

Nix the Noise:

Managing Alarms, Alerts and Interruptions

An Introduction to the Next Generation of Alarm Safety Systems

A 60-year-old man was struck in the head with a large branch while cutting down a tree - the accident resulted in broken bones and bleeding in the brain. After surgery at a major metropolitan hospital, the patient was transferred to a surgical intensive care unit where he was placed on several monitoring devices. When the patient woke following surgery, he was confused and agitated, and kept removing the SpO2 sensor that measures oxygen levels in the blood. Despite attempts to calm the patient with medication, an alarm continued to trigger frequently over the following hours and nurses in the unit - deceived by a barrage of earlier false alarms from this patient - were slower to respond.

Approximately 4 hours post-surgery, the patient's monitors triggered another alarm, signaling that his oxygen saturation had fallen, and his heart rate and breathing had accelerated. These alarms were not immediately addressed given the history of the pulse oximeter 'nuisance' alarms that had already been falsely generated by this patient. After 15 minutes, a more attention-grabbing critical alarm sounded, indicating that the patient had stopped breathing.

At this time, a nurse, who was updating a patient chart in the next room, responded to the alarm. The nurse alerted emergency personnel to the code blue and they quickly performed CPR, and connected the patient to a ventilator. An apnea challenge and EEG were later performed both indicating the patient was clinically brain dead - his family withdrew life support a few days later.

An investigation revealed the nurses' slow response to the initial alarms before the critical alarm kicked in.¹ Although it was not evident that response to the earlier alarms would have changed the outcome, the case is just one example of the alarm fatigue problem that plagues hospitals across the country. Alarm fatigue occurs when the proliferation of alarms causes clinicians to become desensitized, rendering the warnings useless.

Alarm fatigue presents its own set of difficulties, but it is just one of several environmental and workflow challenges that

nurses grapple with on a daily basis. Indeed, the mounting use of patient monitoring and therapy devices as well as clinical information technology contributes additional noise and interrupts direct patient care by requiring clinicians to respond to various electronic alarms, alerts, and reminders. In addition, consider the myriad of traditional interruptions that nurses face - phone calls from patients' family members, requests from doctors, questions from co-workers - and it's easy to understand just how difficult it is for clinicians to adequately take care of all of their primary tasks, while still responding quickly to potentially life-threatening situations.

As new technologies are developed and adopted across healthcare settings, the problem continues to grow, forcing organizations to reach beyond previous attempts to drive chatter out of the hospital. Previous attempts to solve the problem have faltered, leaving healthcare organizations in an uncomfortable position trying to balance the good and the bad associated with alarms. Fortunately, healthcare organizations are acknowledging the severity of the problem and are now recognizing that they need to address the issue by cultivating innovative and strategic plans to foster environments that not only alleviate alarm and alert fatigue, but also address the overall workflow interruption problems and support optimal care.

An Alarming Number of Alarms

Physiological monitors are commonplace in the hospital setting because they continuously measure a patient's vitals and alert clinicians when a potentially life-threatening event has occurred, which has saved countless lives and allows nurses to care for multiple patients at once. These devices monitor a wide variety of patient conditions including cardiac, pulmonary, and brain function. While the monitors measure a wide variety of statuses, they all operate with a common intent: to ensure that clinicians are immediately made aware of situations that require their attention. However, with 100-plus potential types of alerts beeping, it is increasingly difficult for the nurse to discern the criticality of any particular alarm especially given they are often communicated without any situational awareness. In the event that alarms are dispatched to the caregiver's mobile device, they lack relevant data and the context that

supports clinical decisions.

Compounding the expansive list of alarm types, each higher level of “acuity” includes an additional set of medical devices each with their own alarms. For example, the addition of an IV Pump adds 15 potential alarms; the new smart bed technology to reduce fall risk adds another 20 potential alarms; and step down units where there are ventilated patients and yet more alerts. Consider the total number of potential alarms in an intensive care setting where hemodynamic monitors, dialysis machines, bed warmers, feeding tubes, and other alert-generating technologies are adding thousands of potential alarms from medical devices alone.

Hospitals are motivated to implement monitoring and alerting technologies to protect patients. However, leaders are discovering that too much of a good thing can have undesirable consequences. A study conducted at the Johns Hopkins Hospital found that a 15-bed unit at the renowned medical center experienced an average of 942 alarms per day with a critical alarm sounding about every 90 seconds.² The “quality” of the alarms also wears clinicians down. The frequency of both false positives and transitory alarms contributes to the fatigue. One study found that 99.4 percent of alarms in one emergency department were false; for patients experiencing chest pain, less than 1 percent required a change in care.³

The sheer volume of alarms coupled with the large percentage of false positives has a long-term traumatic effect on the clinician. In fact, according to a study from the Association for the Advancement of Medical Instrumentation (AAMI), clinicians who are experiencing alarm fatigue are apt to not only tune out the racket, but to also suffer from symptoms including impaired communication and concentration, disorientation and distraction, elevated blood pressure and stress, and ear fatigue. This profound impact on a nurse’s sensory environment leaves them helpless, cognitively impaired, and prone to commit errors that may harm patients. In a futile effort to protect patients from an endless barrage of alarms, nurses take potentially dangerous, life-threatening risks by turning off monitors altogether.⁴

The most disconcerting fallout from alarm fatigue, occurs when clinicians fail to respond to urgent situations, and patients experience less than optimal outcomes including death. Consider the following: between January 2009 and June 2012, The Joint Commission (TJC) received reports of 80 alarm-related deaths and 13 serious alarm-related injuries. Hospitals report these events voluntarily -- they are not required to -- so the number of deaths and injuries is likely far higher, as TJC noted.⁵ In addition, a Boston Globe report identified at least 216 deaths nationwide between January 2005 and June 2010 linked to alarm fatigue.⁶

Alerts, Alerts - and More Alerts

Medical devices and alarms are not the only noises competing for the attention of overworked nurses. Indeed, with the proliferation of electronic health records (EHRs) and computerized physician order entry (CPOE) systems - many of which integrate various levels of clinical decision support, clinicians also are being prompted or interrupted during their ordinary workflow by a variety of computerized alerts.

The intent, once again, is to improve patient care by prompting clinicians to adhere to best practices or hospital standards of care. Alerts originating from EHRs are designed to provide access to clinical best practices and thereby improve diagnosis, standardize the practice of medicine along common populations and diagnosis codes, and reduce the number of medication errors in the inpatient setting.

Unfortunately, computerized notifications add another layer of alarming and clinicians often dismiss electronic recommendations altogether.

A qualitative study in the International Journal of Medical Informatics suggests EHRs with clinical decision support sometimes produced “too much information” or information that was irrelevant to the patient’s case, “adding to the info-clutter rather than cutting through it.”⁷

Not surprisingly, most medication warnings generated by CPOE systems are overridden or ignored by clinicians, according to research published in the Journal of Hospital Medicine.

According to the study results, clinicians accepted only 4 percent of the 40,391 drug warning alerts issued during the one-year study period. Of the medication alerts issued, 47 percent involved potential drug duplications, 47 percent involved potential drug interactions, 6 percent involved potential allergic reactions, and 0.1 percent involved potential adverse reactions.⁸

Everyday Interruptions - and Lots of Them

There are also an increasing number of nurse call systems integrating with the caregivers’ mobile devices adding to the barrage of messages they are required to address. The overall intent of these communications is to increase responsiveness, thereby increasing patient satisfaction, and improving quality of care. However, when added to the mix of all the other interruptions, it’s just one more distraction for the care provider.

Perhaps most frustrating is the fact that alarms and alerts are just the tip of the interruption iceberg for clinicians. The work of a unit nurse is a 12-hour shift of face-to-face information exchange, counseling, comforting, intervening

– most of it interruption-driven. Indeed, hospital workers are frequently interrupted by patient family members, requests from other staff members, and returned phone calls from doctors. A recent study shows that RNs were interrupted about 12 times per hour – that’s approximately once every five minutes. In 52 percent of the interruptions, the nurse was the recipient of the interruption and in about 35 percent the initiator. In 65 percent of the situations, the nurse returned to the interrupted activity; in 15 percent the nurse did not; and in 20 percent there was not enough detail to determine what happened.⁹ Another study illustrates how these interruptions are more than a simple nuisance. In fact, each interruption was associated with a 12.1 percent increase in procedural failures and a 12.7 percent increase in clinical errors. In addition, error severity increased with interruption frequency. Without interruption, the estimated risk of a major error was 2.3 percent; with 4 interruptions this risk doubled to 4.7 percent.¹⁰

besieged by alarms, alerts, and various other interruptions typically make it almost impossible for nurses to provide the vigilance that their patients deserve.

“If you are constantly being bombarded by beeps and buzzes, it creates a difficult environment. You can’t stay fresh and vigilant in such situations. The irony is that monitors were created and put in use so that nurses can maintain their vigilance when they are not physically at the bedside. But with so much noise in the environment, the monitors might in some cases have the opposite effect and actually hamper vigilance,” Gee says.

In Search of a Solution: Some Current Approaches

While hospitals have struggled with alarm and alert fatigue as well as workflow interruptions for many years, solutions remain somewhat elusive as new technologies are added to the hospital environment and the problem evolves. Many providers fail to solve the problem because they often pin their hopes on a singular intervention when a more comprehensive approach is required. For example, many hospitals would simply zero-in on the monitoring itself. Although, buying quality physiological sensors combined with frequent training to reinforce their proper preparation and placement can make a big difference by cutting down the number of false positive alarms, this approach alone neglects a large group of contributors to alarm fatigue.

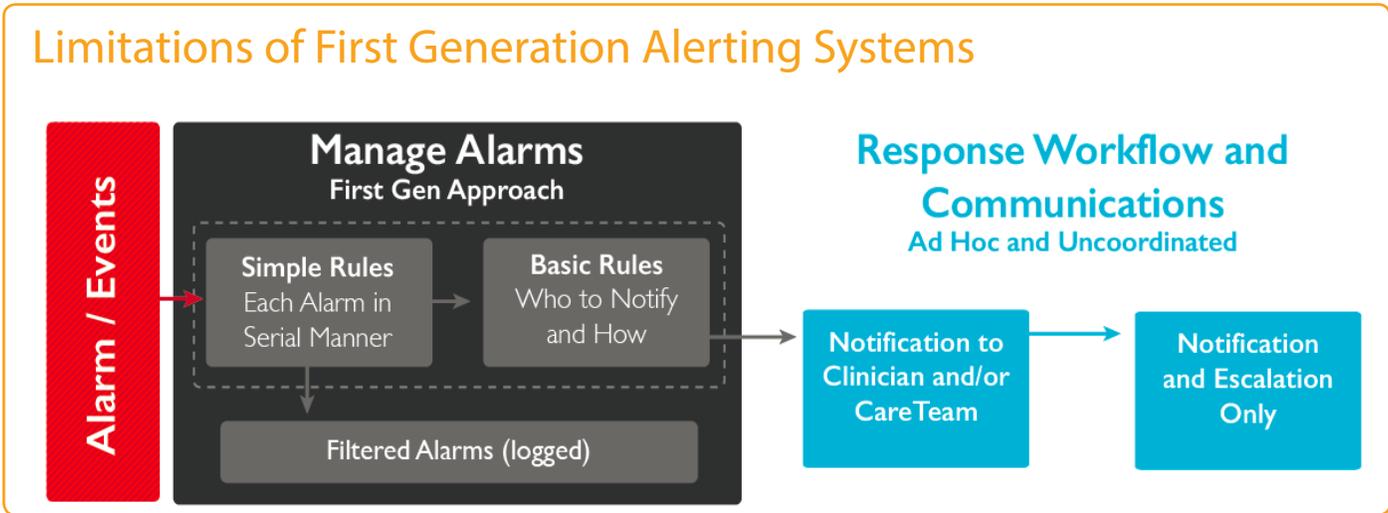
The alarm fatigue problem is difficult to solve because multiple vendors design complex monitoring and therapy devices that each have independent alert and alarm schemes. The lack of consistent alert and alarm presentation, the variety of tones and volumes, and the different ways alerts are silenced or resolved compound the complexity.

Many hospitals have implemented a middleware-based alarm management system that applies rules and prioritizes alarms and events from multiple medical devices and

Stuck in a Hard Place

The proliferation of alarms, alerts, and general interruptions makes it difficult for nurses to get things checked off the new patient admission or care team orders list, but also makes it nearly impossible for nurses to practice “vigilance” – a key element of effective care in the inpatient setting and a duty that is tied closely to the nursing mission. Vigilance is defined as “a state of watchful attention, of maximal physiological and psychological readiness to act and of having the ability to detect and react to danger.” With such a definition applied to nursing care, vigilance is described as “not the action of taking the vital signs, dressing the wound, or starting the IV. It is the ‘watch-ful-ness’ that is always a part of the nurse’s thinking process as activities such as these are completed.”¹¹

Tim Gee, principal of Medical Connectivity Consulting, Beaverton, Ore., points out that environments that are



systems simultaneously. However, these first generation alarm management systems have not fully addressed the problem of alarm fatigue because they take an approach that is limited in scope. These vendors utilize a rules engine that can apply dispatching rules based on priority, assignment, roles, and escalation path regarding any one particular event at a time. These systems look at each alarm as an independent event and are focused on basic clinician notification only. As a result, clinical communication that needs to occur in response to the alarm is often carried out in an uncoordinated, ad hoc manner - in a separate communication thread. Often, the nurse will require access to other members of the care team which is not available as part of the alarm notification in the first generation systems. Another problem with first generation systems is that the predefined rules are unable to re-route based on clinician context -- they do not take into account whether (1) the caregiver is available, or (2) in close enough proximity to respond.

Additionally, first generation systems do not enable the response workflow and the resulting communications required to resolve the event that triggered the alarm.

Current healthcare workflow has adapted to these first generation systems. Evidence of this adaptation is found in many hospitals. Glance at the department desks and in plain sight will be laminated sheets with contact numbers for lab and ancillary departments; an admissions clerk on speed dial to quickly gather admission data; and a staff member who is frustrated with having to log into the EMR every 12 minutes in order to avoid missing an important alarm or alert. While hospital staff members have learned to adapt, the situation is far from optimal.

These first generation systems are a start, but hospitals need to take a much more comprehensive approach to truly conquer alarm fatigue.

"Solving alarm fatigue requires taking a holistic approach," Gee says. "It is not something that you can apply a Band-Aid to and hope that it goes away."

Part two of this white paper illustrates how and why a more comprehensive approach to managing alarms and alerts using an advanced middleware platform is needed to solve the fatigue problem.

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