Continuous Clinical Surveillance

A real-time solution for comprehensive patient safety

INTRODUCTION

In the nearly 20 years since the release of the landmark U.S. Institute of Medicine Report, *To Err Is Human: Building a Safer Health System*[1], many hospitals continue to fight an uphill battle against unrecognized patient deterioration, alarm fatigue, opioid-induced respiratory depression (OIRD), sepsis, unplanned extubation and other preventable hospital-acquired conditions.[2-4]

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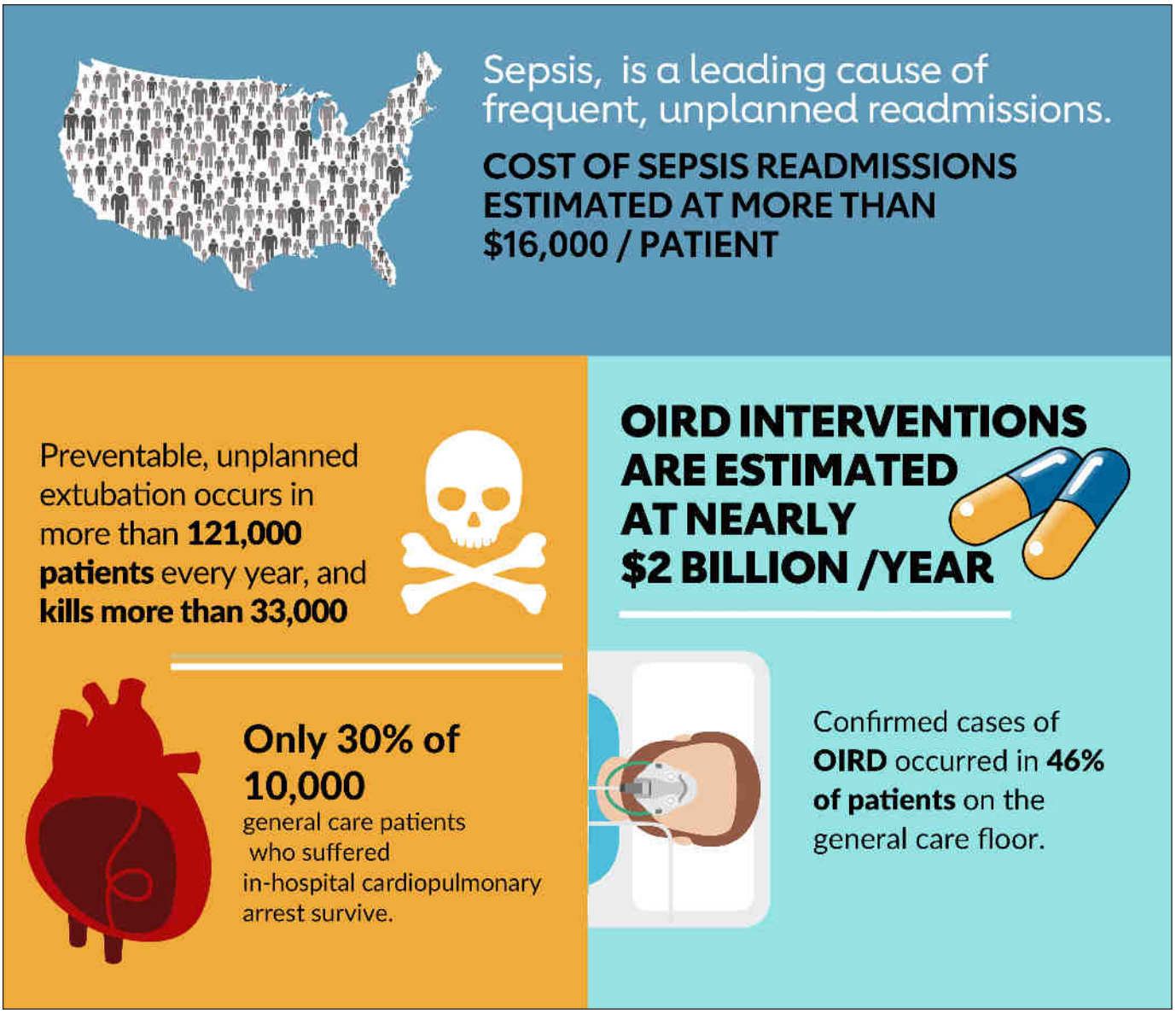
The cost of emergency intervention and rescue is steep in terms of resource utilization, cost and patient outcomes.[5] For example, sepsis, the most expensive in-hospital illness[6], is a leading cause of frequent, unplanned readmissions.[7] OIRD interventions are estimated at nearly $2 billion per year[8] and have the highest aggregate costs per stay among all hospital-acquired conditions.[9] Preventable, unplanned extubation occurs in more than 121,000 patients every year, and kills more than 33,000, at a cost of nearly $5 billion to the health system.[10]



Complicating matters, at-risk patients, especially those who require respiratory support or monitoring, are found across the patient care continuum, not just high-acuity areas. A recent study found that confirmed cases of OIRD occurred in 46 percent of patients on the general care floor.[11] Another study identified 10,000 general care patients who suffered in-hospital cardiopulmonary arrest (IHCA), which kills 70 percent of patients who experience it.[12] Although OIRD accounts for more than half of medication-related deaths in care settings,[13] literature reviews suggest that the overwhelming majority of cases—97 percent—were preventable.[14]

Identifying which patients are vulnerable to deterioration is difficult, but critical to comprehensive patient safety. Many patients who experience adverse events, such as OIRD, do not follow any simple criteria for determining whether they will be at risk. As a result, the focus of patient safety rests mostly on rescue, rather than timely intervention.

A Time for Change

Fortunately, key advancements in real-time healthcare and advanced data analysis present a significant opportunity for health systems to push patient safety initiatives into the realm of proactive healthcare.

Several prominent healthcare advocates and agencies, including the Centers for Medicare and Medicaid Services[15], the Joint Commission[16] and the Anesthesia Patient Safety Foundation[17] cite continuous surveillance as a recommended practice—and the industry is responding.

Shifting away from reactive, episodic monitoring in favor of a comprehensive model of surveillance enables clinicians to intercept adverse events and prevent costly care escalations. The utilization of real-time data adds rich and holistic details to the patient's story, comprising the history of present illness and past medical history, which are essential pieces of knowledge necessary for diagnosis and treatment.

Continuous surveillance puts that data to work by aggregating continuous streams of data from multiple monitoring devices, as well as retrospective information from EHRs, then applying advanced analytics to detect subtle trends that may indicate that clinical intervention is required.

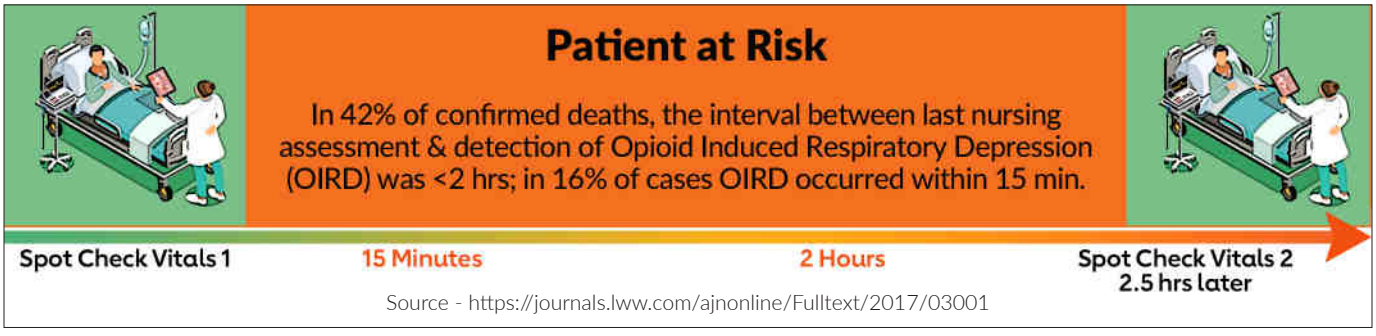
This capability has emerged as a feasible solution for the negative costs associated with patient deterioration.[18] A recent KLAS report, ***Clinical Surveillance 2018***, indicates that "clinical surveillance tools hold the promise of giving caregivers clinically actionable insights that decrease mortality, reduce readmissions, and improve overall patient outcomes, and clinicians expect these alerts to be embedded directly within their workflow."[19]

This white paper will demonstrate the transformative power of continuous surveillance to help clinical teams anticipate the early signs of imminent, tractable problems; upend inadequate monitoring practices; distribute actionable notifications to mobile care teams; and innovate with current technology infrastructure, such as electronic health records and early warning scores.

THE INADEQUACIES OF CURRENT MONITORING PRACTICES

Conventional monitoring practices suffer from shortcomings that negatively impact both patient outcomes and clinical workflow, including inadequate monitoring and alarm fatigue. According to the Joint Commission, between 2004 and 2011, 29 percent of adverse events were attributed to improper monitoring.[20] One of the most common patient monitoring practices, visual spot checks, are wholly inadequate as a consistent and reliable safeguard in the modern patient care environment.[21]

In fact, visual spot checks can leave patients unmonitored 96 percent[22] of their hospital stay, and often fail to capture key activity, such as periods of apnea, low hemoglobin oxygenation levels, or periods of bradycardia or tachycardia.[23] The manual checks are also riddled with inaccuracies and beset by significant delays in recording that information to the patient chart.[24]



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Even the most rigorous vital-sign protocols are peppered by data gaps where the onset of deterioration can occur. In one study, "the interval between the last nursing assessment and the detection of respiratory depression was less than two hours, and in 16 [percent] of the cases, it was within 15 minutes."[25]

Alarm-enabled medical devices have been used to supplement vital sign spots checks, but at the cost of alarm proliferation and fatigue—itself a significant threat to patient safety.

Despite countless initiatives by hospitals and an alarm management mandate from the Joint Commission[26], the volume of alarms continue to proliferate. In 2016, the Health Technology Foundation released its third iteration of a survey on clinical alarms and found "few improvements in perceptions of clinical alarm safety and management occurred in the past 10 years, and several positive trends noted between the 2006 and 2011 surveys were reversed on the 2016 survey. Most concerning was the near doubling of respondents indicating that their institutions had experienced an adverse patient event related to clinical alarms."[27] The decade-long data collection demonstrates that while technology has advanced, it is not being used as intended, resulting in an increase in noise and non-actionable alarms.

According to Ruppel et al., "when nurses and other staff experience alarm fatigue, critical patient events may go unnoticed and preventable patient harm may occur. From 2009 to 2012, patient deaths were associated with 80 of the 98 alarm-related sentinel events voluntarily reported to the Joint Commission."[28]

Nine in 10 hospitals indicated they would increase their use of patient monitoring, particularly capnography and pulse oximetry, if false alarms could be reduced.[29]

However, one of the major challenges in alarm management is separating clinically relevant alarms from non-actionable alarms (i.e., a sensor on a patient detached momentarily or brief self-correcting physiological responses). The simplistic threshold limits of physiologic devices, like patient monitors, pulse oximeters and capnographs, are highly susceptible to non-actionable alarms, which can make up 85 percent to 99 percent of all device-generated alerts.[30,31] "Determining clinical relevance requires understanding alarm context, including the clinical status of the patient."[32]

Emergence of clinical surveillance

What is continuous surveillance, how does it work and how is it distinct from monitoring?

Continuous surveillance, in contrast to traditional patient monitoring, is a systematic, goal-directed process that detects physiological changes in patients early, interprets the clinical implications of those changes and alerts clinicians so they can intervene rapidly.[33]

How it works, real-time patient data are captured from multiple sources, such as bedside monitors, EKGs and live-streaming waveforms. This continuous stream of data, aggregated with retrospective data stored in EHRs and data inputted from clinical encounters, is filtered through an intelligent, analytics engine that uncovers clinically relevant trends that capture a patient's condition from moment to moment.[34]

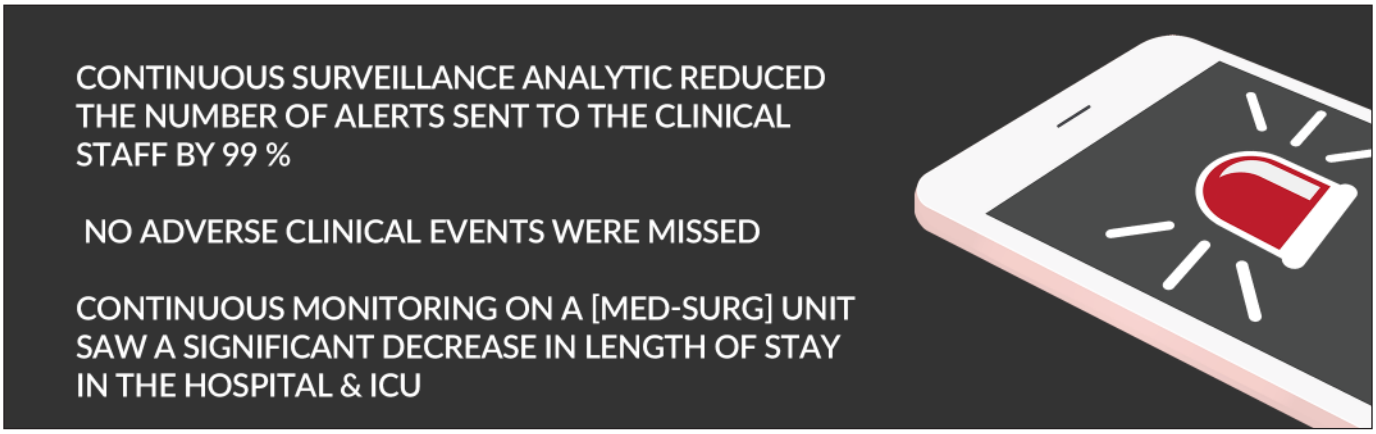
Predictive models based on multiple sources of data can help clinicians anticipate adverse events much more reliably than data from a single source[35, 36] and facilitates the generation of 'smart alarms'[37] that underscore the multiple variables that could compromise the health of a patient.

Data collection and analysis is further enhanced when methods for disseminating, exploiting and distributing both the data and the smart alarm signals are included. These latter features facilitate better patient care management and clinical workflow by tracking patients throughout the hospital and distributing real-time patient monitoring to dashboards and mobile devices.

Several studies and use cases demonstrate the dramatic impact of continuous surveillance in terms of improved patient outcomes and cost efficiency.

Early Intervention. A recent study at Virtua Health System sought to establish that continuous surveillance could notify clinicians about signs of OIRD more effectively than traditional monitoring without compromising patient safety.

The results showed that a continuous surveillance analytic reduced the number of alarms sent to the clinical staff by 99 percent compared to traditional monitoring. No adverse clinical events were missed, and while several patents did receive naloxone to counter OIRD, all patients at risk were identified early enough by the analytic to be aroused and avoid the need for any rapid response team deployment, intubation or escalation in care.[38]



Length of Stay. Hospital stays cost the health system $378 billion per year.[39] During an 18-month clinical trial in a 33-bed inpatient MED-SURG unit, Brown et al., observed that "continuous monitoring on a [MED-SURG] 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."[40]

Alarm Management. A case study described the process undertaken by the Hospital for Special Care (HSC) to dramatically reduce non-actionable alarms by 80 percent.[41] Moreover, HSC's clinical surveillance capabilities enabled the hospital to collect and distribute real-time data from more than 100 alarm-enabled ventilators and pulse oximeters for enhanced, continuous patient surveillance, and leverage data to assess caregiver responses to patient incidents. In addition, alarm data was used in reporting to the hospital's audit committee, which monitors ventilator management performance and helps identify potential areas of improvement.

CONTINUOUS SURVEILLANCE—WHERE TO START

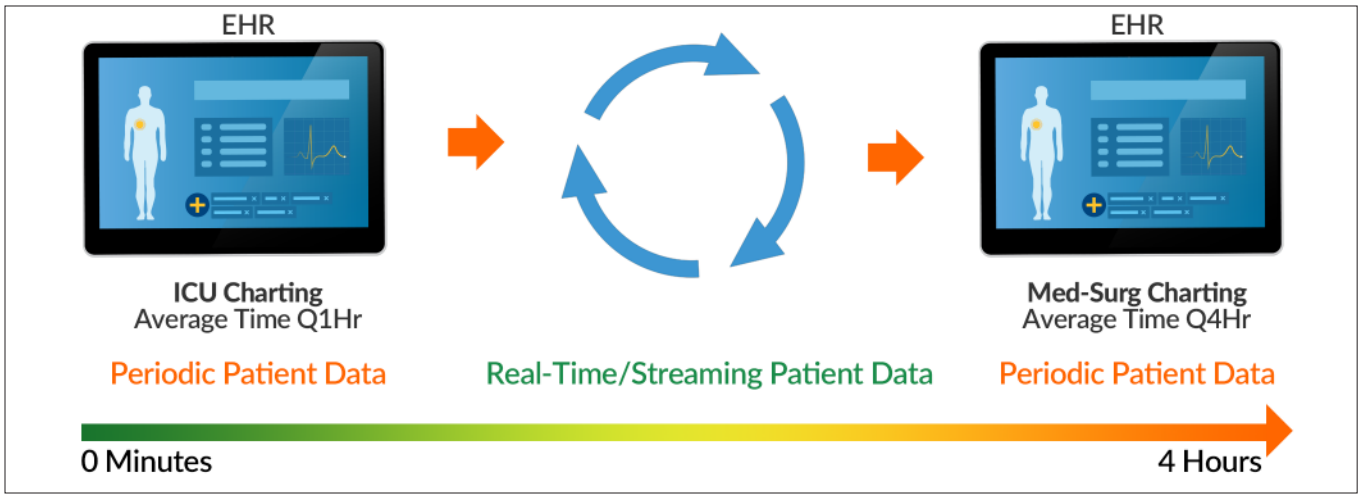
Over the past 15 years, the widespread adoption of EHRs has largely resolved the challenges of data capture and have mitigated issues related to clinicians' access to critical information. The central role the EHR plays in day-to-day clinical operations practically requires that peripheral technologies—ranging from medical devices and telehealth to financial and administrative solutions—integrate with the system. This is also true of continuous clinical surveillance platforms.

As such, EHRs have formed the foundation of how hospitals innovate with clinical surveillance. More than 80 percent of hospitals that have deployed clinical surveillance solutions are "leveraging their multi-million EHR investments as a starting point [for] early warning risk scoring and sepsis detection."[42]

While "EHRs are great repositories of data and can accomplish some low-level data aggregation… these systems were never designed to address the level of data analytics needed to advance care delivery from reactive to proactive."[43]

One of the objectives of analytics is to seek interrelationships among seemingly unrelated measurements and sources of data to determine whether these interrelationships can yield the detection of the onset of an adverse event that would not normally be visible by observing a single parameter or multiple parameters individually.

Real-time data capabilities can be used in conjunction with retrospective data in the EHR to add even richer and more holistic detail to a patient's condition, thereby fully maximizing "EHR investments and align performance with national quality initiatives." [44]



Clinical surveillance complements hospitals' EHR capabilities by providing bi-directional integration features through middleware that resides in the space between point-of-care devices and the EHR. For example, a clinical surveillance solution can capture historical data from the EHR and correlate it with real-time streaming data from streaming devices, including heart rate, oxygenation levels and blood pressure.[45] The combination of high-fidelity data with multivariate, EHR information provides a holistic and complete source of objective information on a patient that can be used for prediction and clinical decision making prospectively.

Additionally, analytics based on multiple sources of data also can help offset the problem of alarm fatigue by filtering out false or artifact signals that typically invade the high-fidelity data at the core of continuous surveillance.

The challenge with attenuating alarm data is achieving the balance between communicating the essential, patient-safety specific information that will provide proper notification to clinical staff while minimizing the excess, spurious and non-emergent events that are not indicative of a threat to patient safety. In the absence of contextual information, the option is usually to err on the side of excess because the risk of missing an alarm or notification carries with it the potential for patient harm or death. Hospitals need to take a system-wide inventory of alarms, assess their current algorithms and determine where real-time data can be used to improve sensitivity and specificity to reduce false positives.

CONCLUSION

Hospital investments in clinical surveillance and analytics solutions are driven by organizations who are migrating toward value-based care models and are trying to achieve the objectives of value-based care, including improving care quality and outcomes, reducing clinical variation and reducing healthcare costs.[46]

The inadequacy of tried-and-tested processes, like vital sign spot-checks, point to an urgent need for new best practices. Fortunately, healthcare now possesses the ability to analyze billions of patient data elements in real-time and identify trends that capture an evolving portrait of a patient's condition—continuous clinical surveillance.

Patient monitoring depends on a team of clinicians, working as individuals, to observe the state of the patient's health at a particular moment in time, and leans heavily on the (often technical) threshold violations of individual devices. By contrast, clinical surveillance is team-based, allowing multiple caregivers to assess a holistic portrait of multiple patients from a centralized location or via mobile alarm notifications.[47]

Continuous clinical surveillance offers hospitals the opportunity for immediate and predictable patient safety improvements.

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