

# ADDRESSING THE ALARM BURDEN WITH CONTINUOUS SURVEILLANCE MONITORING

## THE EXISTING ALARM BURDEN AND FATIGUE

Alarm-equipped devices are designed to provide safe care to patients in many health care settings and clinicians depend on these devices to guide treatment decisions and deliver appropriate care. The number and frequency of alarms is highest in ICU settings, where drug therapy and mechanical devices including monitors, ventilators, and IV pumps—all with alarm settings—are used to carefully control a patient's physiology. Every aspect of care is highly sensitive. Alarm thresholds and delay settings are commonly set to ranges that quickly identify any deviation from expected values. In these settings, the monitoring done is called "condition monitoring" which is the use of a patient monitoring system that targets a patient's risk profile. Another example of condition monitoring is the use of cardiac telemetry ordered for use when a patient with heart disease is considered at risk for a cardiac event.

### *Alarm Hazard Persists Even With Adequate Nurse: Patient Ratio*

The nurse-patient ratio is

higher in ICUs and in Telemetry units to support more careful monitoring. However, even with 2:1 or 4:1 nurse to patient ratios, alarms are seen as a hazard.

### *Too Many False Alarms*

Research has demonstrated that 72-99% of clinical alarms are false.<sup>1</sup> Too often, excessive false alarm activations result in missed alarms when a patient is truly in distress. Patient deaths have been attributed to alarm fatigue.<sup>2</sup> The need to improve the safety of clinical alarm systems has been recognized by numerous groups including the JCAHO in their 2014 National Patient Safety Goals #6. ECRI Institute also ranks alarm hazards from inadequate alarm configuration policies and practices as its top patient safety concern in 2015.

### *Better Clinical Alarm Management Needed*

The Joint Commission has challenged all hospitals to develop a systematic, coordinated approach to clinical alarm system management that is appropriate for each clinical setting.<sup>3</sup> An excessive number of alarms lead to a risk of desensitization, where staff miss or ignore alarm signals or even disable them. Other related concerns include too many devices with alarms, default settings that are not at an actionable level, and alarm limits that are too narrow.

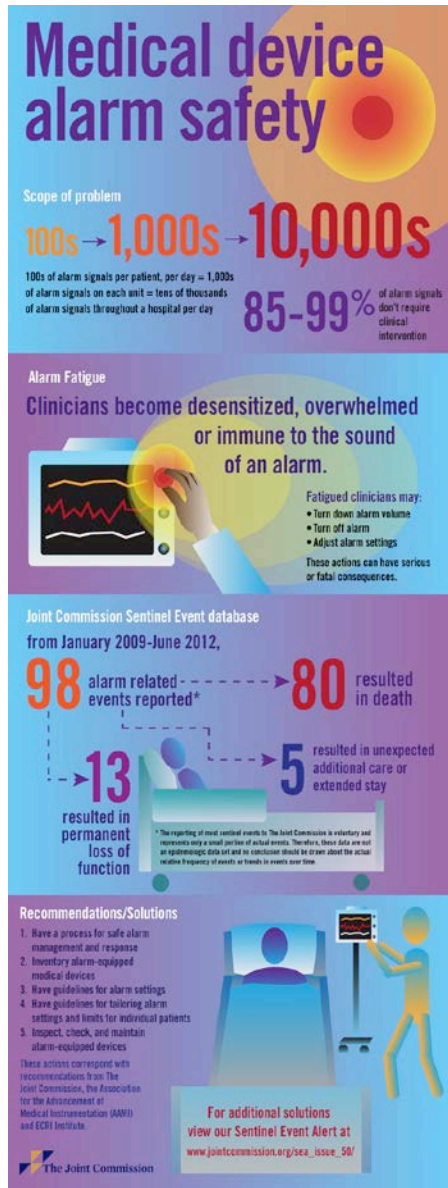
## ADDRESSING NON-ICU INPATIENT RISKS

While the acuity in non-ICU settings is certainly less than in ICUs, patients in general care areas of the hospital have become increasingly more complex and at risk for suffering an untoward event during their hospital stay. In fact, according to Institute for Healthcare Improvement (IHI), 25-75% of non-DNR hospital deaths in the U.S. happened outside the ICU.<sup>4</sup> The U.S. data are consistent with results reported in the United Kingdom and Australia.<sup>5</sup> Studies also confirm that arrests and deterioration are preceded by relatively long periods of hemodynamic or respiratory instability that goes undetected by busy staff.<sup>6</sup> Despite the evident risk, these patients typically undergo vital sign checks every 4-8 hours, a practice which further reduces the likelihood of discovering patients at risk.

### *Need to Identify Patients At Risk*

To recognize patient deterioration, it is essential to capture vital signs data as frequently as possible. The evident risk to patient safety has prompted the Joint Commission (TJC) to also mandate that hospitals develop systems which "improve recognition and response to changes in patient condition" in their safety goals.<sup>7</sup> Available evidence suggests that continuous monitoring which broadly captures and records vital signs is the best way to detect patients at risk in general care settings, however,

there are challenges to adopting continuous monitoring. Some challenges are cultural and financial, but more importantly, for continuous monitoring to be viable, alarms need to be addressed.



[http://www.jointcommission.org/assets/1/6/medical\\_device\\_alarm\\_safety\\_infographic.pdf](http://www.jointcommission.org/assets/1/6/medical_device_alarm_safety_infographic.pdf)<sup>1</sup>

### Can't Add to the Alarm Burden

For continuous surveillance monitoring to be effective and

ultimately integrated into clinical decision making, the system needs to detect patients at risk while not adding to the alarm burden. The system needs to detect patients at risk while not adding to the alarm burden; it must minimize the alarms and maximize the save. In order to accomplish this, alerts generated by the system must have a high positive predictive value: the alerts must be viewed as highly meaningful and actionable. Conventional condition monitoring systems are unable to achieve these goals, and as a result have not seen a broad adoption for use in surveillance monitoring. Without addressing alarms, the burden of too many nuisance alarms overwhelms the nursing benefit of continuous monitoring outside on the general care units.

### VISI MOBILE® SYSTEM: ENABLING CONTINUOUS SURVEILLANCE MONITORING

The ViSi Mobile System is a body worn, multi-parameter continuous early detection system that measures Heart Rate, Pulse Rate, Respiration Rate, SpO<sub>2</sub>, Continuous Non-Invasive Blood Pressure and Skin Surface Temperature. ViSi Mobile incorporates multiple parameters as published data shows that patients with abnormal vital signs are more likely to suffer serious or lethal event, and no single parameter is sufficient for detecting critical deterioration.<sup>8</sup>

Sotera Wireless is dedicated to enabling hospitals to adopt

continuous surveillance monitoring for all patients. Unlike condition monitoring, no guidelines or data yet exist to set surveillance alarm parameters. Helping customers to develop policies and practices to support alarms management is necessary for the successful adoption of continuous surveillance monitoring, as well as to comply with TJC requirements.

Many false alarms result from motion artifact (for example, spikes or dips caused by normal bodily movement rather than a change in condition). Reducing these alarms is critical to success, particularly for a population of patients that is likely to be mobile. Accelerometers are integrated into Sotera's ViSi Mobile System to detect motion artifact and suppress alarms.

### A Data Driven Approach to Reducing Nuisance Alarms

To develop alarms settings and alarm performance benchmarks, Sotera has taken a uniquely data-driven approach. When patients are discharged from the ViSi Mobile System, waveform and numeric data are de-identified and stored in a secure cloud data repository. As of August 24<sup>th</sup>, the data includes over 420,000 hours (and growing) of high resolution, multi-parameter vital signs data on over 15,000 patients. This approach also supports the development of new and improved physiologic algorithms.

## Tailored for Each Location

Sotera understands that the adoption of continuous surveillance monitoring on all patients is a patient safety investment that requires transformation of the care delivery process on general care units. To support the transformation, Sotera conducts a complete analysis of current clinical workflow and then engages with the customer at the policy, as well as the practice, level.

As a starting point, the aggregate data from Sotera's vast repository is available to inform practice, but each client's alarm information is gathered and passed through a series of "what-if" alarm configurations to arrive at the Alarms Performance table illustrated below. This table demonstrates how hospitals can set their individual alarm configurations to a level of benefit vs. burden for the nursing staff, adjusting threshold levels and alarm delays, while measuring outcomes to determine if there are any missed events.

### Case Study from a 19-Week ViSi Mobile System Pilot

ViSi Mobile was evaluated for a 19-week period on a neurologic general care unit. This unit was selected due to a high incidence of rapid response calls requiring escalation of care. All patients were monitored regardless of admitting diagnosis. The alarm configuration was iterated

Table 1: ViSi Mobile System Default Alarm Configuration

Parameter	Delay (Sec)	Threshold (High/Low)	Alarms/ Patient/ Day
SpO <sub>2</sub>	60	OFF /85	2.32
Cardiac Rate	5	150 / 30	0.67
Resp Rate	120	35 / 4	0.29
Continuous BP	SYS: 120 MAP: 90	SYS: 190/OFF MAP: OFF/60	1.23
<b>TOTAL</b>			<b>4.51</b>

several times and resulted in alarm settings configured uniquely for this population of patient whose blood pressure was kept intentionally high. The table below demonstrates the final alarms configuration and resulting alarms per patient per day. During the pilot, there were 18 incidents requiring escalation of care. The distribution of alarm type

alarms were sent to nursing assistants.

### Proposed National Benchmark

Based on the experience derived from multiple customers that have used ViSi Mobile, the current performance benchmark is less than 6 alarms per patient, per day. At that level, nursing workflow required for

Table 2: Alarm Optimization Case Study

Parameter	Delay (Sec)	Threshold (High/Low)	Alarms/ Patient/ Day
SpO <sub>2</sub>	90	OFF /85	1.14
Cardiac Rate	5	150 / 30	1.27
Resp Rate	120	35 / 4	0.38
Continuous BP	SYS: 240 MAP: 60	SYS: 200/OFF MAP: OFF/58	0.49
<b>TOTAL</b>			<b>3.29</b>

requiring caregiver attention shows the escalation of care events by each vital sign. This supports the consensus recommendation by the rapid response community that no single vital sign will catch all physiologic deterioration. In this population, continuous blood pressure, followed by heart rate, were the dominant indicators. To further reduce the impact to nursing practice, all vital signs data were automatically entered into the EHR. Physiologic alarms were distributed to nurses on their mobile devices, while technical

continuous surveillance monitoring is equivalent to checking vital signs every 4 hours. Anecdotal reports from Sotera's partner hospitals indicate that the vast majority of these alarms are true and actionable events. For new hospitals beginning surveillance monitoring, Sotera has crafted simulation tools that allow individual hospitals to predict and compare their alarm performance against the national benchmark.

## CONCLUSIONS

Intermittent collection of vital signs is insufficient for detecting patients at risk, often resulting in failure to rescue. Early detection is best achieved by the adoption of continuous surveillance monitoring that broadly covers all vital signs and the accompanying adjustments to clinical practice. Adoption only makes sense if the benefits of the system outweigh the costs and do not add to the alarm burden. Working with data relevant to a specific patient population it is now possible to set alerts most likely to be meaningful and actionable. In most cases, a rate of 6 predominantly actionable alarms or less per patient/day is possible, making continuous surveillance monitoring of all hospitalized patients a practical alternative.

## REFERENCES

<sup>1</sup>[http://www.jointcommission.org/assets/1/6/medical\\_device\\_alarm\\_safety\\_infographic.pdf](http://www.jointcommission.org/assets/1/6/medical_device_alarm_safety_infographic.pdf)

<sup>2</sup>Sendelbach, S.; Funk, M. Alarm Fatigue: A Patient Safety Concern, AACN Advanced Critical Care. Volume 24, Number 4, pp. 378 - 38e6 © 2013 AACN

<sup>3</sup> Joint Commission National Patient Safety Goals 2015

[http://www.jointcommission.org/assets/1/6/2015\\_NPSG\\_HAP.pdf](http://www.jointcommission.org/assets/1/6/2015_NPSG_HAP.pdf)

<sup>4</sup>[http://www.ihl.org/education/conferences/APACForum2012/Documents/I2\\_Presentation\\_Diagnostics\\_Haraden.pdf](http://www.ihl.org/education/conferences/APACForum2012/Documents/I2_Presentation_Diagnostics_Haraden.pdf)

<sup>5</sup> McGloin H et al. Unexpected deaths and referrals to intensive care of patients on general wards. Are some cases potentially preventable? J Royal Col Physicians 1999;33:255-259.

<sup>6</sup> Curry, J.P. et al. A critical assessment of monitoring practices, patient deterioration, and alarm fatigue on inpatient wards: a review. Patient Saf Surg. 2014;8:29

<sup>7</sup>[http://www.patientsafety.va.gov/docs/TIPS/TIPS\\_JanFeb08.pdf](http://www.patientsafety.va.gov/docs/TIPS/TIPS_JanFeb08.pdf)

<sup>8</sup>DeVita, M. Hillman, K. Textbook of Rapid Response Systems. Springer Science+Business Media, LLC 2011.