Safety Innovations

Vital Signs Monitoring Leads to Increased Patient Safety and Workflow Efficiency

Martha Vockley and Theresa Kloewer

Methodist Specialty and Transplant Hospital in San Antonio cares for many high-acuity patients. Its busy, nationally recognized Texas Transplant Institute performs kidney, pancreas, and liver transplants. Its bariatric surgical center is a designated Center of Metabolic and Bariatric Surgery Excellence. The 275-bed, acute care hospital is known for its multispecialty surgical services, among other types of specialized care.

Historically, the hospital had monitored bariatric patients with identified risk factors for deterioration, particularly sleep apnea, with pulse oximetry to measure oxygen saturation (SpO2). Then, a planned upgrade of pulse oximeters turned into an unexpected opportunity to monitor all bariatric and transplant patients, as well as many other patients, comprehensively with continuous surveillance monitoring of all vital signs. This noninvasive wireless technology appealed to nurses, physicians, and executive leaders alike. That clinched the decision to make the switch.

More than a year after the successful launch of continuous surveillance monitoring on its transplant unit and one medical-surgical unit, Methodist Specialty and Transplant Hospital began expanding the initiative to more medical-surgical units. The main reasons behind the decision to expand included enhanced patient safety, strong support from clinicians, patient satisfaction, and improvements in clinical workflow efficiency.

Orchestrated as a test case for the nine-hospital Methodist Healthcare system and its corporate affiliate, Hospital Corporation of America (HCA), the implementation paved the way for broader use of continuous surveillance monitoring across both systems.

Nurse-Driven Patient Safety Initiative

Even in an award-winning hospital and healthcare system, nurses at Methodist Specialty and Transplant Hospital had nagging concerns about patient safety. Specifically, they worried about the monitoring protocols on the bariatric and transplant units. They sensed that the tools at their disposal for early detection of physiological deterioration in high-acuity patients were inadequate.

For bariatric patients, surgeons historically had been diligent about testing patients for sleep apnea before surgery. They insisted that bariatric surgical patients bring their continuous positive airway pressure devices to use in the hospital. They ordered pulse oximetry to monitor SpO2 for all patients with sleep apnea.

“We noticed that we have a lot of other obese patients,” said Theresa Kloewer, MSN, RN, vice president of nursing at Methodist Specialty and Transplant Hospital. Obesity is a risk factor for deterioration. “We may not have a clear picture if a patient has sleep apnea. So if we had concerns, we’d call...
doctors and get orders to put them on pulse oximetry as a safeguard.”

Nurses suspected many patients on other units had unidentified risk factors for deterioration as well. On the transplant unit, patients tend to be sicker and have comorbidities. Absent diagnosis, however, nurses were uncertain where patients’ conditions put them on the risk scale. Nurses wanted better monitoring technology for these patients as well.

Beyond pulse oximetry for some patients, nurses relied on spot checks of patient vital signs every four hours and as needed. But intermittent spot checks can miss early signs of deterioration, resulting in delayed intervention. Typically, patients experiencing deterioration were transferred to the intensive care unit (ICU) and had longer lengths of stay.

After evaluating different technology options, the nursing leadership team (chief nursing officer, vice president of nursing, nurse directors, nurse educators) changed course. When they saw the continuous surveillance monitoring technology, they knew right away that they wanted to bring it into their building for patient safety.

The selected early detection system, the Sotera Wireless ViSi Mobile System (Figure 1), is a wearable device (a physiological monitor worn on the wrist) that measures multiple vital sign parameters continuously:

- Heart rate
- Pulse rate
- Respiratory rate
- SpO₂
- Noninvasive blood pressure (initial cuff calibration)
- Continuous noninvasive blood pressure (measured by pulse arrival time, which is the time it takes for a single cardiac beat to travel to a peripheral sensor. For this device, it’s the time from the electrocardiogram (ECG) to the corresponding pulse oximeter pulse sensed on the base of the thumb.)
- Skin temperature

The system works wirelessly. “We didn’t find another one where the patient was completely mobile,” Kloewer said. “With the system that we had, the patient was tethered to a machine. They would unplug to go to the bathroom or go for a walk. That’s pretty valuable data to capture, SpO₂ with activity, but we weren’t capturing it. Having the patient not tethered and continuously monitoring them when they’re ambulating is very valuable. We’ve actually been able to see patients desaturating during activity and get them back on oxygen in a timely manner.”

The technology can be integrated into the electronic health record (EHR), allowing clinicians to access patient vital signs on a smart handheld device, workstation on wheels, or nurse’s station. The system generates alerts and alarm signals if a patient’s vital signs indicate deterioration.

Continuous surveillance monitoring applied universally on patient care units removes the guesswork inherent in condition monitoring. Kloewer explained the difference:

- **Condition monitoring** is the use of a patient monitoring system that is limited to clinical targets based on a patient’s unique, identifiable risk profile.
- **Surveillance monitoring** is the use of a patient monitoring system that has continuous, broad clinical targeting independent of a patient’s unique, identifiable risk profile, recognizing that all risks cannot be identified as a priority.

After the nursing leadership settled on continuous surveillance monitoring, they educated the hospital’s chief executive officer,
chief financial officer, and physician leaders, all of whom supported the decision to move forward.

**Focused, Replicable Implementation Plan**
The nursing leadership team identified two hospital units in which to introduce continuous surveillance monitoring: 1) the 57-bed transplant unit that provides pre- and posttransplant care and 2) a 47-bed medical-surgical unit that provides postsurgical care to bariatric, endocrine, gynecological, urological, maxillofacial, vascular, colon-rectal, plastics, and general surgery patients.

The decision to choose these units was clear, Kloewer said. Both units are busy and full of high-acuity patients—the kinds of patients about whom nurses were most concerned. Both had been using traditional spot-check monitoring, supplemented on the medical-surgical unit with pulse oximetry for bariatric patients.

In the lead-up to the implementation on the two units, Methodist Specialty and Transplant Hospital took on two unusual projects:
1. **Conducting a comparative workflow analysis of traditional and continuous surveillance monitoring.** A benefit of continuous surveillance monitoring is that it shifts the work of clinicians from time spent manually collecting vital signs to time spent focused on the patient. The nursing leadership team wanted to verify the impact of workflow, efficiency, and quality in their hospital.
2. **Laying the technical groundwork to expand continuous surveillance monitoring throughout the hospital, healthcare system, and HCA affiliate hospitals.** This project was undertaken in conjunction with Methodist Healthcare and HCA, which operates 169 hospitals and 116 freestanding surgery centers in 20 states and the United Kingdom.

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**Intuitions Confirmed by Evidence**
To its credit, the nursing leadership team at Methodist Specialty and Transplant Hospital took the time to understand the rationale for more effective and comprehensive patient monitoring. Their inquiry focused on failure to rescue and nursing surveillance of patients. In an AAMI Foundation patient safety webinar, Kloewer summarized the team’s findings:

**Defining Terms**
- *Failure to rescue* is the failure to prevent a clinically important deterioration from a complication of an underlying illness or a complication of medical care, such as respiratory compromise, pulmonary embolus, and sepsis.1
- *Nursing surveillance* is “the purposeful and ongoing collection and analysis of information about the patient and the environment for use in promoting and maintaining patient safety.”2

**Why Is Failure to Rescue Important?**
- Failure to rescue is associated with up to 75% of adverse events and preventable events that occur outside of the ICU in unmonitored beds.3
- 84% of patients exhibit signs of deterioration within eight hours preceding cardiopulmonary arrest.4
- Up to 60% of all hospital patients are not monitored continuously.4
- To perform a rescue, clinicians need to know patients are deteriorating and respond immediately.5
- For every one-hour increase in delay of transfer of deteriorating patients to ICU, the odds of in-hospital death increased 3%. For patients who survived until discharge, delayed transfer was associated with a longer length of stay.6
- When nursing surveillance is performed an average of 12 times a day or more, the odds of experiencing failure to rescue decreases significantly.7 Studies have shown few nurses actually are able to reach this level of nurse monitoring outside the ICU, and even this level of monitoring will not detect patients who deteriorate faster than within 2 hours.

**Three Fundamental Problems**
Three problems often lead to failure to rescue, according to the Institute for Healthcare Improvement and its 5 Million Lives Campaign8: 1) failures in planning, including assessments, treatments, and goals; 2) failure to communicate (patient to staff, staff to staff, and staff to physician); and 3) failure to recognize a problem.

**Metrics for Quality Improvement**
The Institute of Medicine described six aims to improving healthcare quality: safety, effectiveness, patient centeredness, timeliness, efficiency, and equity.9 Continuous surveillance monitoring responds to these aims with:
- Early identification of deterioration, including sepsis, opioid-induced hypoventilation, hypertension, and indications for reoperation.
- Timely intervention for patients experiencing deterioration and reduced rapid-response and code blue calls.
- Efficiency and effectiveness in collecting patient vital signs and in clinical workflow.
- Patient and clinician satisfaction.
Essentially, Methodist Specialty and Transplant Hospital served as the test case for broad adoption of continuous surveillance monitoring.

**Comparative Workflow Analysis**

The first project came about in response to clinicians’ reservations about the impact of the technology. Specifically, because they spent a considerable amount of time collecting and documenting vital signs manually in spot checks, patient care assistants (PCAs) expressed concern that automatic, electronic monitoring of vital signs would jeopardize their jobs.

Nursing leadership suspected that PCAs would indeed spend less time collecting vital signs. However, they also believed that this time would be better spent in clinically meaningful activities. “So we said, ‘Let’s measure it. Let’s see if this would be more efficient for the staff,’” Kloewer said. “You can have a gut instinct about something and then when you check it, it isn’t so. We wanted to make sure it was really going to be more efficient in the long run. Sure enough, it was.”

The nursing leadership team used workflow analysis tools to document the traditional method of collecting vital signs, via a five-step process:

1. Nurse (or PCA) finds traditional vital sign device.
2. Nurse (or PCA) brings device to patient room.
3. Nurse (or PCA) takes vital signs in three stages: temperature, blood pressure, pulse oximetry.
4. Nurse (or PCA) returns vital signs device to storage area.
5. Nurse (or PCA) documents vital signs in the EHR (or validates them if they are transmitted automatically).

The time required for these steps also was documented. “We actually learned that our PCAs were spending a significant amount of time gathering those vitals,” Kloewer said.

During the implementation on the two units (from July to October 2015), the nursing leadership team then documented the time spent on continuous surveillance monitoring.

Figure 2 shows time spent on traditional collection of vital signs compared with time spent on continuous surveillance monitoring on the two units. A potential savings of about 16.5 hours a day on the 47-bed surgical unit and about 20 hours per day on the 57-bed transplant unit was determined.

“I do have to say to the finance leaders, because they get all excited when I talk about this, ‘No, we don’t need to decrease FTEs (full-time equivalent staff),’” Kloewer said. “We’re still doing nursing care. We’re able to do baths, walk patients, do...
clinically significant interventions when we run into any kind of change to a patient. The staff are very busy and they’re doing clinically meaningful work."

In fact, continuous surveillance monitoring supports not just operational efficiencies but also the best practice of clinicians working at the top of their license or credential on more complex, rather than routine, tasks.

Of note, the 16.5 to 20 hours saved does not include additional time saved resulting from the most monitored patients no longer needing a nurse or PCA to stay with them when they are transported to other parts of the hospital for tests or procedures, such as X-rays or computed tomography (CT) scans. Patients are now monitored remotely through the wireless monitoring device throughout the building. (Patient monitors are removed for magnetic resonance imaging scans, and patient cables are removed for CT scans of the chest.)

**Systemic Infrastructure**

The second project undertaken to prepare for the implementation involved the technical infrastructure at the hospital, its healthcare system, and its corporate affiliate (HCA). After the decision was made to implement the technology, the hospital information technology (IT) team swung into action.

At the hospital, the IT team first worked in concert with the vendor on a connectivity assessment to ensure that the continuous surveillance monitoring system would work in every room, hallway, and department in the building. (The hospital did upgrade its wireless infrastructure, but that upgrade already had been planned to accommodate other healthcare technology coming into the building.)

The IT team and vendor also worked with their counterparts at Methodist Healthcare to select a location and set up the server for the system. They selected and configured the server so that any other hospital in the healthcare system could use it for continuous surveillance monitoring.

Finally, the IT team and vendor worked with Methodist Healthcare and HCA on another key piece of the preparation: establishing the securities, permissions, and interfaces to integrate the technology with the EHR system. Vital signs data can be easily interfaced to the patient’s EHR, thus avoiding time-consuming, error-prone manual entry. The nurse validates and documents the vital sign values in the EHR at intervals consistent with hospital policy. Vital sign data in the EHR is available whenever and wherever needed and can be viewed on the patient’s wrist monitor, at the nurse’s station, via a central monitor, and on remote viewing devices. Again, the IT team and vendor designed this integration so that any other Methodist Healthcare or HCA system could piggyback on the configuration.

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**Time Drain of Traditional Vital Signs Monitoring**

Kloewer shared several other statistics showing the amount of time required to assess patient vital signs in traditional spot checks—time that can be repurposed to clinically meaningful tasks with continuous surveillance monitoring:

- Vital signs obtained for five minutes every four hours represents 2% of a patient’s day. However, it represents hours of nurse or PCA time on each shift.
- Registered nurses (RNs) are in patient rooms for 1.5 hours during a 12-hour shift. They spend less than 7% of their time assessing the patient.
- RNs experience an average of nine cognitive shifts per hour. They refocus from one patient to another every six to seven minutes.
Education and Go-Live

Hospital and patient care unit educators collaborated with the vendor’s clinical education team to develop an education plan for nursing staff, respiratory therapists, and ancillary staff (healthcare professionals in departments or service areas involving monitored patients). The education consisted of classroom training for small groups of eight to 10 people, a short slide presentation, and hands-on training. Super users on each unit received additional training.

Following the vendor’s recommendation, the hospital introduced the technology with “a very slow go-live,” Kloewer said. This meant connecting one patient at a time to the monitoring devices and system, checking to make sure that the vital signs data were coming across on monitors, then moving to the next patient. The process took about a day. “It’s not a rush, which felt really good to the staff,” she said.

Super users and vendor clinicians were on hand to support unit clinicians for the first two weeks of the implementation. They shadowed every clinician the first time they put a patient on the new monitoring system.

Results and Lessons Learned

Tracking Meaningful Interventions

For the first four months of the implementation (July to September 2015), the nurse leadership team had nurses keep logs of meaningful interventions for patients experiencing deterioration.

Figure 3 shows the analysis of nurse intervention logs from that period that indicate the vital sign parameters that detected deterioration. Figure 4 shows the analysis of events in which nursing intervention prevented deterioration. Other results tallied during July to October 2015 included the following:

- More than 99,500 hours of patient vital sign data were logged.
- More than 75 clinically meaningful nursing interventions to alarm signals recorded that either detected or prevented deterioration.
- Interventions were coded to determine early deterioration diagnosis (e.g., sepsis, hypertension, pulmonary vascular congestion).
- A total of 20 conditions were related to deterioration. All patients were treated and discharged. The conditions included a broad range of clinical situations: sepsis, pulmonary embolism, pulmonary edema, oversedation, hypertension, dysrhythmia, surgical leak (return to operating room), respiratory arrest, respiratory insufficiency, hypovolemia, hemothorax, sleep apnea, tachycardia, hypotension, bradycardia, pain, activity.

Figure 3. Parameters that detected deterioration: analysis of nurse intervention logs (10-week sample). Abbreviations used: cNIBP, continuous noninvasive blood pressure; HR, heart rate; SpO₂, oxygen saturation; RR, respiratory rate.

Figure 4. Type and number of events (47 total) in which nursing intervention prevented deterioration: analysis of nurse intervention logs (10-week sample).
intolerance, tachypnea, bradypnea, and desaturation (unknown origin).

Behind the data is a shift in practice that has improved patient outcomes. Whereas clinicians used to be quick to send deteriorating patients directly to the ICU, early detection of deterioration through continuous surveillance monitoring now supports early intervention. Here are two examples:

1. A monitor alarm signal indicated a high heart rate in a 62-year-old liver transplant patient with a history of atrial fibrillation. The waveform on the monitor showed an irregular heartbeat, as did a physical exam. A stat ECG confirmed atrial fibrillation and rapid ventricular response. The patient was administered metoprolol, a beta blocker used to treat heart conditions. A repeat ECG showed an abnormal sinus rhythm with premature atrial contractions. The patient was administered amiodarone, a drug used to treat life-threatening rhythm disorders. The patient stabilized, remained on the floor, and was discharged home after completing the normal posttransplant course of treatment.

2. A new nurse noticed that a postsurgical bariatric patient was desaturating and experiencing hypotension. She alerted the surgeon, who ordered stat CT and upper gastrointestinal scans, which showed a gastric leak—a complication of gastric surgery. In the past, this complication would have landed the patient in the ICU for an extended period. Instead, the early detection of deterioration resulted in a timely return to the operating room to repair the leak, followed by recovery in the telemetry unit and discharge home.

Easing the Alarm Burden

Introducing new technology into any healthcare setting can increase alarm burden, particularly in patient care units where many medical devices include built-in alarm systems. However, Methodist Specialty and Transplant Hospital had a refreshingly different experience: fewer, and more meaningful, alarm signals.

“That was one of the great things a surgeon noticed,” Kloewer said. “He said, ‘I hear alarms and I see people move. I love that!’ With the previous systems, we had a lot of false alarming. People tend not to move as quickly” when they think it’s just another false technical or equipment alarm. Now, they trust the system to relay clinically significant alarm signals. Table 2 shows the alarm signals that the system generated for the first three months on the transplant and medical-surgical units. Although the events per patient per day increased from September through October, this was due to a change in the case mix index, not because of false technical or equipment alarming.

For the most part, the hospital adhered to the vendor-recommended alarm parameters and settings on the continuous surveillance monitoring system. The exception was for bariatric patients, whose surgeons insisted on tighter parameters for SpO2. However, even these surgeons came to trust the system. The alarm parameters for their patients are now at the vendor-recommended settings.

Clarifying Roles and Responsibilities

The two patient care units initially approached “ownership” of continuous surveillance monitoring differently. On one unit, RNs led the charge, taking responsibility for moving from spot checks and getting...
patients connected to the new system. The RNs also organized supplies (charged wrist cuff monitors, electrodes, cables) for staff efficiency, despite physical storage limitations. On the other unit, RNs continued to delegate monitoring to PCAs.

As a consequence, the unit with the RNs in charge had a faster learning curve and adoption rate than the other unit, where it took longer for RNs to grasp the technology. Therefore, the nurse leadership team stepped in with extra education for these RNs, as well as a standard protocol for the initial patient setup. “PCAs can help, but RNs are responsible for that first set of vitals to make sure everything is set up appropriately,” Kloewer said. “It’s part of the initial assessment. It makes perfect sense.”

**Gaining Deeper Understanding**

The education team had developed and delivered a training session for ancillary staff who provided off-unit services to monitored patients. It turned out, however, that the training didn’t go far enough.

“We actually learned afterwards that we needed to include more ancillaries than we did to make sure they’re familiar with the technology and they’re not alarmed by it when they see it,” Kloewer said. “That was some of the concern initially—seeing a patient is on a monitor and there’s not a nurse with them.”

Therefore, the team circled back and helped ancillaries understand that continuous surveillance monitoring isn’t the same as ICU monitoring. Patients with their wireless monitoring devices are safe without a nurse, because these patients are still being monitored from the patient care unit.

**Moving Forward**

Having ironed out the manageable process issues in the rollout on the first two units, and with trust and satisfaction in the system growing, Methodist Specialty and Transplant Hospital has expanded continuous surveillance monitoring to other patient care units.

“It was probably about four months into the project when I realized I need continuous

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<th>Time Period</th>
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**Table 2.** Average alarm events per day, July to September 2015. *Combination of pulse and heart rate. Abbreviations used: cNIBP, continuous noninvasive blood pressure; HR, heart rate; NIBP, noninvasive blood pressure; SpO₂, oxygen saturation; RR, respiratory rate.
surveillance monitoring on all of my medical-surgical units," Kloewer said. Physicians and nurses were clamoring for it as well.

In September 2016, implementation began on the hospital’s medical telemetry unit. As of October 2016, all inpatient medical-surgical beds are monitored via continuous surveillance monitoring.

Acknowledgments
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References
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