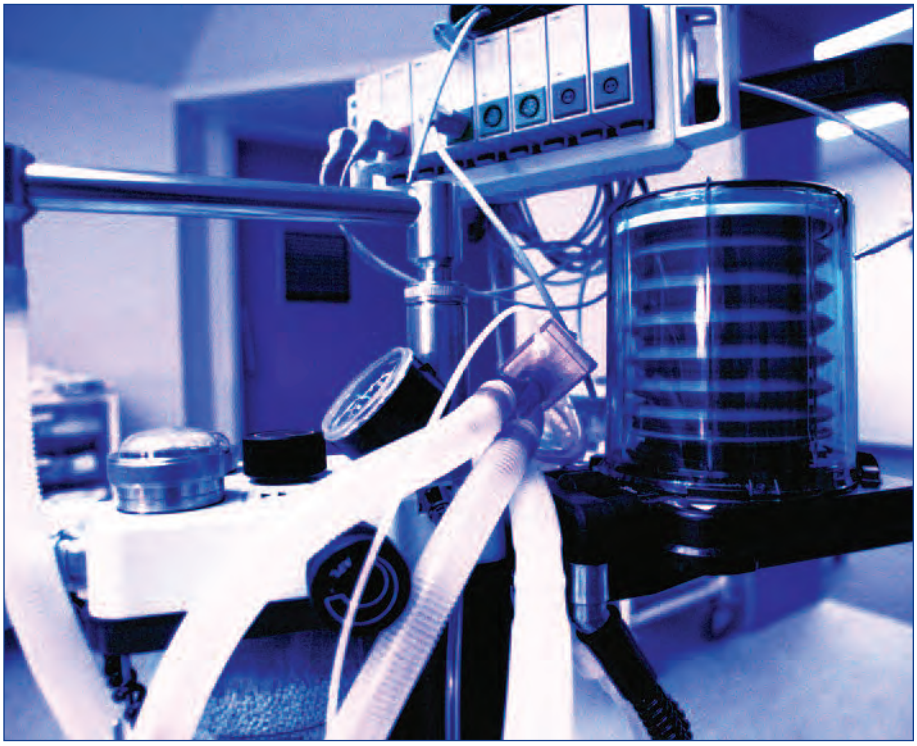
Sound the Alarm:
Managing Physiologic Monitoring Systems



Technologies designed to improve patient safety can create new hazards if not carefully implemented and managed.

A patient is taken from the emergency department (ED) to radiology for an x-ray. Approximately 20 minutes after being returned to the ED, the patient is found unresponsive with no pulse. The hospital investigates and finds that staff did not reattached a cardiac monitor after the patient returned to the ED.[1]

When staff members disconnect monitoring equipment or silence alarms, they can miss important safety signals.[1] Physiologic monitoring systems generate visual and audible alarm signals to alert clinicians to changes in a patient's condition that may require immediate intervention.[1,2] (For common types of physiologic monitoring systems, *see* Sidebar 1 on page 7.) "Health care organizations use physiologic monitoring systems to monitor a patient's condition. These systems provide clinicians with essential information to evaluate the patient and make appropriate treatment decisions," says Kathryn Pelczarski, director, Applied Solutions Group, ECRI Institute. "Clinicians are alerted to critical changes in a patient's condition when a monitor activates a high-priority alarm."

Many organizations nationwide are struggling with safety issues related to alarms and physiologic monitoring systems. The Pennsylvania Patient Safety Authority recently queried its own database for patient deaths related to physiologic monitoring over a six-year period. It discovered that of 187 patients who died while receiving physiologic monitoring, 35 died from issues related to physiologic monitoring equipment. Thirty-one of those deaths were due to human error: The other four were attributed to equipment failure.[1]

The Joint Commission is taking the issue of clinical alarms seriously. In October 2011 The Joint Commission convened a Medical Device Alarms Summit, during which experts, clinicians, medical device manufacturers, patient safety officers, and other stakeholders gathered to identify priorities related to the safety and effectiveness of medical device/system alarms. The Joint Commission is also developing a proposed National Patient Safety Goal for 2013 that addresses clinical alarm systems. (Note: This requirement is in development and subject to field review and to approval by The Joint Commission Board of Commissioners. Language for this proposed goal is not yet available.) The Joint Commission also included a discussion of alarm systems in *Sentinel Event Alert* Issue 25, "Preventing Ventilator-Related Deaths and Injuries," available at http://www.jointcommission.org/assets/1/18/SEA_25.pdf.

ECRI Institute in 2008 initiated an annual list of top ten health technology hazards. "Alarms have consistently been at the top of our list," says James P. Keller, Jr., M.S., vice president of health technology evaluation and safety, ECRI Institute. "A year ago, they were number two on the list. They've now been elevated to number one." Some of the factors that determine an item's placement on the list include the prevalence of the problem, how serious the problem is, whether the issue is "high profile," and whether there are solutions available for improvement. "Alarm hazards ranked high in each of these categories," Keller says. "Alarm safety should be a high-

priority patient safety initiative in all hospitals."

Patient Safety Risk Points

Numerous risk points contribute to alarm- and monitoring-related adverse events, including alarm fatigue, communication breakdowns, training issues, and equipment failures.

According to Pelczarski, alarm fatigue is one of the most common contributors to alarm failures. "Staff become overwhelmed by the sheer number of alarm signals, which results in alarm desensitization and delayed response or missed alarms," she says. "On one critical care unit, the organization determined that between 150 and 400 physiologic monitoring alarms were sounding per patient per day." Each nurse was responsible for 1 or 2 patients but actually was exposed to that number of alarms times all 12 patients on the unit each day. "That can be pretty daunting," Pelczarski continues. "When so many alarms are going off, staff can't always differentiate the urgency of the alarm and will sometimes take inappropriate actions to silence some alarms, such as turning down the volume, turning them off, or adjusting them outside the appropriate limits."

Pelczarski says that alarm response can sometimes be delayed because it is unclear who is responsible for responding to the alarm. "In some cases, all nurses are told to respond to all alarms, so whoever is closest might be expected to respond," she says. "However, if the closest nurse is busy when an alarm goes off, he or she might assume that someone else is going to respond. This may result in significant delays."

Communication breakdowns often occur during handoffs in which patients are being transferred between units or transported to and from diagnostic testing areas.[1] "There are sometimes breakdowns in communication between nurses and transport staff," says Pelczarski. "Sometimes the transport staff may tell the unit clerk when the patient returns to the unit, but the unit clerk may not report this to the nurse promptly, so the monitors remain unconnected for a time." Breakdowns in communication can also occur between nursing staff and diagnostic testing staff. This can cause a lack of monitoring during the time the patient is off the unit.[1]

Some alarm failures may occur due to inadequate staff training on proper use of the equipment. "Physiologic monitoring systems are complex devices," Keller says. "Sometimes hospitals haven't given staff members the amount of education they need to use these devices, to set alarm limits properly, or even to follow hospital protocols related to the monitoring systems."

Another problem is equipment failure. In one case, a telemetry unit inadvertently retained a default setting designed to conserve power automatically, which powered down after 10 minutes of nonusable waveform.[1] In order to get the unit to work properly, the battery had to be removed and replaced.

Strategies for Managing Monitoring Systems

Despite the many challenges, organizations have developed best practices for managing alarms and other aspects of physiologic monitoring. Organizations can use the following strategies to improve patient safety related to physiologic monitoring.

STRATEGY Develop a multidisciplinary team to review trends and develop protocols. "The team should include key stakeholders, such as nurses, physicians, nurse managers, clinical engineers, and information technology [IT] staff," says Pelczarski. "Each hospital and each care area has a unique set of circumstances and vulnerabilities. Members of a multidisciplinary team should be going onto the units, observing their processes, and asking for input from staff, including any challenges that need to be addressed."

Sidebar 1. Physiologic Monitoring Systems

Common types of physiologic monitoring systems include the following:

- Bedside physiologic monitors with various physiologic parameters, including the following:
  - Electrocardiogram (ECG)
  - Pulse oximetry
  - Blood pressure
- Telemetry monitors
- Central station monitors

STRATEGY Take appropriate measures to reduce the number of "nuisance" (false-positive) alarms. "The underlying causes of nuisance alarms are alarm levels that are not tailored to a specific patient, poor skin prep and electrode placement, and failure to troubleshoot frequent alarms," Pelczarski says. "Steps can be taken to help ensure that staff members are exposed only to clinically actionable alarms. For example, alarm limit defaults for heart rate are often set at 60. If you have a young marathon runner on the unit who has a consistently low heart rate, it might be appropriate to reset the limit for this particular patient to 50 so that staff are getting only significant alarms for that patient. Proper skin prep and electrode placement verification when setting up the patient for monitoring and routine replacement of electrodes every 24 hours can also significantly decrease artifact alarms." (*Artifact alarms* are alarms that are caused by some factor other than what is being monitored, such as light sources, equipment issues, or other types of interference.)

(continued on page 8)

(continued from page 7)

STRATEGY **Clarify who is responsible for alarm notification and response.** "Develop alarm escalation plans and protocols that clearly define responsibility for alarm notification, response, and tiers of responsibility for backup coverage," says Pelczarski. "If the patient's nurse is assigned initial responsibility for responding to an alarm, a partner nurse or a charge nurse might be responsible for backup coverage."

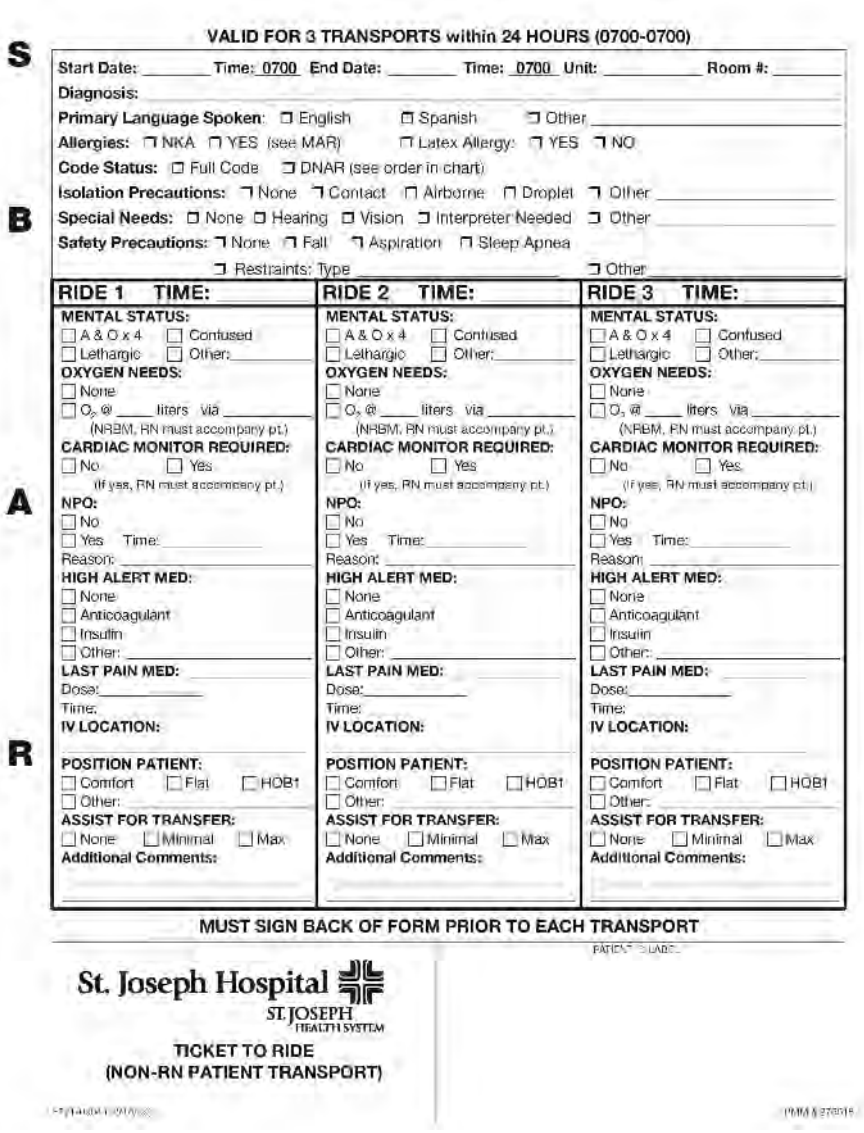
STRATEGY **Develop clear protocols for handoff communication.** "When a patient is moved to a new unit or transported for diagnostic testing, someone has to be responsible for ensuring that monitoring is continued," Pelczarski says. "Some organizations use tools like 'Ticket to Ride,' which communicates essential patient information between caregivers, such as the need for the patient to be on a monitor, when the patient leaves and returns to the unit." (*See* Figure 1 at right.) Note that Joint Commission Provision of Care, Treatment, and Services **Standard PC.02.02.01**, Element of Performance 2, requires an organization to have a process for handoff communications that provides an opportunity for discussion between the giver and receiver of patient information.

STRATEGY **Carefully analyze and measure potential alarm-related problems.** "A first step in any alarm improvement initiative is to observe how staff use alarms in a clinical setting and then, if possible, measure any negative effects," says Keller. "For example, I know of a hospital that had concerns about the effectiveness of communication of clinical alarms in its telemetry unit. The hospital measured how long it took for clinicians to respond to high-priority alarms and found it to be an average of 9.5 minutes. It determined that the slow response was due to a variety of communication issues. The hospital implemented a two-way, voice-activated wireless communication system and was able to dramatically improve responsiveness."

STRATEGY **Build a culture of safety.** An organizationwide culture of safety, in which all staff—including leadership—make safety a top priority, is essential to improving patient safety. Safety issues related to physiologic monitoring should be included in the organization's overall safety improvement efforts. "Many organizations may not focus adequate attention on addressing alarm management issues until a sentinel event occurs. This is sometimes because nursing staff, or even senior leadership, may not be aware of how essential effective alarm management is to ensuring patient

(continued on page 11)

Figure 1. Ticket to Ride



VALID FOR 3 TRANSPORTS within 24 HOURS (0700-0700)

S

Start Date: _____ Time: 0700 End Date: _____ Time: 0700 Unit: _____ Room #: _____

Diagnosis: _____

Primary Language Spoken: ☐ English ☐ Spanish ☐ Other _____

Allergies: ☐ NKA ☐ YES (see MAR) ☐ Latex Allergy: ☐ YES ☐ NO

Code Status: ☐ Full Code ☐ DNAR (see order in chart)

B

Isolation Precautions: ☐ None ☐ Contact ☐ Airborne ☐ Droplet ☐ Other _____

Special Needs: ☐ None ☐ Hearing ☐ Vision ☐ Interpreter Needed ☐ Other _____

Safety Precautions: ☐ None ☐ Fall ☐ Aspiration ☐ Sleep Apnea

☐ Restraints: Type _____ ☐ Other _____

RIDE 1 TIME:	RIDE 2 TIME:	RIDE 3 TIME:
MENTAL STATUS: ☐ A & O x 4 ☐ Confused ☐ Lethargic ☐ Other:	MENTAL STATUS: ☐ A & O x 4 ☐ Confused ☐ Lethargic ☐ Other:	MENTAL STATUS: ☐ A & O x 4 ☐ Confused ☐ Lethargic ☐ Other:
OXYGEN NEEDS: ☐ None ☐ O_2 @ ____ liters via _____ (NRBM, RN must accompany pt.)	OXYGEN NEEDS: ☐ None ☐ O_2 @ ____ liters via _____ (NRBM, RN must accompany pt.)	OXYGEN NEEDS: ☐ None ☐ O_2 @ ____ liters via _____ (NRBM, RN must accompany pt.)
CARDIAC MONITOR REQUIRED: ☐ No ☐ Yes (If yes, RN must accompany pt.)	CARDIAC MONITOR REQUIRED: ☐ No ☐ Yes (If yes, RN must accompany pt.)	CARDIAC MONITOR REQUIRED: ☐ No ☐ Yes (If yes, RN must accompany pt.)
A NPO: ☐ No ☐ Yes Time: Reason:	NPO: ☐ No ☐ Yes Time: Reason:	NPO: ☐ No ☐ Yes Time: Reason:
HIGH ALERT MED: ☐ None ☐ Anticoagulant ☐ Insulin ☐ Other:	HIGH ALERT MED: ☐ None ☐ Anticoagulant ☐ Insulin ☐ Other:	HIGH ALERT MED: ☐ None ☐ Anticoagulant ☐ Insulin ☐ Other:
LAST PAIN MED: Dose: Time:	LAST PAIN MED: Dose: Time:	LAST PAIN MED: Dose: Time:
IV LOCATION:	IV LOCATION:	IV LOCATION:
R POSITION PATIENT: ☐ Comfort ☐ Flat ☐ HOB1 ☐ Other:	POSITION PATIENT: ☐ Comfort ☐ Flat ☐ HOB1 ☐ Other:	POSITION PATIENT: ☐ Comfort ☐ Flat ☐ HOB1 ☐ Other:
ASSIST FOR TRANSFER: ☐ None ☐ Minimal ☐ Max	ASSIST FOR TRANSFER: ☐ None ☐ Minimal ☐ Max	ASSIST FOR TRANSFER: ☐ None ☐ Minimal ☐ Max
Additional Comments:	Additional Comments:	Additional Comments:

MUST SIGN BACK OF FORM PRIOR TO EACH TRANSPORT

PATIENT LABEL

St. Joseph Hospital
ST. JOSEPH HEALTH SYSTEM

TICKET TO RIDE
(NON-RN PATIENT TRANSPORT)

St. Joseph Health System, Orange County, California, developed the "Ticket to Ride" tool to help standardize patient handoffs. Reprinted with permission.

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(continued from page 8)

safety," says Pelczarski. "I've actually had nurses ask me why they should rush to address a leads-off alarm when those leads are only going to come off again. An organizationwide culture in which everyone understands the relationship between alarm management and patient safety is very important."

STRATEGY Adequately train staff. "Nurses should be trained periodically on alarm management protocols and why they are important to patient safety," says Pelczarski. "They should also be trained on appropriate use of monitoring systems—for example, how to set alarm limits." Organizations should include clinical engineers in staff education about physiologic monitoring systems. "Clinical engineers are the health care professionals typically most familiar with the details of how these monitors work," Keller observes. "They need to be active contributors in the multidisciplinary team and should be relied upon to help with the staff training."

STRATEGY Track product recalls. Organizations should be aware of manufacturer recalls of equipment they are using. "An organization needs to have a good process to track and take action on recalls before the affected devices can cause harm," Keller says. "If an organization doesn't have an effective process in place, it may unknowingly use devices with defective alarms." PS

References

1. Lacker C.: Physiologic alarm management. *Pennsylvania Patient Safety Advisory* 8:105–108, Sep. 2011.
2. Graham K., Cvach M.: Monitor alarm fatigue: Standardizing use of physiological monitors and decreasing nuisance alarms. *Am J Crit Care* 19:28–34, Jan. 2010.