Case Study
Implementing Early Detection of Patient Deterioration in Medical and Surgical Units

Phyllis J. Miller

Located in the greater Boston area, Newton-Wellesley Hospital is a 265-bed community and teaching hospital. The facility is a member of Partners HealthCare, a network founded by Massachusetts General Hospital and Brigham and Women’s Hospital. Newton-Wellesley also partners with Tufts Clinical and Translational Science Institute and serves as a clinical setting for students from a number of academic programs throughout the area.

Perry An, MD, is a hospitalist physician, serves as chief operating officer for the hospitalist group, and is chair of the Quality Improvement Committee for the Department of Medicine at Newton-Wellesley. He also serves as the implementation director for the Early Detection of Deterioration Project.

The mean age of the patients served by the medical units at Newton-Wellesley is 82 years. The patients experience multiple comorbidities, are not necessarily ambulatory, and may or may not be able to speak for themselves.

The Early Detection of Deterioration Project in hospitalized patients at Newton-Wellesley began in response to The Joint Commission’s 2009 National Patient Safety Goal (NPSG) on Alarm Management, which stated that hospitals must “improve recognition and response to changes in a patient’s condition.” Newton-Wellesley staff responded to this goal by implementing continuous-monitoring, contact-free technology (EarlySense, Waltham, MA; i.e., a highly sensitive sensor placed under a mattress pad) to measure heart and respiratory rate, as well as bed exit alarms for patients at risk for falls. This technology provides early detection of patient deterioration and alerts staff to intervene before an adverse event occurs.

The hospital’s concern for effective monitoring of postoperative patients, who were receiving opioids, also was a key factor when deciding to undertake this initiative. After patients were transferred from the postanesthesia care unit to their respective units, early detection would allow the hospital to perform continuous respiratory monitoring, thereby alerting caregivers of possible decompensation.

Rationale for Project
Studies have reported that patients often exhibit clinically observable signs 6 to 8 hours before a cardiac arrest. Interventions have focused on early detection of changes in vital signs and trends to alert and enable caregivers to intervene sooner in order to prevent further patient deterioration.2-5

Continuous electronic monitoring is useful because instead of providing a single point in time when vital signs are taken, it offers a comprehensive approach, depicting trends in a patient’s condition over time that may not be readily apparent during a single “spot check.” Early detection provides continuous monitoring of the patient with

About the Author
Phyllis J. Miller, MS, RN, FHCE, is an independent nursing consultant and assists the AAMI Foundation with its patient safety initiatives. Email: millerphyllis@verizon.net
the expectation that an actionable intervention alert for intervention will occur much earlier, preventing advanced deterioration of a patient’s condition.

The driving force behind this initiative was to find an effective response to achieve the NPSG and to improve caregiver response in order to improve patient outcomes. Clinical staff at Newton-Wellesley were searching for a solution that would provide early detection of patient deterioration that went beyond telemetry and included respiratory rate monitoring, as reliance on telemetry alone may result in a high number of non–clinically actionable or “false” alarms. Newton-Wellesley also serves a large number of elderly patients, who may or may not be verbal, which makes assessing their condition more challenging. With the bed exit alarm and motion detector sensor, in addition to the vital sign monitor, the monitoring device selected by Newton-Wellesley seemed suitable for this monitoring initiative.

Both the physicians and nurses involved in the pilot became engaged in the project, and as they tracked the results from month to month, the improvements became more discernible.

Pilot Project
After development of the program by a multidisciplinary team consisting of physician and nursing staff, two pilot units (one medical and one surgical unit) were selected for the initial implementation in 2011. Clinical alarms are intended to alert caregivers of potential adverse events. This can create potential liability issues when response times and interventions are tracked. When introducing additional technology, the potential also exists for introducing additional non–clinically actionable alarms, which may contribute to alarm fatigue. Therefore, commitment from hospital administration, particularly the chief nursing officer and the accompanying nursing leadership from the pilot units, was important to supporting this effort and encouraging staff buy-in.

The multidisciplinary project team sought to improve response time to the continuous monitoring alarms so that early intervention could occur as needed and intensive care unit (ICU) use and length of stay could potentially be reduced. After initial education was provided for the nursing staff on the pilot units, monitoring of alarm activity began. The staff initially noted little improvement in response times. However, after additional, more in-depth education and the provision of regular feedback reports to the nursing staff regarding response time, improvements began to emerge. Both the physicians and nurses involved in the pilot became engaged in the project, and as they tracked the results from month to month, the improvements became more discernible. Some months later, because of the response time improvement, a decision was made by hospital administration to cut short the pilot and plan for facilitywide implementation. The hospital expanded its implementation of the program in 2013 to include additional medical and surgical units. This included five units (three medical and two surgical units).

Expanding the Effort
To address the inevitable challenges that emerge from new initiatives, as the hospital broadened its initiative from two to five units, a group of nursing staff and leadership from the involved units was again convened, as well as the hospitalist for the designated areas and several research staff who assisted with data collection. Led by Dr. An, the hospitalist for the areas, the group met for 1 hour each month to discuss implementation issues, discuss obstacles encountered by staff, determine policy changes needed to accommodate the initiative, and, eventually, share success stories.

Staff Education
Staff education included the importance of the initiative, training on the new technology, and ways to address the effect on workflow. To address these challenges, a half-day kickoff event was held for 50 nurses, including nurse managers, charge nurses, and a nurse educator, all of whom were to become champions of the initiative on their respective units. The event included presentations by representatives from the project team, who shared the rationale for the intervention and the subsequent policy
changes. The technology vendor also attended, demonstrating how the technology functioned, and smaller breakout groups provided nurses with the opportunity to work directly with the equipment. The breakout sessions focused on how the technology would be used and how to interpret the reports that were generated. In addition, anecdotal case studies from the pilot units were shared to demonstrate the effectiveness of the technology and benefits of early intervention to prevent negative patient outcomes. The groups also discussed real and perceived barriers to implementation, as well as strategies to counteract them. From this workshop, unit-based teams were developed that became the champions for their respective units.

Alarm Management Strategies

Pagers versus distributed alarm notifications. The technology provides two modes of notification for when changes in patient status occur: 1) through a pager, which is specific to the technology, or 2) through a distributed alarm system in the hallway of the unit. Both types of alarms have positive and negative aspects; therefore, each unit was encouraged to determine how they would prefer to receive the alert based on their own culture and workflow. Some units chose the pager alert system, as they felt the noise level on their particular units would make the use of the hallway alarm impractical. Other units that had infrequent alarms chose the distributed hallway alarm system, as the sounding of an alarm would garner greater awareness and response.

The use of the individual pager was initially one of the biggest issues for the implementation team. Nursing staff found it cumbersome to carry an additional pager, along with the hospital-issued pager they were already carrying.

Bed exit alarms. The beds used by Newton-Wellesley Hospital are equipped with an embedded bed exit alarm. Staff learned that they preferred the use of the bed’s alarm for its distinctive sound, and after review and discussion, the project team decided to turn off the early detection system’s bed exit alarm. This eliminated a potential duplicate alarm, and with this decision, the team was able to demonstrate a response to the concerns of the nursing staff, which in turn improved nursing buy-in to the program.

Battery replacement. Other smaller issues the group addressed included replacement of the pager’s batteries for when they ran low and whether they should be changed on a regular basis to prevent depletion. Each unit using the pager system has now developed standard practices within each unit regarding how frequently batteries should be changed.

Policy and Workflow Improvements

Policy changes. The hospital, led by the project team, implemented a change in its reporting policy to require documentation and verbal communication of the actionable alarm activity within the electronic health record at each change of shift, as well as in their change-of-shift reports with the incoming and outgoing nursing staff. As a result, the alarm activity was made more visible to the nursing staff and any repeated alarms were escalated to the medical staff for intervention for the particular patient, as needed.

- **Awareness**: The majority of cardiac arrest patients have heart rate (HR) and respiratory rate (RR) abnormalities 6 hours before the arrest.
- **Awareness**: As a result, we are committed to early detection of HR and RR abnormalities through continuous monitoring via the no-contact system.
- **Awareness**: We are no longer using the no-contact system Bed Exit alert feature.
- **Awareness**: We are committed to three features of the no-contact system on all medical/surgical units: 1) HR (mandatory), 2) RR (mandatory), and 3) turn alerts (as needed).
- **Workflow**: Nurses and patient care assistants work as a team to ensure appropriate response to turn alerts.
- **Workflow**: At the start of each shift, as part of the initial assessment, nurses review bedside monitors for alerts and trends during the previous 8 hours.
- **Workflow**: At the end of each shift, as part of the handoff, nurses report HR and RR alerts that occurred during the shift, as well as turn alert status (if in use).

Measuring our progress:

- **Response times**: Response times are being reported daily on all medical/surgical units.
- **Unit-specific goals**: Unit-specific goals will be determined in the near future.

In the future continuous monitoring alerts and trends will be scripted into daily multidisciplinary rounds.

Figure 1. Continuous monitoring system implementation checklist at Newton-Wellesley Hospital
Workflow policies were developed for each unit regarding use of the technology, nursing responsibilities for responding to alarms, and required interventions for an alarm response. Instructions for when to escalate the alarm to medical staff for potential intervention also were provided. A summary of the workflow is shown in Figure 1.

**Customizing alarm default parameters.** In 2015, the hospital gave the individual units the authority to adjust and customize alarm limit defaults based on their patient populations, in order to decrease non–clinically actionable alarms. For example, for a patient with a tachyarrhythmia, the alarm will sound within the default parameters. In response to this arrhythmia, medication can be given; however, it may take time for the medication to lower the heart rate. The policy allowed the nursing staff to slightly liberalize the alarm limits for a short time while the medication took effect, then readjust the limits after the therapeutic window for the medication was reached.

**Impact of unit culture on alarm response times.** Although it was important that the individual unit’s responses to alarms be consistent with their culture, these nuances also presented challenges. Given the different cultures on each unit, the way the nursing staff would interpret the urgency of an alarm and the response rate varied. For example, the urgency of response to respiratory alarms on a cardiac unit, which routinely has multiple, simultaneous vital sign alarms, might be slightly slower than that for a surgical unit caring for patients on opioids. As nurses floated from unit to unit, the possibility existed that they would respond in a manner to which they were accustomed rather than one consistent with the culture of that given unit.

**Staffing patterns.** Another major challenge during implementation was staff turnover, as incoming nursing staff had to be trained and become proficient with the technology. Likewise, as nursing staff transferred to different units or floated to multiple units, the individual units’ response to the alarms varied and each nurse needed to learn the workflow processes of a given unit. Challenges such as these can slow the momentum and effectiveness of new initiatives. From 2015 to 2016, the hospital experienced an increase in the number of nurses moving among units, as staffing patterns were adjusted to increase efficiency and locate nurses to the areas of greatest need. To maintain momentum, the units continually reinforced the workflow processes and their unit’s results, as well as provided education and reeducation of staff.

**Reinforcement: rounds and sharing stories.** An additional strategy aimed at reinforcing protocols and interventions is for a member of the original project team to conduct, unannounced, weekly spot checks on the involved units. When the researcher notes an unanswered continuous monitoring alarm sounding for 1 to 2 minutes, the team member verbally alerts the nurse to respond to the alarm. In this way, feedback is given in real time to the nurse on the alarm response. The respective nursing managers also perform similar rounding and provide the same level of feedback. These rounding activities reinforce the importance of the notification and the need for a prompt response. The project team has found this to be an effective strategy to maintain compliance to workflow protocols with frontline staff.

The project team is compiling a collection of real-life scenarios that demonstrate patient deterioration, followed by an alarm sent from the device, and the resulting intervention by the nursing and medical staff. The project team is compiling a collection of real-life scenarios that demonstrate patient deterioration, followed by an alarm sent from the device, and the resulting intervention by the nursing and medical staff. In this way, they can share stories that have altered potential negative outcomes for patients and demonstrate the importance of early intervention. Three such patient scenarios are shown in Figures 2–4.

**Results and Development of Best Practices**

The ongoing collection of data and results for the Early Detection of Deterioration Project at Newton-Wellesley has been encouraging. The hospital has seen an overall reduction of 59% in median nurse response times to alarms since the initiation of the project (Figure 5).

As the hospital analyzed the results of continuous monitoring on the five units, it
**About the patient:**
A 68-year-old male patient admitted to the orthopedic floor post-surgery.

**EarlySense indication:**
Low respiratory rate alerts (7 breaths/min) at 1:45 pm

**Assessment:**
The patient was unresponsive upon nurse assessment. Patient was postoperatively on opioids.

**Response:**
The hospitalist was notified and naloxone was given.

**Outcome:**
The patient responded to the naloxone; his medication was adjusted and he remained stable.

**Figure 2.** Case example of low respiratory rate alerts leading to treatment of respiratory depression

---

**About the patient:**
Female patient admitted to the medical/surgical unit following orthopedic surgery. Patient had no known history of arrhythmia.

**EarlySense indication:**
High heart rate alerts (139–149 bpm) from 2:07 pm through 3:51 pm

**Assessment:**
The nurse confirmed high heart rate and ordered an electrocardiogram. The physician was notified.

**Response:**
The patient was transferred to the cardiology unit for further monitoring.

**Outcome:**
She was stabilized in the cardiology unit and discharged the following day.

**Figure 3.** Case example of high heart rate alerts leading to diagnosis of rapid atrial fibrillation and transfer to telemetry unit
Questions to Consider when Launching an Initiative

- Who are the key executive leaders in your organization whose support is essential to the success of the project?
- Among your frontline staff, which individuals can serve as champions?

About the patient:
A 60-year-old female was admitted with asymptomatic pneumonia. Patient had a history of lung cancer and lymphoma. She was transferred from the cardiac care unit off telemetry the previous evening.

EarlySense indication:
High heart rate alerts (130–147 bpm)

Assessment:
Nurse identified that the patient had become mildly tachycardic throughout the shift. The physician was notified and telemetry was ordered. Telemetry showed atrial flutter.

Response:
The patient was transferred to the cardiology floor.

Outcome:
Patient was stabilized through medication adjustment and discharged home.

Figure 4. Case example of high heart rate alerts leading to identification of atrial flutter and to timely transfer to cardiology unit.
Lessons Learned

Looking to the future. Although these interventions are ongoing, the Newton-Wellesley staff are encouraged with the results thus far. They continue to make improvements in response to The Joint Commission’s 2016 National Patient Safety Goal, which states, “Make improvements to ensure that alarms on medical equipment are heard and responded to on time.” In addition to response times, the hospital plans to expand its data analysis to look at other parameters, including ICU admissions and potential impact on length of stay. In reflecting on the process, Dr. An stated that initiatives such as these are all about people: “Change and quality improvement are about being able to take what they perceive and experience on the frontlines and then develop ideas for the better.” He cautioned that this focus must not be lost as the initiative unfolds.

Buy-in from hospital leadership and frontline staff. Dr. An emphasized that the support of key hospital executives and clinical leaders is paramount to the success of the project so that the work can be carried forward. Champions at the executive level signal the priority and importance of the initiative within the organization and their support and buy-in cannot be minimized. This backing allows for consistent messaging and the provision of both financial and human resources over the life of the project.

Gaining buy-in from frontline staff is just as important as having the buy-in of executive leadership, according to Dr. An. “Having champions among end users who are ready to lead their colleagues in new initiatives and adoption of new technologies is critical, but finding these champions isn’t always easy. Effective champions must be well-respected peers: articulate, persuasive, and enthusiastic,” he said.

Continuous improvement. Dr. An also suggested that for an initiative to be successful, it must be viewed as an iterative process from the onset. Once positive results begin to emerge, the organization cannot become comfortable or complacent. They must continually examine their results and ensure that they are maintaining and improving outcomes for patients.

Dr. An also observed that “technology in and of itself is just a tool and that tool is not a savior nor is it evil or the problem in and of itself. ... It instead is how we use the technology in a meaningful way that is important.” With the decreased length of stay and the increased acuity of patient care, information overload for patients and staff can result. Decreased length of stay is positive, but with the quick turnaround, mistakes can be made and critical details can be overlooked. Technology can assist in alerting staff to these very details. The key is how staff respond to the alarm and intervene on behalf of patients.

Conclusion

Responding to The Joint Commission’s National Patient Safety Goal on alarm management, as well as other safety initiatives, can consume much of an organization’s energy and resources as they seek to develop the optimum level of patient care. The Early Detection of Deterioration Project at Newton-Wellesley Hospital demonstrated how a committed group of clinicians can respond to a patient safety issue and make a positive impact on clinical outcomes. To be successful, it must include a collaborative multidisciplinary approach and a willingness to reflect on the organization’s processes and protocols. The group steering
the intervention must have the courage to implement evidence-based initiatives, monitor the effect of those interventions, and then make further adjustments with an eye toward continuous quality improvement. It also takes executive leadership support in allocating resources, as well as championing the initiative. With these actions, an organization’s response can effectively improve the care they deliver to patients.

Acknowledgments
To Perry An, MD, for sharing his expertise and experience. This article is a result of the efforts of the AAMI Foundation’s National Coalition to Promote Continuous Monitoring of Patients on Opioids. The Foundation thanks the following industry partners for making this coalition possible: BD, Connexall, Hospira, Masimo, Medtronic, Mallinckrodt, Sotera, Early Sense, and Bernoulli.

References