Telemetry Monitoring on the Medical/Surgical Floor

Introduction

In response to the rising acuity levels of patients on medical/surgical floors and the perceived need for more robust surveillance of these patients, some hospitals are choosing to invest in telemetry devices or ECG-capable monitors for their general care beds. This expanded use of cardiac monitoring is intended to allow hospitals to care for sicker patients in a lower-cost care setting, admit patients faster, ease bottlenecks in the ER and ICU, and avoid costly adverse events by detecting deterioration of patient condition. In addition, some hospitals may be influenced by manufacturers of ECG-capable monitors, who use ECG functionality as a lock-out specification against other types of solutions.[1]

However, research has documented that a significant proportion of patients placed on ECG-telemetry do not meet the American Heart Association indications for telemetry monitoring and are not deemed to be at increased risk for irregular heart rhythm.[2-4] Despite the implication of 'over-monitoring', the routine use of ECG monitoring on general care floors may seem like an effective way to improve patient safety and minimize risk. Yet, research on telemetry has shown that hospitals may overestimate its clinical effectiveness.[5-6] It appears that physicians routinely make the choice to put patients on telemetry monitoring based in part on "the often erroneous expectation that telemetry will lead to prompt recognition and timely intervention for life-threatening changes in patients".[2]

Furthermore, deploying ECG monitoring in a general care setting may have unintended negative consequences, such as an increase in nuisance alarms, which creates the risk of alarm fatigue—a widely

recognized risk to patient safety.[7] In light of the marginal clinical efficacy of ECG monitoring in the general care setting, its high incidence of nuisance alarms[8-13], the added cost of floor-wide telemetry systems, and their more demanding workflow and staffing requirements, the utilization of telemetry for medical/surgical patient surveillance may be called into question.

A more effective strategy for surveillance of patients in the general care setting should focus on proper patient assessment, accomplished through regular vital signs and clinical observation. Expanded surveillance monitoring should be based on the existing care protocols and staff skill set found in general care areas today.

Potential Problems with the Use of Telemetry in General Care

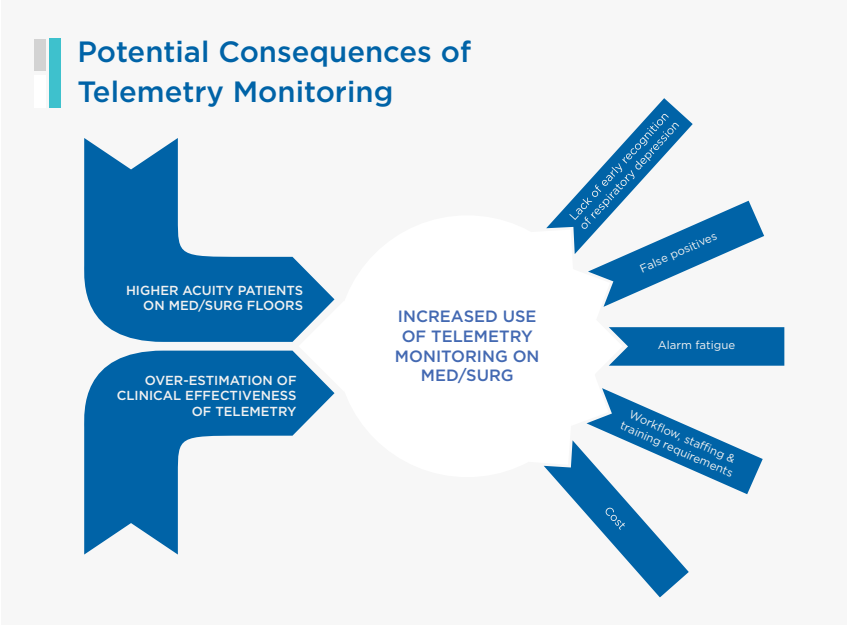
Clinical Effectiveness

Health care delivery organizations are more focused than ever on evaluating the efficacy of interventions and quantifying the link between quality of care and cost-effectiveness.[14] Hospitals want to ensure that any investments produce the desired clinical results.

However, in a literature review of the efficacy of cardiac monitoring, researchers at the Cleveland Clinic concluded that "the available evidence suggests that telemetry infrequently influences physician management decisions for patients at low risk, although it may in a relatively small subset at high risk".[15] Studies of telemetry patients show that only a small fraction of patients have significant arrhythmias that lead to urgent intervention.[6] Thus, for those patients on the medical/surgical floor today, many of whom are at low risk according to the AHA guidelines, telemetry may not significantly influence care decisions.

For patients who do eventually encounter cardiac events, it has been established that there are frequently clinical signs of deterioration hours before cardiac arrests or urgent transfers to the ICU.[16-18] The two most important predictors for patient adverse events have been shown to be Heart Rate/Pulse Rate (HR/PR) and Respiratory Rate (RR).[19] While ECG does measure continuous HR, there are other less complicated, less costly methods of monitoring HR/PR, for example, via pulse oximetry.

For many patients on the medical/surgical floor today, it is respiratory failure that poses the most significant risk.[20] Data from a literature review on parameters that trigger rapid response team calls suggest respiratory dysfunctions, such as tachypnea, bradypnea, and desaturation, are the most common triggers for RRT activation.[21] Other studies find respiratory depression to be the most common reason for code blue events in patients receiving opioids[22] and one of the most common antecedents of in-hospital cardiac arrest.[18] For these patients at risk for respiratory complications, monitoring of pulse oximetry (SpO_2) and capnography ($etCO_2$) is an earlier indicator of respiratory depression than is respiratory rate from chest wall impedance.[23] Furthermore, ECG monitors derive a RR from changes in electrical impedance, which can be problematic due to artifacts and false alarms caused by patient movement and poor lead contact.[24] The RR measured via impedance pneumography has been shown to be less accurate than other methods, including capnography, manual measurements, and contact-free sensing.[25-26]



Although monitoring respiratory rate is a useful component of assessing patient status, the numeric reading provides only breaths per minute, not a measure of the quality of ventilation, which, in some patients is crucial. In patients whose airway becomes obstructed, respiratory rate is not a reliable monitor of ventilation, because episodes of obstruction are not usually associated with slow respiratory rates, and there is often chest movement without ventilation. Patients may experience profound hypoventilation due to shallow breathing while maintaining a respiratory rate within normal limits.[27]

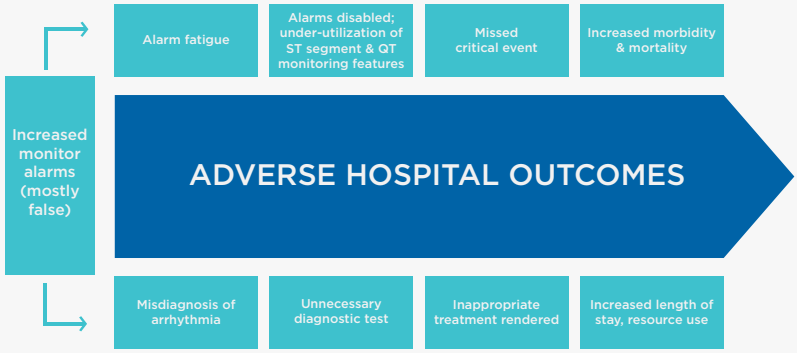
False Positives and Alarm Fatigue

One potential unintended consequence of the overuse of telemetry monitoring is the increased chance of artifacts being misinterpreted as abnormal rhythms, which could potentially lead to errors in patient care.[15] In fact, cases have been reported of patients undergoing unnecessary diagnostic or therapeutic procedures because of artifacts seen during telemetric monitoring.

A second, potentially more dangerous consequence of the overuse of telemetry, especially on medical/surgical floors, is that of alarm fatigue. Cardiovascular monitoring has been shown to be a significant driver of alarm events among the commonly monitored parameters. The following table summarizes alert rates documented in ICU settings:

Study	Type of alerts	Alerts per 100 recording hours
Chambrin et al., 1999[9]	1. Ventilators (38%) 2. Cardiovascular monitors (37%) 3. Pulse oximeters (15%) 4. Capnography (14%)	161
Gorges et al., 2009[29]	1. Ventilators (40%) 2. Cardiovascular monitors (21%) 3. Pulse oximeters (15%) 4. Infusion pumps (12%)	636
Siebig et al., 2010[12]	1. Cardiovascular monitors (66%) 2. Pulse oximeters (26%) 3. Respiration rate (3%)	604

It is estimated that up to 99% of cardiac alarms do not require an intervention.[8-13] Causes of false alarms include setting the alarm thresholds "too tight," default alarms not adjusted to individual patient needs, sensors that are not correctly applied, and patient movement.[24,30,31] Clinicians overwhelmed by the sheer multitude of beeps may disable or ignore alarms (known as alarm fatigue) sometimes with catastrophic results. The Boston Globe published a series of articles on the results of alarm fatigue which reported that between January 2005 and June 2010, 200 hospital patient deaths nationwide were linked to problems with alarms on patient monitors.[32-36] Clearly, deploying any monitoring technology will increase the quantity of patient alarms occurring on the medical/surgical floor. However, eliminating unnecessary ECG monitoring would significantly reduce false alarms and the alarm fatigue phenomenon.



Drew, BJ. Cardiac Monitoring Devices; Clinical Alarm Fatigue. Presented at FDA Public Workshop on Study Methodology for Diagnostics in the Post-Market Setting. May 12, 2011, Silver Spring, MD.

Workflow and Staffing Implications

In addition to clinical efficacy, there are several important factors to consider when contemplating the deployment of telemetry monitoring into a general care environment—an environment where challenges around cost constraints, staff skill sets and workload, patient and staff satisfaction and risk mitigation abound.

A typical deployment for telemetry systems is to have patient data monitored in a centralized 'war room' outside of the floor. In this scenario, nurses at the bedside do not have actionable patient data at their fingertips. For example, they would be unable to effectively monitor patient status when administering drugs or performing other interventions. Alternatively, the telemetry data could be sent to a central station at the floor's nursing station. While this would improve access to accurate patient data, many of these ECG-based central stations were designed for the ICU, not for the medical/surgical floor or for use by non-CCRN trained nurses.

ECG monitoring requires interpretation of waveforms and recognition of waveform artifacts, and most nurses in medical/surgical units are not trained in this skill. Therefore, effective use of ECG monitoring would require either training the nursing staff on ECG interpretation or employing a monitoring technician at each central station.

Regardless of where the monitoring will be done, the floor nurses would be charged with managing the ECG lead preparation and placement, which can be challenging, especially if done for every patient. Incorporating this task into the current workload of medical/surgical nurses could be problematic in light of the high patient-to-nurse ratios found in general care settings. For this reason, national staffing standards for medical/surgical units with telemetry monitoring are higher than those of unmonitored medical/surgical units. For example, in California, the nurse-to-patient ratio for telemetry patients is 1:4, while for 'unmonitored' medical/surgical beds, it is 1:5.[37]

Cost

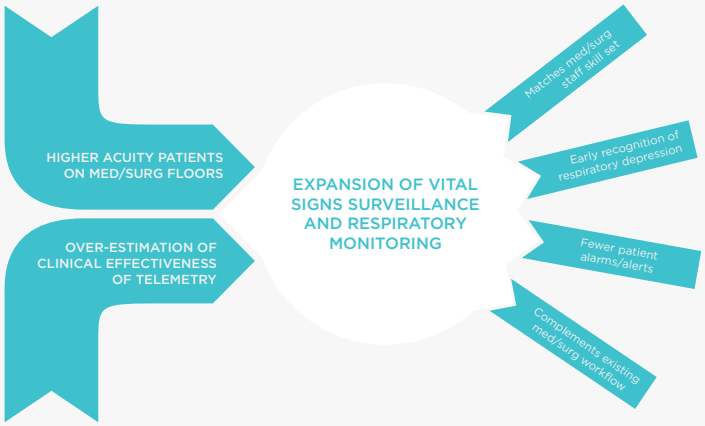
Telemetry requires specialized equipment and trained personnel, making it both costly and labor-intensive. Researchers at the Cleveland Clinic estimate that the cost of telemetric monitoring in their hospital is at least $1,400 per patient per 24 hours.[15] Whatever the true cost, inappropriate use of telemetry on patients who may not materially benefit from it can create an unnecessary financial burden on the health care system and an unnecessary cost for patients.

Alternative Solutions to Telemetry Should Be Considered

While the risk of adverse events on the medical/surgical floor is very real, the foregoing problems suggest that deploying telemetry monitoring throughout a hospital's general care areas may not be the most effective means for the early recognition of those changes in vital signs that precede most adverse events. In fact, the possibility of the unintended consequences of improper treatment and alarm fatigue due to false positive alarms may lead to compromised patient safety. Furthermore, telemetry is a costly system that requires a specialized skill set not generally found in medical/surgical settings and that may negatively impact clinical workflow.

Employing traditional cardiac monitoring technologies and workflows on medical/surgical floors is often tantamount to converting them to step-down floors or intermediate care—essentially critical care with higher patient-to-nurse ratios. The medical/surgical floor

Potential Benefits of Vital Signs Surveillance



therefore may be better served by utilizing the vital signs monitoring technology and workflows presently in use, rather than deploying traditional continuous cardiac monitoring to perform patient surveillance for early detection of deterioration. This alternative approach focuses efforts on patient assessment, regular vital signs observations, and the ability to continuously monitor PR, RR, quality of ventilation and oxygenation with the same devices which general care nurses are already confident and competent using for their vital signs protocols.

It has been shown that changes in a patient's oxygenation and respiration can reliably provide early indication of respiratory depression.[38,39] For this reason, and as a reaction to the increasing risk of respiratory failure in the general care setting, patient safety organizations recommend the continuous assessment of oxygenation and ventilation, via pulse oximetry (SpO_2) and capnography ($etCO_2$), to reduce the incidence of respiratory failure in patients receiving opioids post-operatively.[40-42]

Fortunately, this type of continuous monitoring can be readily incorporated into care protocols on a medical/surgical floor.

SpO_2, PR and RR parameters are already familiar to general care nurses. These parameters also tend to generate fewer patient alarms than do cardiac monitoring (see Table 1), and, thanks to innovative alarm management algorithms, industry leaders Covidien® and Masimo® have documented significant reductions in false alarms compared with older pulse oximetry technology.[43-44] While the use of capnography in medical/surgical care settings is still growing, and can be new to some, there are technologies and algorithms available which ease its adoption and use. For example, Covidien Microstream® capnography provides the Integrated Pulmonary Index™, a single 1-to-10 value that represents a real-time respiratory profile based on $etCO_2$, RR, PR and SpO_2, and provides a comprehensive indication of respiratory status and trends.[45]

There are other, newer, monitoring technologies available which provide early recognition of patient deterioration, and are designed specifically for the patient population, nursing skill set and clinical workflow on the medical/surgical floor. For example, EarlySense® contact-free monitoring uses an under-mattress sensor to monitor PR, RR and motion levels to help nursing staff detect patient deterioration so they can intervene to help patients avoid falls and pressure ulcers. One study assessed the effects of using EarlySense to continuously monitor HR and RR in a medical/surgical unit, and found a significant decrease in total length of stay, in ICU days for transferred patients, and in code blue rates.[46]

Unlike traditional telemetry monitoring, this type of contact-free continuous monitoring has been shown to produce a much smaller volume of patient alerts, particularly false alarms. Data from the same study showed that the EarlySense System generated about 2 alerts per nurse per 12-hour shift. Another study reported that 100% of major events and 88.6% of all events of deterioration, which occurred on sub-acute units in three hospitals, were detected by EarlySense, with only 1 false alarm per 80 hours of monitoring (3.4 days).[47]

Summary

It appears that, in some hospitals, ECG/telemetry monitoring has been the default approach for surveillance of patients that fall between the ICU and the medical/surgical setting on the care continuum, even though they may not meet the indications for telemetry or truly benefit from arrhythmia monitoring.

This approach may lead to unintended clinical outcomes, including missed events due to alarm fatigue, and has very real implications for clinical workflow and staffing on medical/surgical floors. Fortunately, an alternative approach designed specifically for general care floors exists: one of emphasizing patient assessment, regular vital signs observations, and the ability to monitor (pulse rate, respiration rate, quality of ventilation and oxygenation) with the same devices general care nurses are already confident and competent using for their vital signs protocols.

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