Clinical Alarm Management Strategies – Meaningful Alerts

Sharon H. Allan DNP, RN, ACNS-BC, CCRC
Johns Hopkins School of Nursing
Johns Hopkins Hospital
Baltimore, MD
Disclosures

• I have no financial relationships to disclose

• I will not discuss off label use and/or investigational use in this presentation.
Alarm Management: Learning Objectives

• State why nuisance alarms are a patient safety hazard

• Recognize how best practice interventions reduce the number of non-actionable alarms.

• Identify innovative ways to reduce alarm burden using alarm profiles and maximizing capabilities of clinical alarm devices
Which sound to respond to first

CENTRAL MONITOR

ECMO

IV Pump

Vent

Bedside Monitor

Pager

Bed Alarm

NURSE CALL

Wi-Fi Phone

Mechanical Circulatory Support Device
Alarm Fatigue: Lack of response to an alarm due to excessive numbers (most of which are false/non-actionable) resulting in sensory overload and desensitization.

THE GOAL OF AN ALARM SIGNAL SHOULD BE: TO INFORM AND THEN MOVE THE NURSE TO AN APPROPRIATE ACTION.
Background

More is not better

Nuisance alarms = non-actionable (patient status), false alarms (technical)

Concept of “alarm fatigue” – difficult to define

Case studies that demonstrate alarm burden is a patient safety issue.

• “new nurse” – too many alerts – hit acknowledge on her middleware device

TJC/Policy driven best practice change

Individual clinical areas remain high in alarm numbers
## 2018 Hospital National Patient Safety Goals

The purpose of the National Patient Safety Goals is to improve patient safety. The goals focus on problems in health care safety and how to solve them.

### Identify patients correctly

| NPSG.01.01.01 | Use at least two ways to identify patients. For example, use the patient’s name and date of birth. This is done to make sure that each patient gets the correct medicine and treatment. |
| NPSG.01.03.01 | Make sure that the correct patient gets the correct blood when they get a blood transfusion. |

### Improve staff communication

| NPSG.02.03.01 | Get important test results to the right staff person on time. |

### Use medicines safely

| NPSG.03.04.01 | Before a procedure, label medicines that are not labeled. For example, medicines in syringes, cups and basins. Do this in the area where medicines and supplies are set up. |
| NPSG.03.05.01 | Take extra care with patients who take medicines to thin their blood. |
| NPSG.03.06.01 | Record and pass along correct information about a patient’s medicines. Find out what medicines the patient is taking. Compare those medicines to new medicines given to the patient. Make sure the patient knows which medicines to take when they are at home. Tell the patient it is important to bring their up to date list of medicines every time they visit a doctor. |

### Use alarms safely

| NPSG.06.01.01 | Make improvements to ensure that alarms on medical equipment are heard and responded to on time. |

### Prevent infection

| NPSG.07.01.01 | Use the hand cleaning guidelines from the Centers for Disease Control and Prevention or the World Health Organization. Set goals for improving hand cleaning. Use the goals to improve hand cleaning. |
EXECUTIVE BRIEF

Top 10 Health Technology Hazards for 2018

A Report from Health Devices

The List for 2018

1. Ransomware and Other Cybersecurity Threats to Healthcare Delivery Can Endanger Patients
2. Endoscope Reprocessing Failures Continue to Expose Patients to Infection Risk
3. Mattresses and Covers May Be Infected by Body Fluids and Microbiological Contaminants
4. Missed Alarms May Result from Inappropriately Configured Secondary Notification Devices and Systems
5. Improper Cleaning May Cause Device Malfunctions, Equipment Failures, and Potential for Patient Injury
6. Unholstered Electrosurgical Active Electrodes Can Lead to Patient Burns
7. Inadequate Use of Digital Imaging Tools May Lead to Unnecessary Radiation Exposure
8. Workarounds Can Negate the Safety Advantages of Bar-Coded Medication Administration Systems
9. Flaws in Medical Device Networking Can Lead to Delayed or Inappropriate Care
10. Slow Adoption of Safer Enteral Feeding Connectors Leaves Patients at Risk
Clinician Perspective

Alarm signals should be about redirecting our attention from something that’s less important to something that’s more important.
Clinical Monitoring

Data-Driven Implementation of Alarm Reduction Interventions in a Cardiovascular Surgical ICU

Sharon H. Allan, ACNS-BC, MSN, RN, CCRC; Peter A. Doyle, PhD; Adam Sapirstein, MD; Maria Cvaich, DNP, RN, FAAN

Background: Alarm fatigue in the ICU setting has been well documented in the literature. The ICU’s high-intensity environment requires staff’s vigilant attention, and distraction from false and non-actionable alarms pulls staff away from important tasks, creates dissatisfaction, and is a potential patient safety risk if alarms are missed or ignored. This project was intended to improve patient safety by optimizing alarm systems in a cardiovascular surgical intensive care unit (CVSICU). Specific aims were to examine nurses’ attitudes toward clinical alarm signals, assess nurses’ ability to discriminate audible alarm signals, and implement a bundled set of best practices for monitor alarm reduction without undermining patient safety.

Methods: CVSICU nurses completed an alarm perception survey and participated in alarm discriminability testing. Nurse survey data and baseline monitor alarm data were used to select targeted alarm reduction interventions, which were progressively phased in. Monitor alarm data and cardiorespiratory event data were trended over one year.

Results: Five of the most frequent CVSICU monitor alarm types—pulse oximetry, heart rate, systolic and diastolic blood pressure, pulse oximetry sensor, and ventricular tachycardia > 2—were targeted. After implementation, there was a 61% reduction in average alarms per monitored bed and a downward trend in cardiorespiratory events.

Conclusion: To reduce alarm fatigue it is important to decrease alarm burden through targeted interventions. Methods to reduce non-actionable alarms include adding short delays to allow alarm self-correction, adjusting default alarm threshold limits, providing alarm notification through a secondary device, and teaching staff to optimize alarm settings for individual patients.
CVSICU Alarms/Bed/Day Trend Chart

Phase 1A
Mid-Oct 2014

Phase 1B/II
Feb-Mar 2015

Phase III
Apr-June 2015

July 2014: 177
Aug 2014: 194
Sept 2014: 211
Oct 2014: 172
Nov 2014: 154
Dec 2014: 150
Jan 2015: 145
Feb 2015: 97
March 2015: 86
April 2015: 89
May 2015: 96
June 2015: 83
July 2015: 84

Ave Alarms/Bed/Day
Take-away
From CVSICU study

- Staff and unit leadership buy-in is key
- Project management team
- Transparency of data across ICUs
- Identified a lack of:
  - staff education on the specifics of device function
  - staff confidence
  - unit-based alarm management champions
<table>
<thead>
<tr>
<th>Departments</th>
<th>Parameters</th>
<th>PULSE OX %</th>
<th>HEART RATE</th>
<th>BP SYSTOLIC</th>
<th>BP DIASTOLIC</th>
<th>BP MEAN</th>
<th>ST Elev/Dep</th>
<th>RESP RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>* = 15 sec delay</td>
<td>BPM</td>
<td>mmHg</td>
<td>mmHg</td>
<td>mmHg</td>
<td></td>
<td>Breaths / min</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Medical ICU (MICU)</td>
<td></td>
<td>88*</td>
<td>105</td>
<td>50</td>
<td>140</td>
<td>90</td>
<td>180</td>
<td>40</td>
</tr>
<tr>
<td>Cardiac Care Unit (CCU)</td>
<td></td>
<td>88*</td>
<td>105</td>
<td>45</td>
<td>120</td>
<td>85</td>
<td>180</td>
<td>40</td>
</tr>
<tr>
<td>Cardiac Progressive Care Unit (PCCU)</td>
<td></td>
<td>88*</td>
<td>105</td>
<td>45</td>
<td>140</td>
<td>85</td>
<td>180</td>
<td>40</td>
</tr>
<tr>
<td>Medical Progressive Step-down Care unit (MPCU)</td>
<td>88*</td>
<td>105</td>
<td>50</td>
<td>140</td>
<td>90</td>
<td>180</td>
<td>40</td>
<td>110</td>
</tr>
<tr>
<td>Medicine Telemetry</td>
<td></td>
<td>88*</td>
<td>105</td>
<td>50</td>
<td>140</td>
<td>90</td>
<td>180</td>
<td>40</td>
</tr>
<tr>
<td>Labor and Delivery</td>
<td></td>
<td>89</td>
<td>105</td>
<td>50</td>
<td>150</td>
<td>80</td>
<td>200</td>
<td>40</td>
</tr>
<tr>
<td>Surgical ICU (SICU)</td>
<td></td>
<td>88*</td>
<td>105</td>
<td>45</td>
<td>120</td>
<td>90</td>
<td>180</td>
<td>0</td>
</tr>
<tr>
<td>Cardiovascular Surgical ICU (CVSICU)</td>
<td></td>
<td>88*</td>
<td>105</td>
<td>50</td>
<td>130</td>
<td>80</td>
<td>170</td>
<td>30</td>
</tr>
<tr>
<td>Weinberg ICU</td>
<td></td>
<td>88*</td>
<td>105</td>
<td>45</td>
<td>120</td>
<td>90</td>
<td>180</td>
<td>0</td>
</tr>
<tr>
<td>Cardiovascular Progressive Care Unit (Z 10W)</td>
<td></td>
<td>88*</td>
<td>105</td>
<td>50</td>
<td>140</td>
<td>80</td>
<td>180</td>
<td>40</td>
</tr>
<tr>
<td>Surgical Telemetry Units (Z 9 and 11W)</td>
<td></td>
<td>88*</td>
<td>105</td>
<td>45</td>
<td>140</td>
<td>90</td>
<td>180</td>
<td>40</td>
</tr>
<tr>
<td>Neurologic ICU (NCCU)</td>
<td></td>
<td>89</td>
<td>105</td>
<td>50</td>
<td>120</td>
<td>90</td>
<td>180</td>
<td>0</td>
</tr>
<tr>
<td>Neuro BRU</td>
<td></td>
<td>89</td>
<td>105</td>
<td>50</td>
<td>150</td>
<td>90</td>
<td>200</td>
<td>40</td>
</tr>
<tr>
<td>Oncology Units</td>
<td></td>
<td>89</td>
<td>105</td>
<td>50</td>
<td>130</td>
<td>90</td>
<td>180</td>
<td>40</td>
</tr>
</tbody>
</table>

This chart reflects monitor alarm default settings as of 10/10/2017 and is updated annually. Please contact the Clinical Engineering Department (410-955-2100) when you change monitor alarm default settings or if this chart does not reflect your current settings.

I:\Alarm Management\Alarm Management Taskforce\Alarm Inventory\Monitor Default Inventory\UHH Monitor Defaults 11-28-17.docx
Adapted from AAMI Foundation HTSI Alarm Parameter Grid: Accessed 10/2014

© Copyright 2017 by The Johns Hopkins Health System Corporation and/or The Johns Hopkins University
Figure 4.1. CCU Alarm Data Comparison to Other ICUs Over a 6-month Time Period.
You Need to Look at

? is Telling You?

The DATA
Total Number ST alarms in CCU Over 7 Days = 3573
Week of 10-17 to 10-27-2016
Figure 5.2 ST-segment Alarm Data

CCU ST Alarm Data Week of 1-23-2017

Total number of “Advisory Alarms = 16690
ST alerts = 34% of ALL Advisory

Figure 5.1. ST-segment alarms make up a significant portion of the total number of alarms/bed/day in the CCU.
The PULSE trial - a 5-year multisite randomized clinical trial to evaluate the implementation of the AHA Practice Standards for ECG Monitoring on nurses' knowledge, quality of care including the appropriateness of monitoring, and patient outcomes (Funk et al., 2013). Patients who have top priority for ST-segment monitoring include those at significant risk of myocardial ischemia that, if sustained, may result in acute myocardial infarction (MI) or extension of the MI. It is not appropriate for all patients to be monitored for myocardial ischemia. Data from the study supports development of alarm profiles to target patients appropriate for ST elevation alerts and those where ST elevation alerts lead to non-actionable alarms.
The PULSE study results demonstrated that:

Patients with:

• intermittent ventricular pacing
• left bundle branch block and
• intermittent right bundle branch block

should not be continuously monitored for ST-segment changes and would trigger frequent false ST-segment alarms.

The finding indicates that this subset of patients would benefit from alarm profiles.
Innovative Alarm Reduction Strategy
Targeting Non-actionable alarms

Population specific alarm profiles
Patient clinical alarm profiles are preset limits and are highly configurable. Profiles are helpful for defining alarm limits based on age range or disease conditions.
Week of 1-16-2017

ST Alarms are “Advisory Alarms”
STEP 1
STEP 3
STEP 4

RECALL DEFAULT

> RETURN
ST-ON  INACTIVE
ST-OFF  ACTIVE
DO NOT USE INACTIVE
DO NOT USE INACTIVE
DO NOT USE INACTIVE
ST Alarm Template & Analysis Turned ON for this Patient
ST Alarm Template and Analysis is turned off for this Patient
When is it appropriate to place a patient on **ST OFF Profile Default Setting**?

- Pacemaker On
- Left Bundle Branch Block
- Dilated Cardiomyopathy
- No h/o CAD or ischemic events
- H/o CAD but patient has pacemaker ON
- Patient has a very remote h/o CAD, admitted w/o symptoms of acute coronary syndrome and for another diagnosis
CCU Rounding Template for Nurses

Date: ______________  Patient’s Name: ____________________

Current Vital Signs:  BP _______ / _______ (MAP _______ ) HR _______ RR _______ SpO2 _______

O2 device______________  Temperature: Max__________  Current__________

Drips: ____________________________________________________________

Neuro Status:  LOC__________

GCS: __________ if scale is 3 or withdrawal of support per family, call Living Legacy: 410-242-1173

Ordered Sedation Level _______________________ Intermittent sedation (Yes/No)

Restraint order renewal EVERY 24 HOURS: (remind MD to write order in EPIC)

Cardiovascular Status:  PA Readings: Please print (with ordered mixed venous) CVP_________

IABP settings: ratio_____ MAP______ Aug _____ TVPACER settings: Rate_____ MA_____ Sensitivity_____

Pulses: __________ +/-______ Groin/vascular sites: ____________ (indicate D/I or hematoma noted or bleeding)

Pain__________________________  Pain meds__________________________

Pulmonary Status: Current Ventilator Settings: __________________________ Description of Secretions __________________________

Most Recent ABG: ___________/_________/_________/_________ on FIO2:_________

Daily Sedation Vacation__________ Vent Wean Screen: Passed/ Failed  DVT Prophylaxis_________

GI/ GU: Nutrition (Diet/Tube feeds/ parenteral) __________________________ Date of last BM: ____________

PESS consult_____  Nutrition consult_____

Renal: Current I & O status _______  Yesterdays I & O status__________

Current Weight__________________  Yesterdays Weight__________________  CVVHD net loss _______

Fooley: maintain or discontinue? Yes___ No___  Foley days: ______

Infectious Disease: Isolations: __________________________ Wounds: __________________________

Lines with dates: Central Line: __________ # days____ Arterial Line__________ #days____

Other line/s: __________________________

Laboratory: Please allow MD to do labs unless there are recent values obtained

Other consults: PT _____ OT _____ SLP _____ SW _____ SA _____ WC _____ Palliative _____

PLAN(S) FOR THE DAY:

______________________________

**IS THE PATIENT ON THE APPROPRIATE ALARM PROFILE SETTING? YES___ NO___**

ST On____  ST Off_____

Please place this document in boxes labeled: Alarm Project. Thanks
Findings

Phase I
a) Baseline Alarm Data: Identifying the Problem of High Number of Alarms in CCU.
b) Project management team formed with unit and hospital leadership buy-in

Start of ST Alarm Profile Project:
   a) Staff education
   b) Staff awareness of risks associated w/alarm fatigue

RESULTS: 44% reduction in total number of alarms/bed/day over 1 year. Evidence of sustainability of best practice initiative to reduce alarm burden in CCU using population specific alarm profiles
Terminal patients with an ordered DNR status causing excessive alarms for non-actionable reasons. Defining a “comfort care only” alarm profile may eliminate unnecessary alarms.
Setting the bedside monitor to “Comfort Care” profile to prevent inappropriate alarm notifications

- All patient parameters will be set to extreme limits preventing all parameter alarms except HR Lo, which will be set to 0 BPM
- All Arrhythmia detection will be stopped
- AVOA monitor feeds will be discontinued, so other rooms’ displays will not split for the Comfort Care patient
- AVOA “Receive” is also disabled so that family members are not disturbed by other patients’ alarms
- The Color Scheme on the monitor is changed to make it easy for ALL staff to identify the Comfort Care default is active
- Other than HR Lo, no patient alarms will be heard at the CIC nor will they be sent to mobile devices (pagers, Wi-Fi phones).
- * Technical alarms (Leads Fail, etc.) will still be active and sound at the CIC and sent to mobile devices
- *The care unit’s normal profile will automatically return upon monitor discharge of a patient.
Normal Default Profile display

Current default set being used

Regular color scheme
Verify COMFORT CARE profile

COMFORT CARE profile

Arrhythmia detection OFF

New color scheme

Limits set to extreme
Barrier to Accurate, Actionable Alarms = Technological Errors

High sensitivity with low specificity = alarm fatigue.
THE CHALLENGE IS:
Maintaining a Balance Between
Alarm Management Strategies to Decrease Alarm Burden and
Maintaining Patient Safety
Clinical Alarm Data as of January 2018

Ave Alarms/Bed/Day

- CCU
- CVS
- MICU
- NCCU
- SICU

January 12, 2018
FUTURE WORK TO BE DONE….

- Collaborate with Monitor Device Manufacturers to Improve the Specificity of Alarms and Decrease the Number of False Alarms

- Data needed to understand what practice and device manufacturer changes need to be made – to improve efficiency in patient care, improve staff satisfaction, improve patient safety and improve response time to “real changes in patient hemodynamics”.

• Expansion of population specific clinical alarm profiles: COPD, MCSD, fragile elderly patients, tracheostomy patients.

• **Time Trigger Alerts** – HR, SBP, SPO2

• Algorithms based on criticality of drugs
Acknowledgements

• Joy Rothwell and the CCU staff for their contributions and willingness to work with me on this QI project.
• Steven Schulman – Medical Director of the CCU
• John Chang and the Johns Hopkins Clinical Engineering team
• Maria Cvach
Contact Information

Sharon Allan DNP, RN, ACNS-BC, CCRC
Sallan@jhmi.edu
References


References (cont)


doi:10.1097/DCC.0000000000000014 [doi]