of patient deterioration.

The implementation of rapid response systems in acute care hospitals has focused primarily on building the efferent limb of the system—the response team. The mixed results reported on the effectiveness of these systems in reducing major adverse outcomes have shifted the emphasis to strengthening the afferent limb of rapid response systems—the ability to detect patients at risk for these outcomes.[3]

Continuous monitoring of low- to average-risk patients outside of ICUs poses a challenge. Frequent vital signs performed by nursing are labor intensive, and can be distressing to patients, especially when they are trying to sleep. However, a new generation of technologies can enable continuous monitoring of vital signs and at the same time are minimally intrusive. We evaluated the efficacy of a continuous, noncontact heart rate and respiration rate monitoring system in a medical-surgical unit of a community hospital to assess its impact on transfers from the unit to the ICU, length of stay (LOS) in the ICU for transferred patients, and LOS at the medical-surgical unit.

METHODS

Study Site

We performed a study on a medical-surgical service in a 316-bed community hospital, using 2 control groups. The study included a 9-month prospective intervention period (November 2009-July 2010) and a 9-month retrospective baseline period (January 2009-September 2009). Monitoring was performed in a 33-bed medical-surgical unit (the "intervention" unit) whose population included general medical, trauma, and surgical patients. A similar "sister" 33-bed medical-surgical unit served as a contemporaneous control. Patients were admitted to one of the 2 units by the hospital's admissions office in an alternating manner. As the 2 units were similar in patient population, level of supervision (both units had a nurse-to-patient ratio of 1:5) and services provided, the decision on placement of patients to one of the 2 units was practically random. All patients admitted or transferred to the intervention unit were monitored following the implementation of the monitoring systems on October 2009. The hospital's institutional review board approved the study.

Monitoring Technology

The monitoring system evaluated was the EarlySense system (Earlysense Inc., Waltham, Mass). The system consisted of a piezoelectric motion-sensing device embedded in a flat sensor plate placed under the patient's mattress and connected to a bedside processing and display unit, as previously described.[4-6] Previous research has shown these monitors to be accurate in measurement of both heart rate (HR) and respiration rate (RR),[4] and has shown this system's potential in early recognition of clinical deterioration.[6] Each bed on the intervention unit was equipped with a bedside unit that continuously monitored HR, RR, and movement level. The alert thresholds for HR were usually 40 and 135/min, and for the RR, 8 and 32/min. These could have been modified by the nurses with the approval of a supervisor to accommodate patients who regularly exceed the limits, provided a bedside assessment has been done. Alert annunciations were provided at both a central display station and directly to nurses using text messages on SpectraLink telephones. The hospital had implemented and utilized a rapid response system beginning in 2005. Rapid response teams were staffed with an intensive care physician and nurse. The system performance was reviewed periodically through an institutional review committee.

Outcomes and Definitions

Primary outcomes for the study included unplanned ICU transfers, average ICU LOS for transferred patients, and medical-surgical unit LOS. Unplanned ICU transfers were defined as direct transfers from the study and control units to the hospital's ICU (general and cardiac) for patients that spent at least 12 hours in the general medical-surgical