Clinical Alarm Management Strategies – Meaningful Alerts

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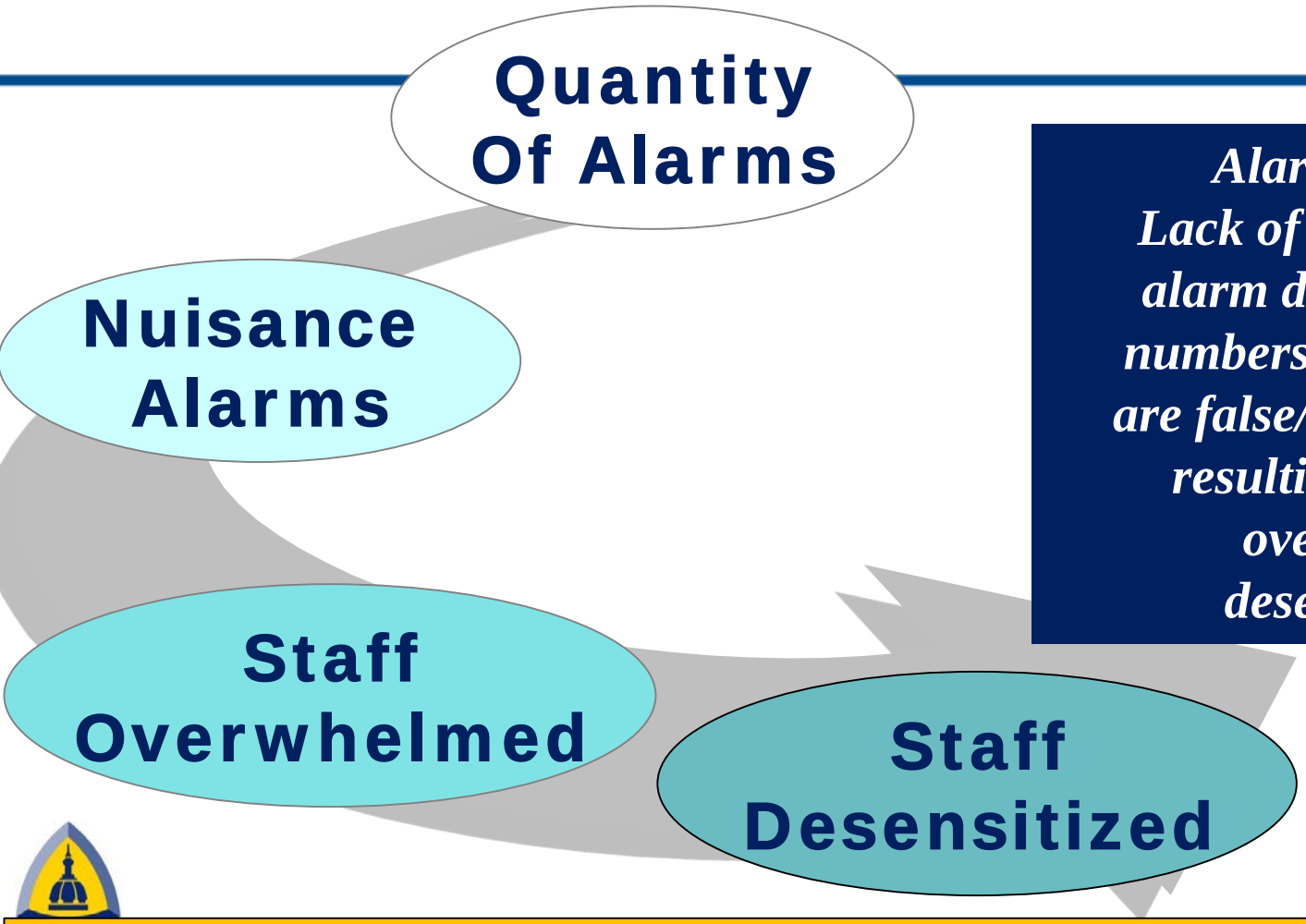
Disclosures

- **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
Bedside Monitor
IV Pump
Vent
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*

health DEVICES

ECRI Institute
The Discipline of Science. The Integrity of Independence.

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.

The Joint Commission Journal on Quality and Patient Safety 2017; 43:62–70

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 Cvach, DNP, RN, FAAN

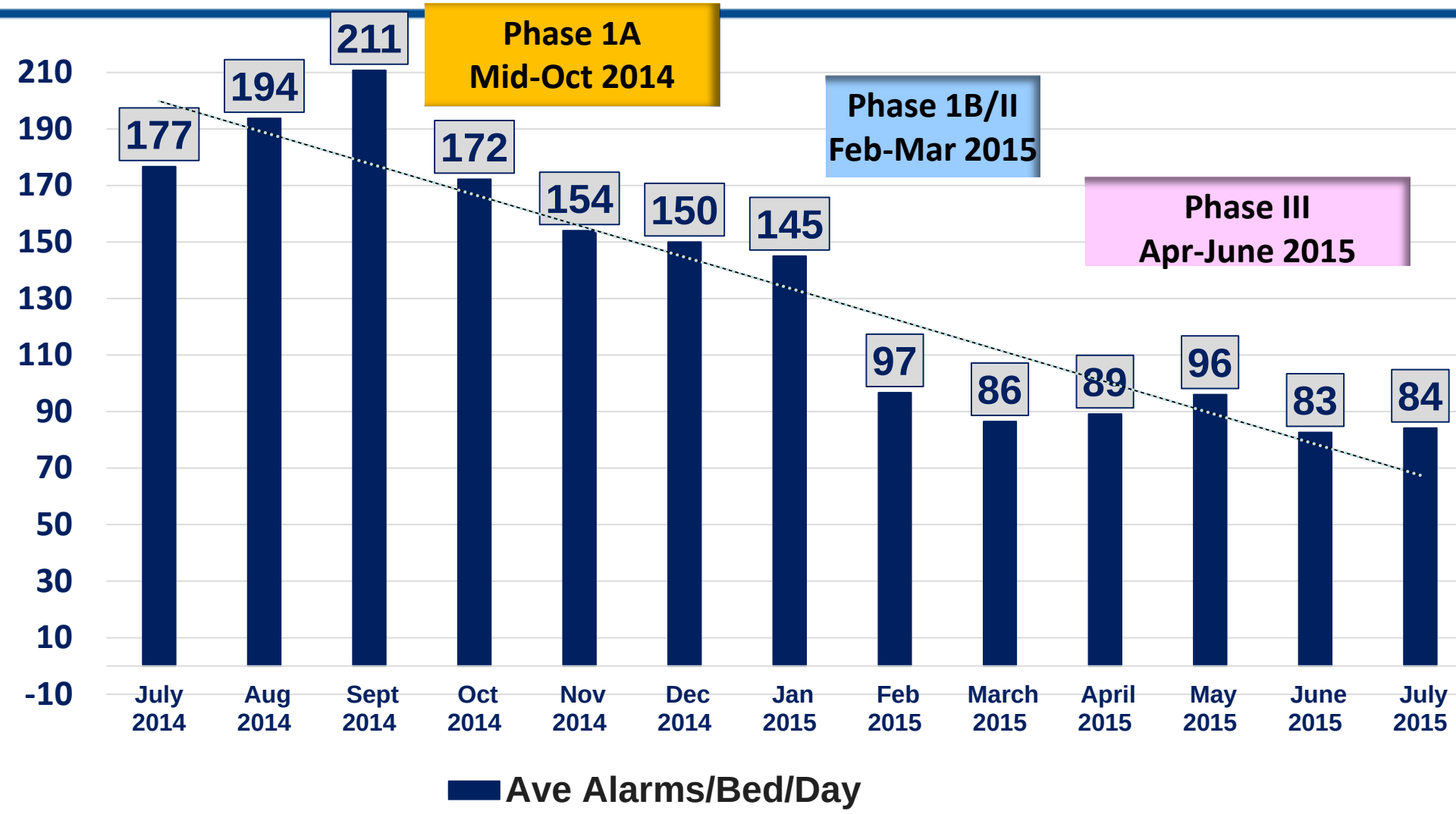
Background: Alarm fatigue in the ICU setting has been well documented in the literature. The ICU's high-intensity environment requires staff's vigilant attention, and distraction from false and non-actionable alarms pulls staff away from important tasks, creates dissatisfaction, and is a potential patient 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



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

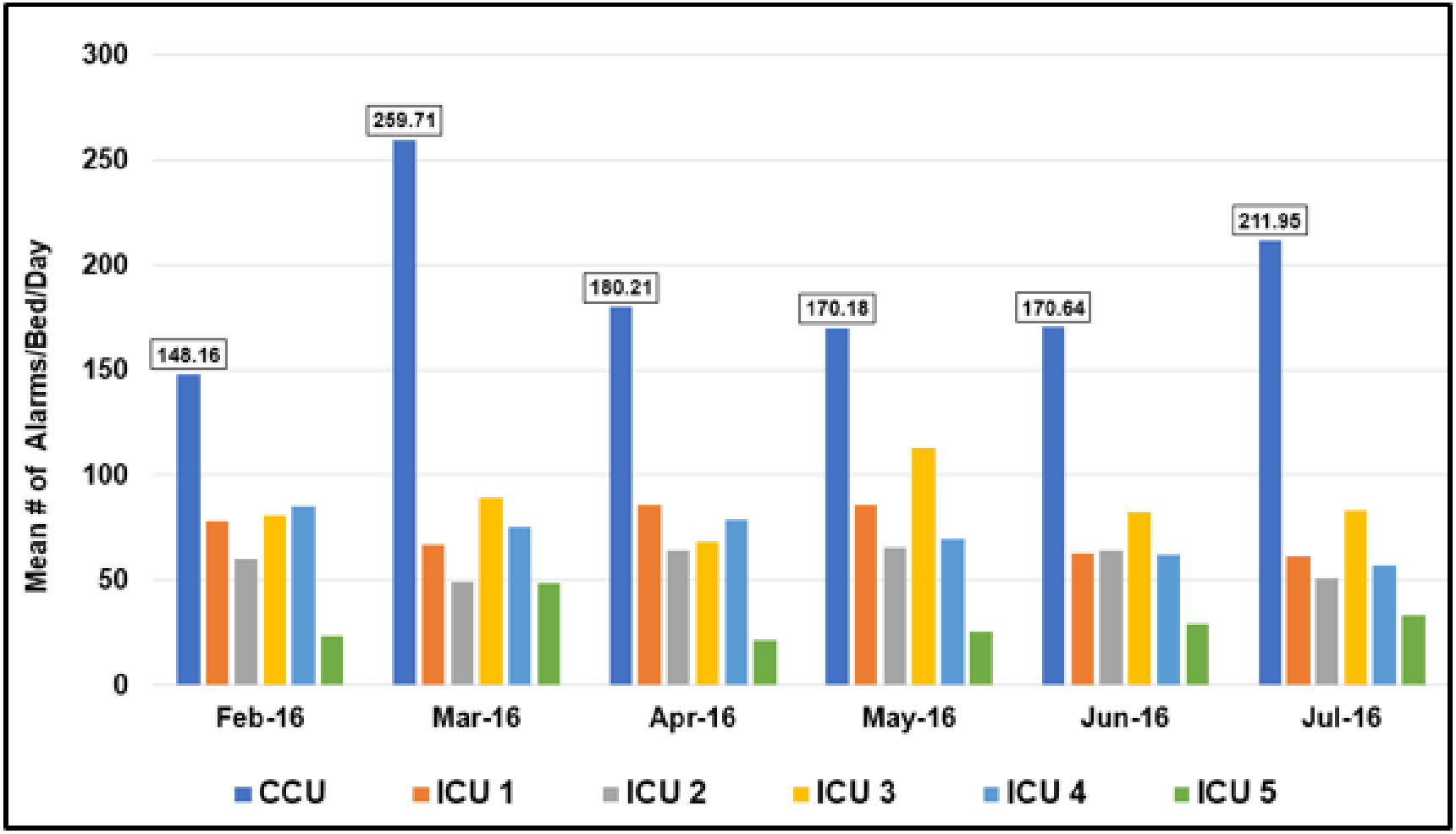
The Johns Hopkins Hospital
Physiologic Monitor Default Parameters
11/28/17

Parameters / Departments	PULSE OX % * = 15 sec delay ** = 10 sec delay		HEART RATE BPM		BP SYSTOLIC mmHg		BP DIASTOLIC mmHg		BP MEAN mmHg		ST Elev/ Dep	RESP RATE Breaths / min	
	Low	High	Low	High	Low	High	Low	High	Low	High		Low	High
Medical ICU (MICU)	88*	105	50	140	90	180	40	110	65	120	OFF	8	30
Cardiac Care Unit (CCU)	88*	105	45	120	85	180	40	350	55	120	2/-2 audible	8	30
Cardiac Progressive Care Unit (PCCU)	88*	105	45	140	85	180	40	110	55	120	2/-2 visual	8	30
Medical Progressive Step-down Care unit (MPCU)	88*	105	50	140	90	180	40	110	60	120	OFF	8	30
Medicine Telemetry	88*	105	50	140	90	180	40	110	55	120	OFF	8	30
Labor and Delivery	89	105	50	150	80	200	40	120	55	140	OFF	8	30
Surgical ICU (SICU)	88*	105	45	120	90	180	0	350	55	120	2/-2 visual	5	50
Cardiovascular Surgical ICU (CVSICU)	88*	105	50	130	80	170	30	130	55	120	2/-2 visual	5	30
Weinberg ICU	88*	105	45	120	90	180	0	350	55	120	2/-2 visual	5	30
Cardiovascular Progressive Care Unit (Z 10W)	88*	105	50	140	80	180	40	110	55	120	2/-2 visual	5	30
Surgical Telemetry Units (Z 9 and 11W)	88*	105	45	140	90	180	40	110	55	120	2/-2 visual	5	30
Neurologic ICU (NCCU)	90	105	50	120	90	180	0	350	55	120	2/-2 visual	5	30
Neuro BRU	89	105	50	150	90	200	40	120	40	140	2/-2 visual	8	30
Oncology Units	89	105	50	130	90	180	40	110	55	120	2/-2 visual	5	30

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.

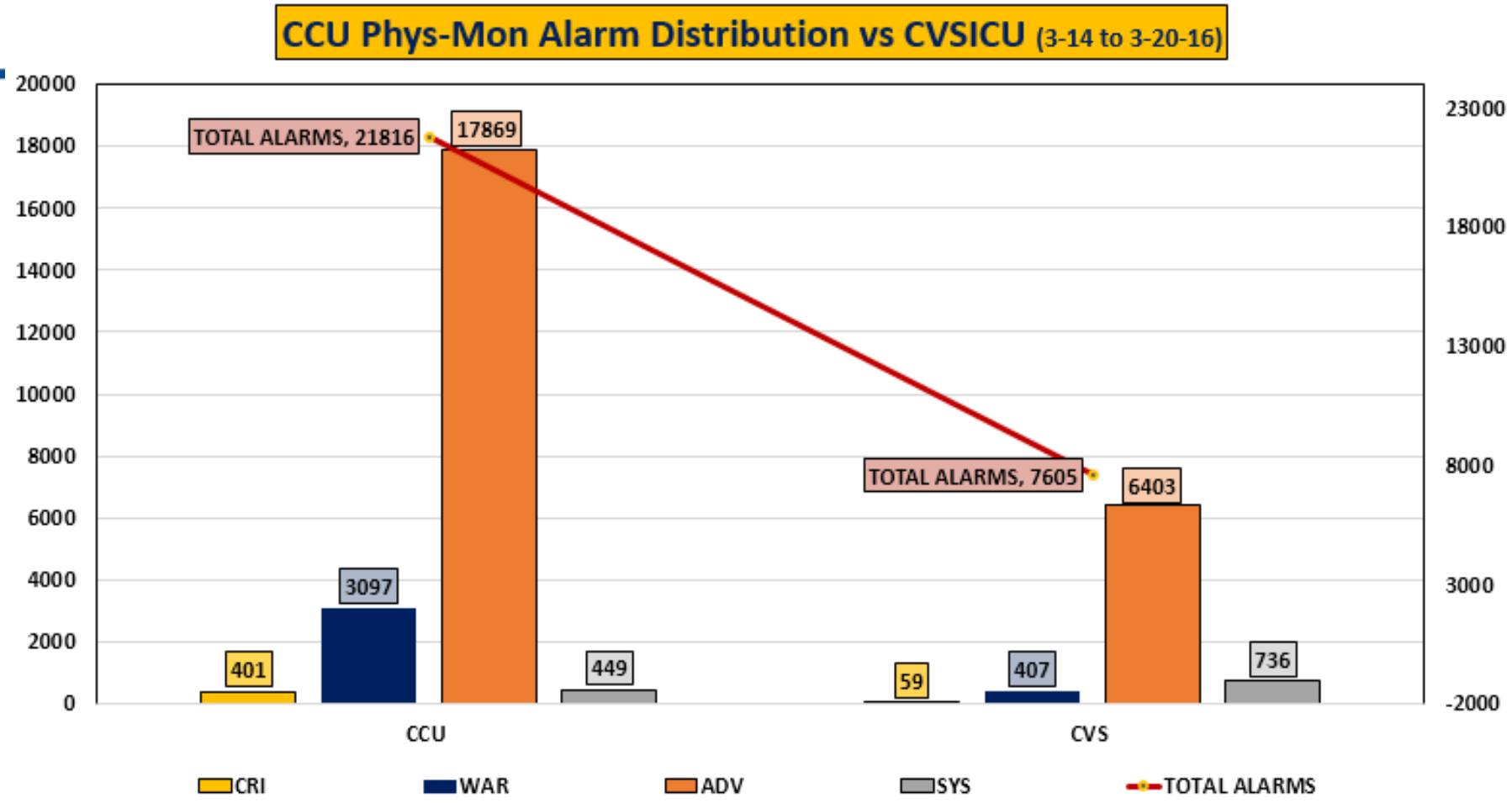
I:\Alarm Management\Alarm Management Taskforce\Alarm Inventory\Monitor Default Inventory\JHH Monitor Defaults 11-28-17.docx
Adapted from AAMI Foundation HTSI Alarm Parameter Grid: Accessed 10/2014

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


CCU Phys-Mon Alarm Distribution vs CVSICU (3-14 to 3-20-16)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
23000
18000
13000
8000
3000
-2000
TOTAL ALARMS, 21816
17869
TOTAL ALARMS, 7605
6403
3097
401
449
59
407
736
CCU
CVS
CRI
WAR
ADV
SYS
TOTAL ALARMS

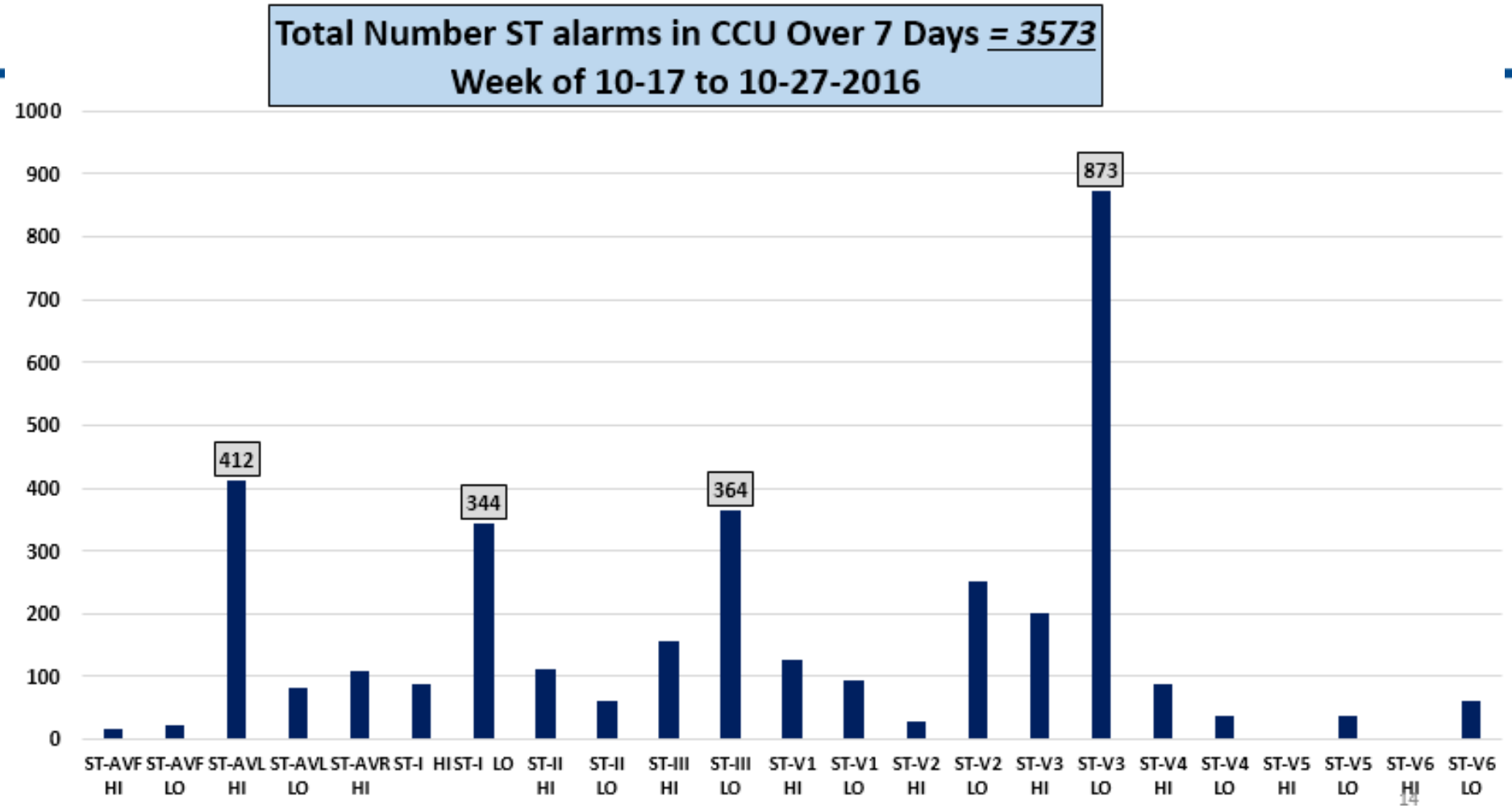

Total Number ST alarms in CCU Over 7 Days = 3573
Week of 10-17 to 10-27-2016
1000
900
800
700
600
500
400
300
200
100
0
412
344
364
873
ST-AVF HI
ST-AVF LO
ST-AVL HI
ST-AVL LO
ST-AVR HI
ST-I HI
ST-I LO
ST-II HI
ST-II LO
ST-III HI
ST-III LO
ST-V1 HI
ST-V1 LO
ST-V2 HI
ST-V2 LO
ST-V3 HI
ST-V3 LO
ST-V4 HI
ST-V4 LO
ST-V5 HI
ST-V5 LO
ST-V6 HI
ST-V6 LO

Figure 5.2 ST-segment Alarm Data

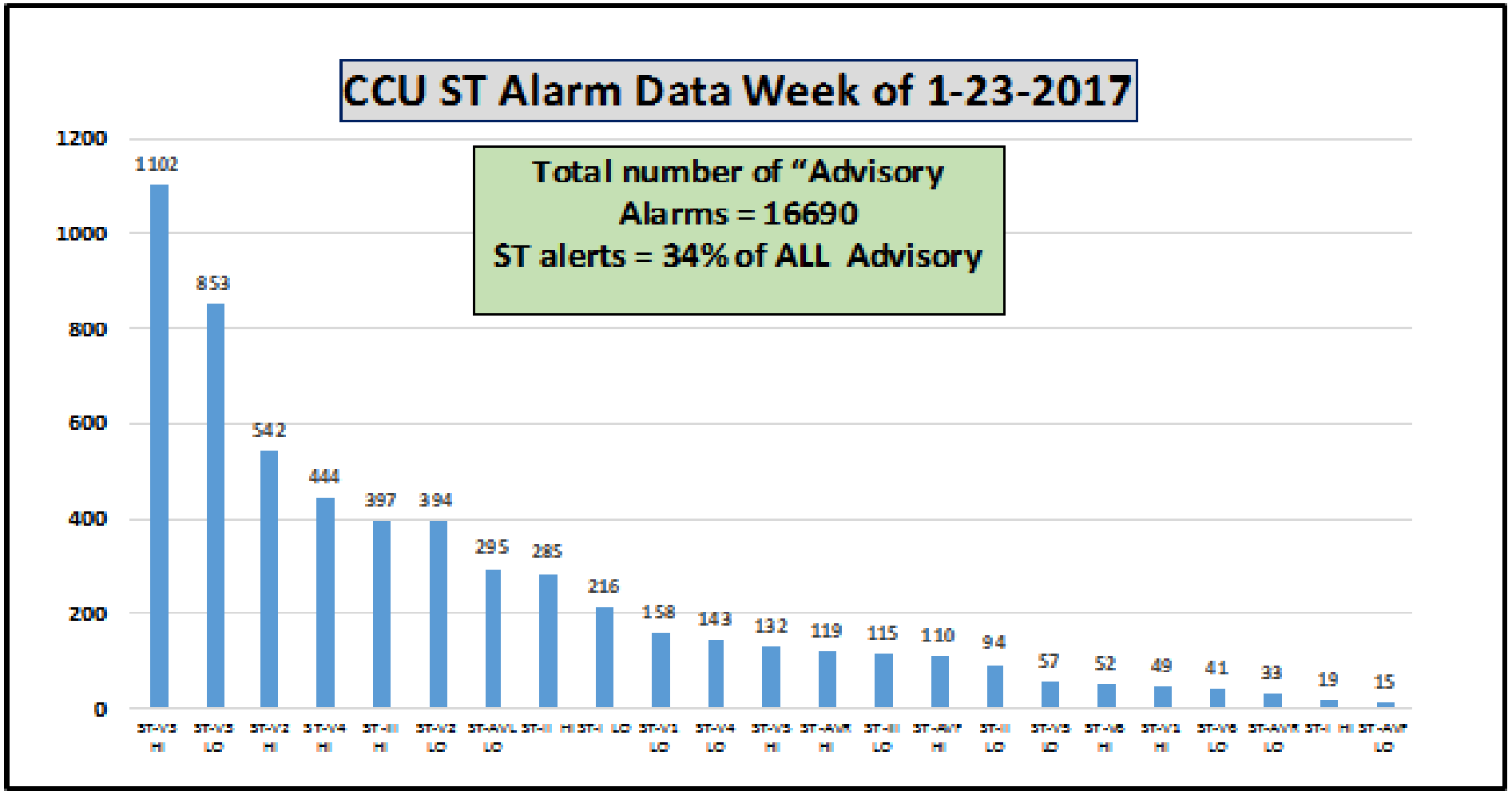


Figure 5.1. ST-segment alarms make up a significant portion of the total number of alarms/bed/day in the CCU.

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:

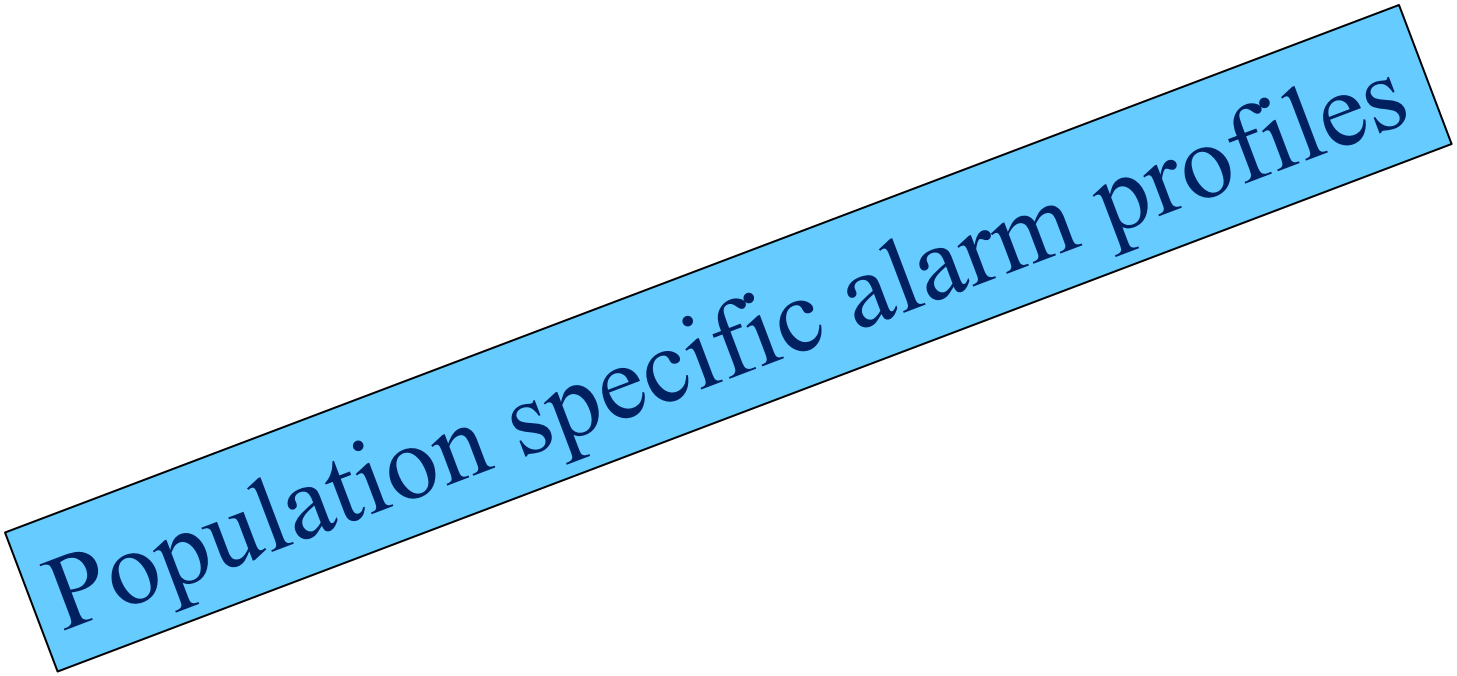
Patients with:

- **intermittent ventricular pacing**
- **left bundle branch block and**
- **intermittent right bundle branch block**

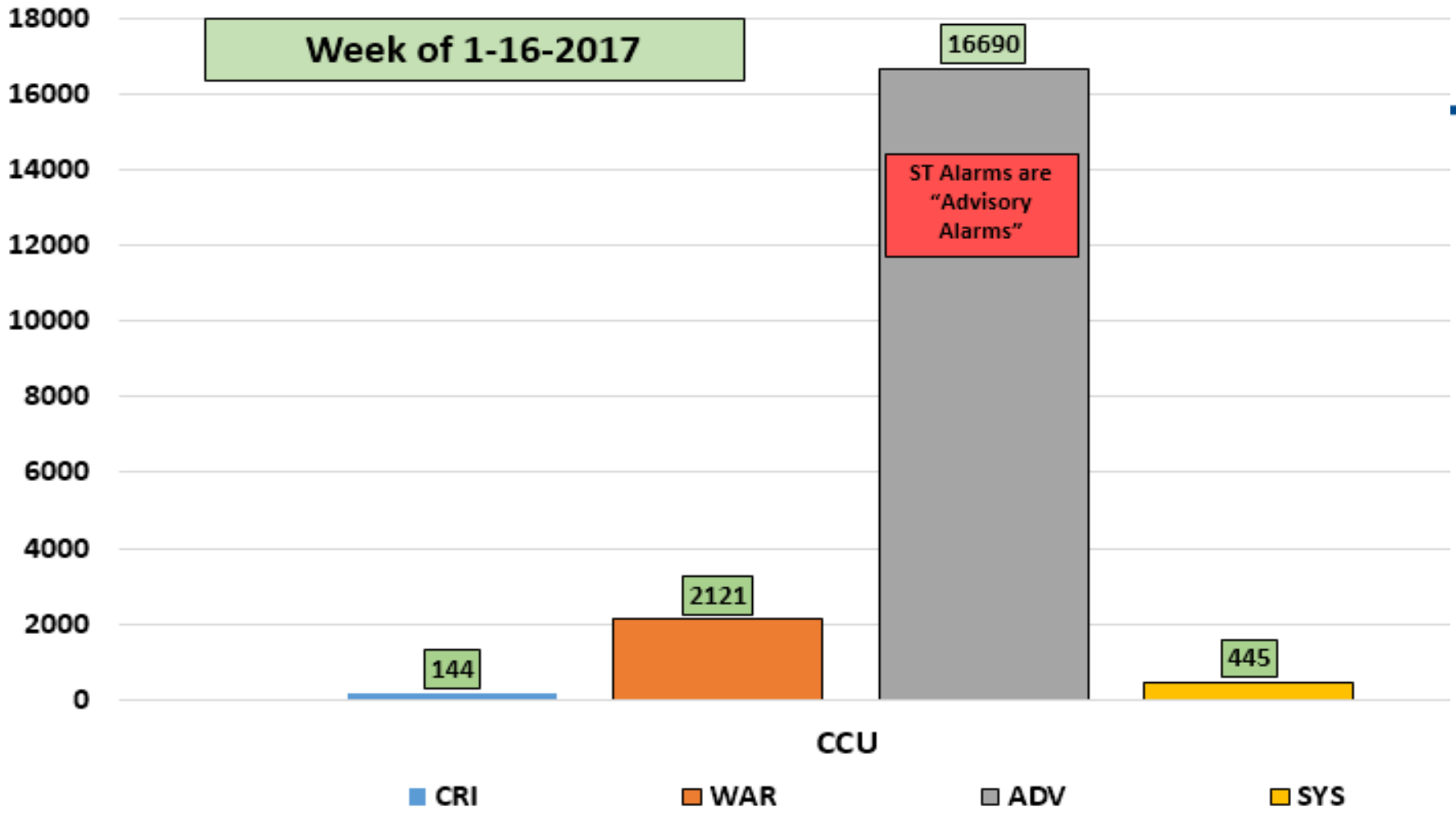
should not be continuously monitored for ST-segment changes and would trigger frequent false ST-segment alarms.

The finding indicates that this subset of patients would benefit from alarm profiles.

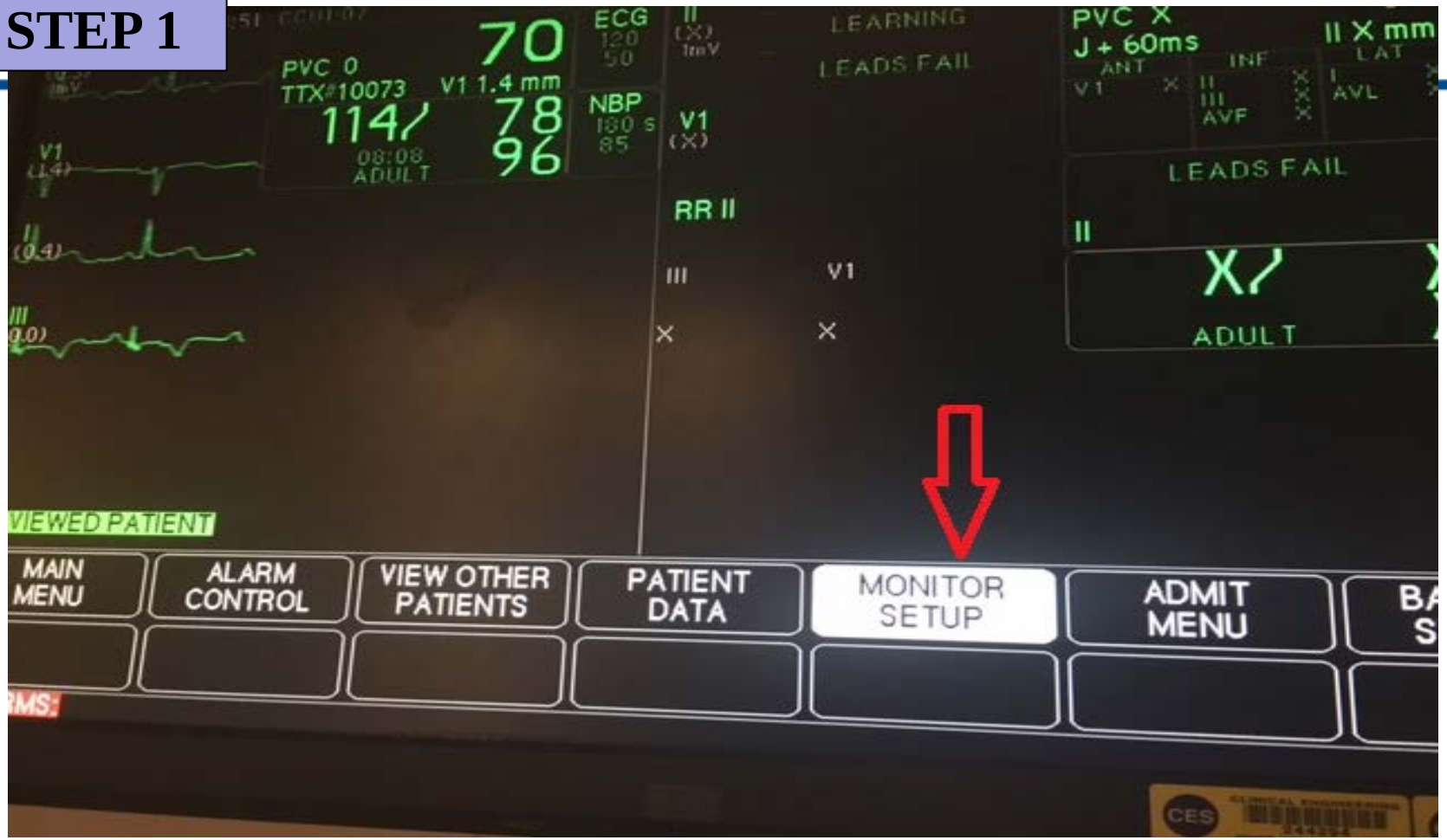
Innovative Alarm Reduction Strategy
Targeting Non-actionable alarms



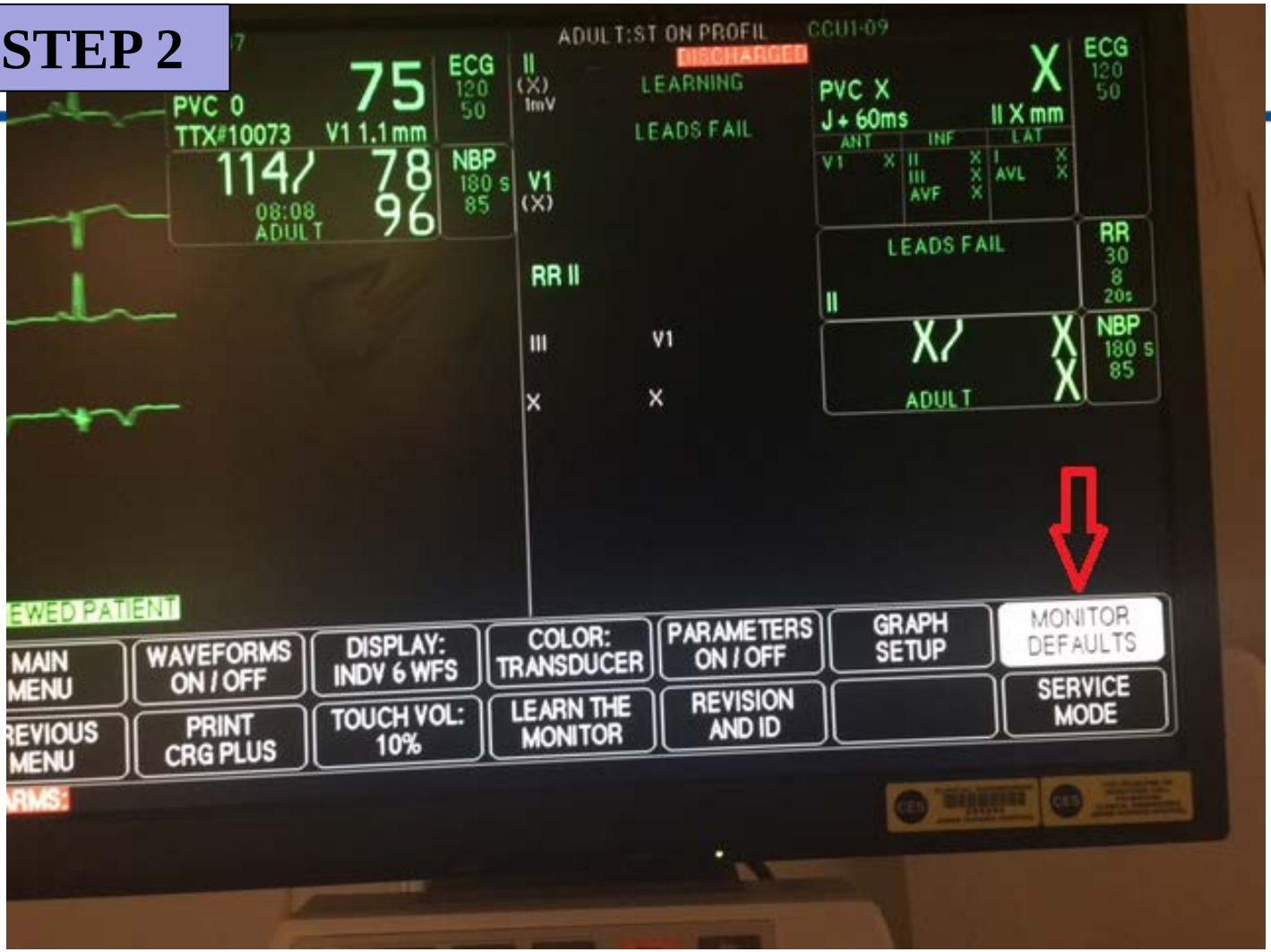
Patient clinical alarm profiles are preset limits and are highly configurable. Profiles are helpful for defining alarm limits based on age range or disease conditions.


Week of 1-16-2017
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
144
2121
16690
ST Alarms are "Advisory Alarms"
445
CCU
CRI
WAR
ADV
SYS

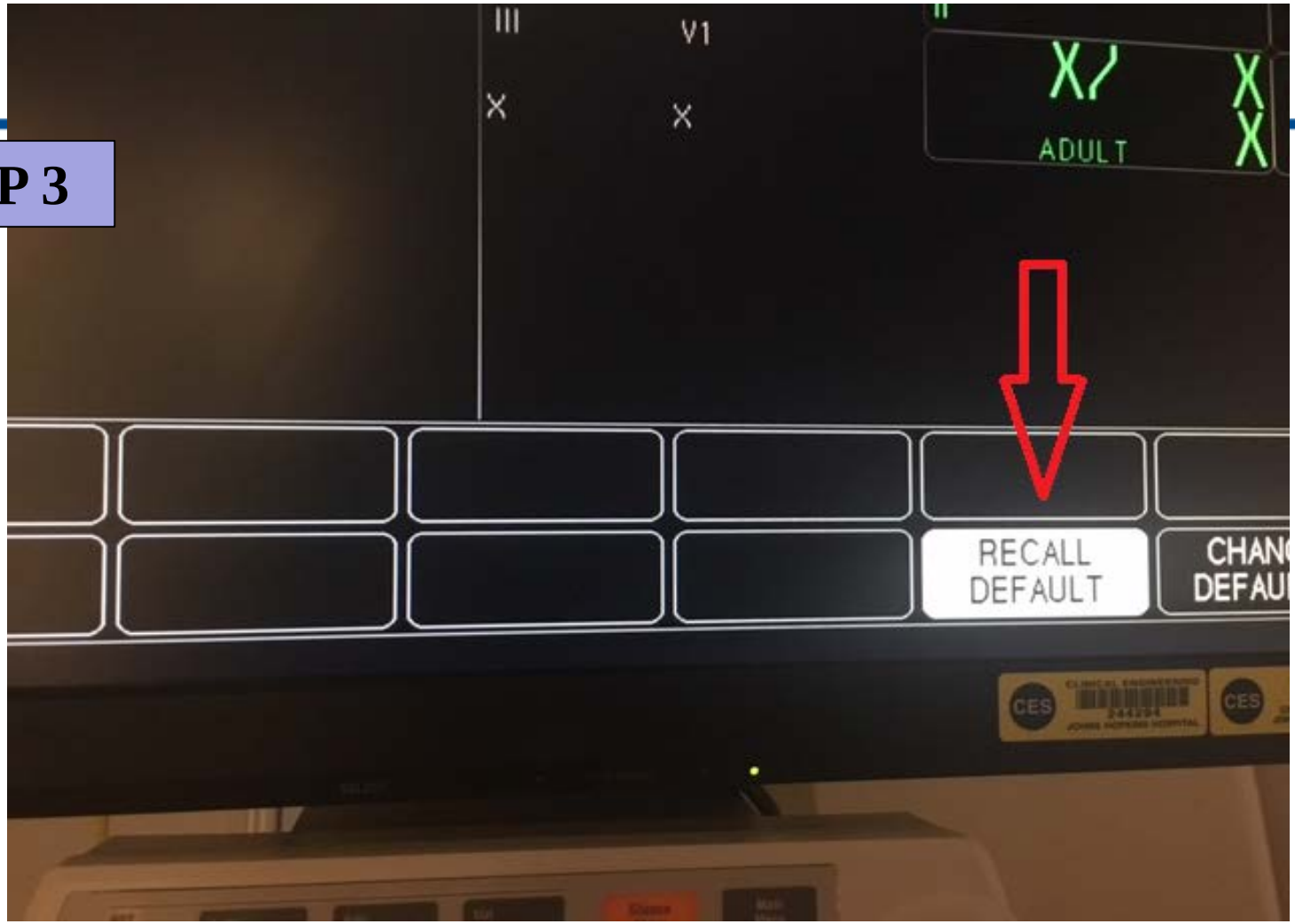
STEP 1


70
ECG
120
50
PVC 0
TTX#10073
V1 1.4 mm
114/
78
96
NBP
180 s
85
08:08
ADULT
V1
(X)
LEARNING
LEADS FAIL
PVC X
J + 60ms
ANT
INF
LAT
V1
II
III
AVF
I
AVL
II X mm
LEADS FAIL
II
X/
ADULT
RR II
III
V1
VIEWED PATIENT
MAIN MENU
ALARM CONTROL
VIEW OTHER PATIENTS
PATIENT DATA
MONITOR SETUP
ADMIT MENU

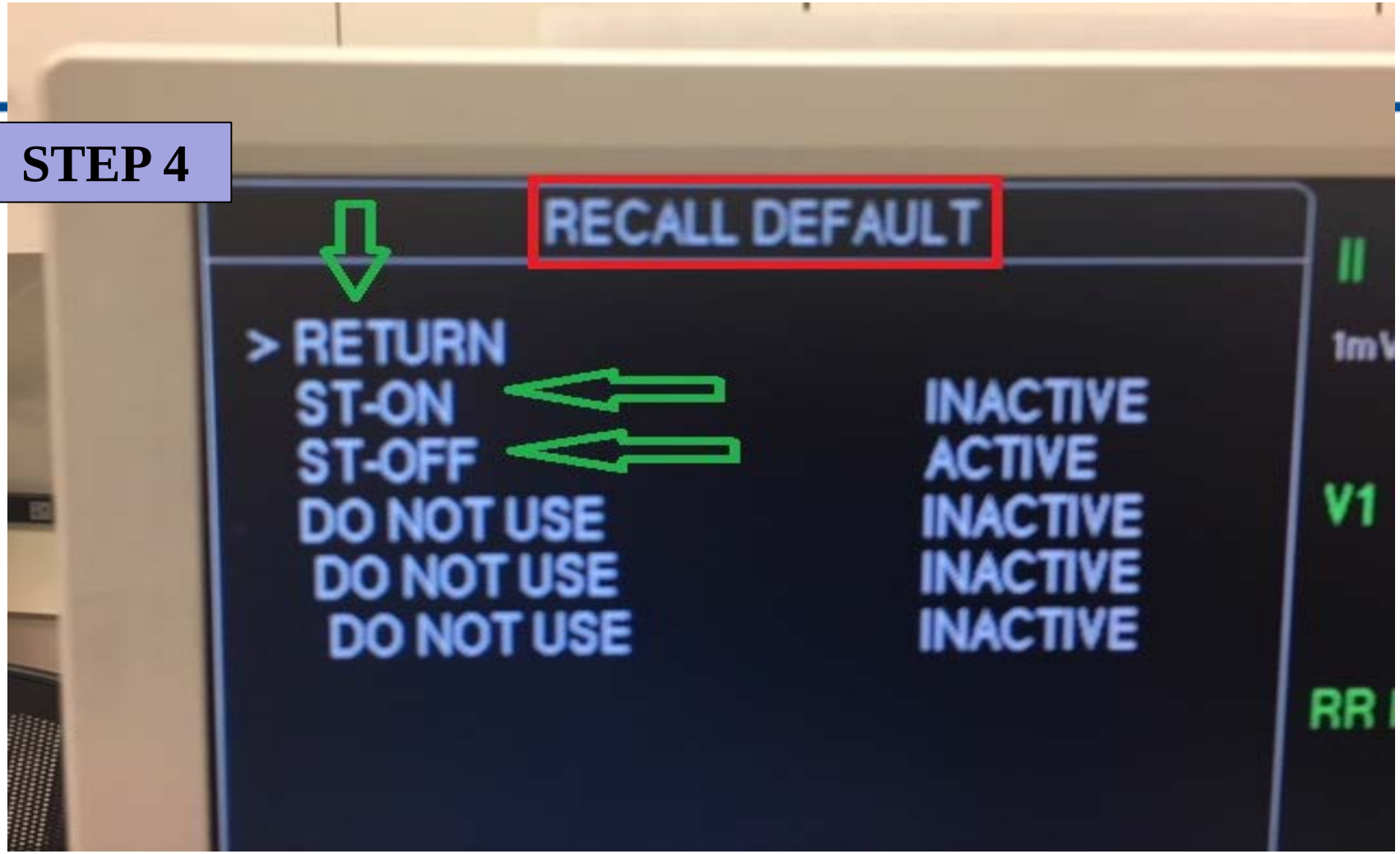
STEP 2


ADULT:ST ON PROFIL
CCU1-09
DISCHARGED
LEARNING
LEADS FAIL
PVC 0
TTX#10073
75
V1 1.1mm
ECG
120
50
NBP
180 s
85
08:08
ADULT
78
96
PVC X
J + 60ms
II X mm
ANT
INF
LAT
V1
AVL
AVF
RR
30
8
20s
RR II
V1
ADULT
MAIN MENU
WAVEFORMS ON / OFF
DISPLAY: INDV 6 WFS
COLOR: TRANSDUCER
PARAMETERS ON / OFF
GRAPH SETUP
MONITOR DEFAULTS
PREVIOUS MENU
PRINT CRG PLUS
TOUCH VOL: 10%
LEARN THE MONITOR
REVISION AND ID
SERVICE MODE

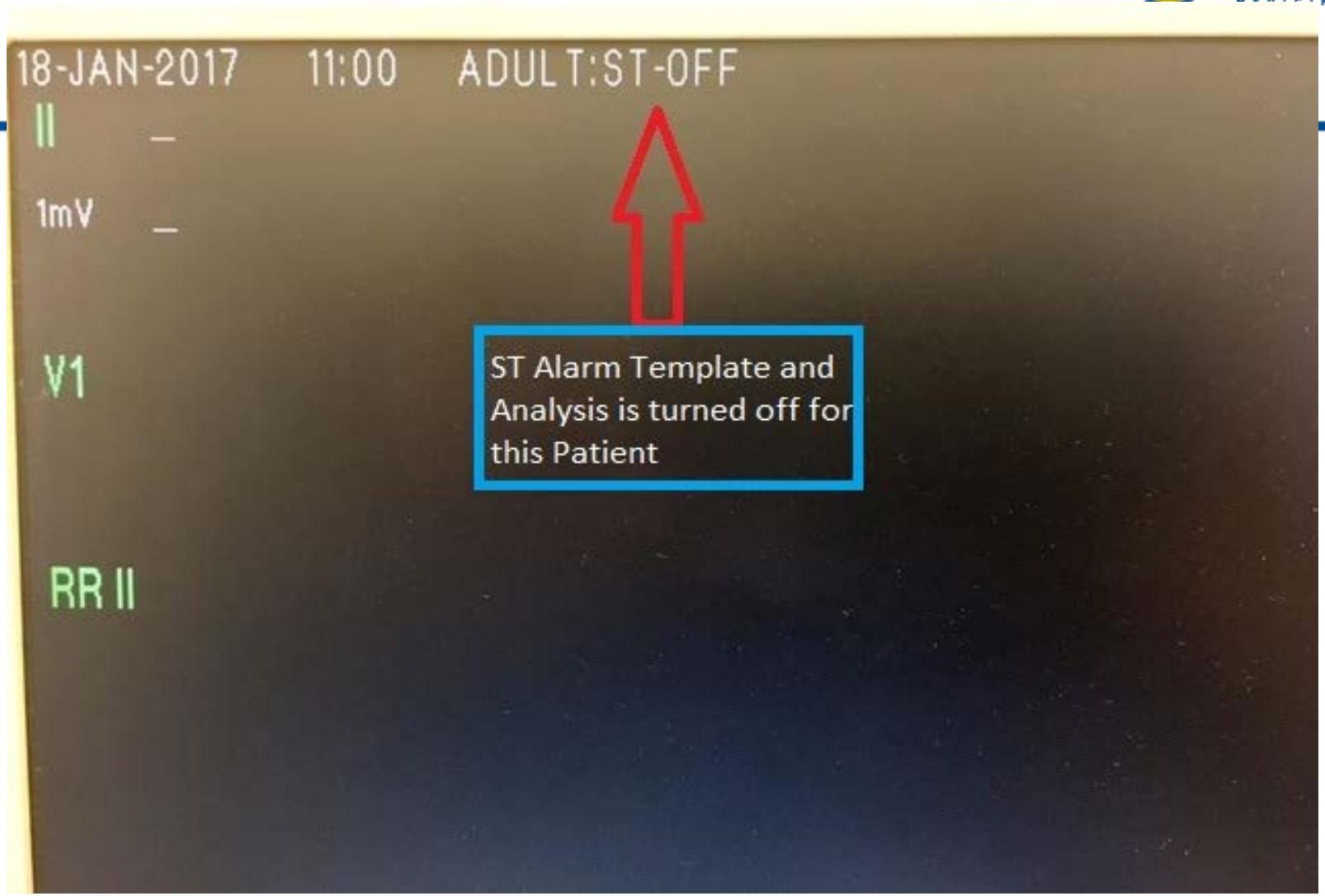
STEP 3



STEP 4


RECALL DEFAULT
> RETURN
ST-ON
ST-OFF
DO NOT USE
DO NOT USE
DO NOT USE
INACTIVE
ACTIVE
INACTIVE
INACTIVE
INACTIVE
II
V1
RR


18-JAN-2017 10:59 ADULT:ST-ON
II
(X)
1mV
V1
(X)
ST Alarm Template & Analysis Turned ON for this Patient
RR II
2.0
30 MIN
-2.0
III
V1
III
V1
X
X


18-JAN-2017 11:00 ADULT:ST-OFF
II
1mV
V1
RR II
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/radial 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 _____

Foley: 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____

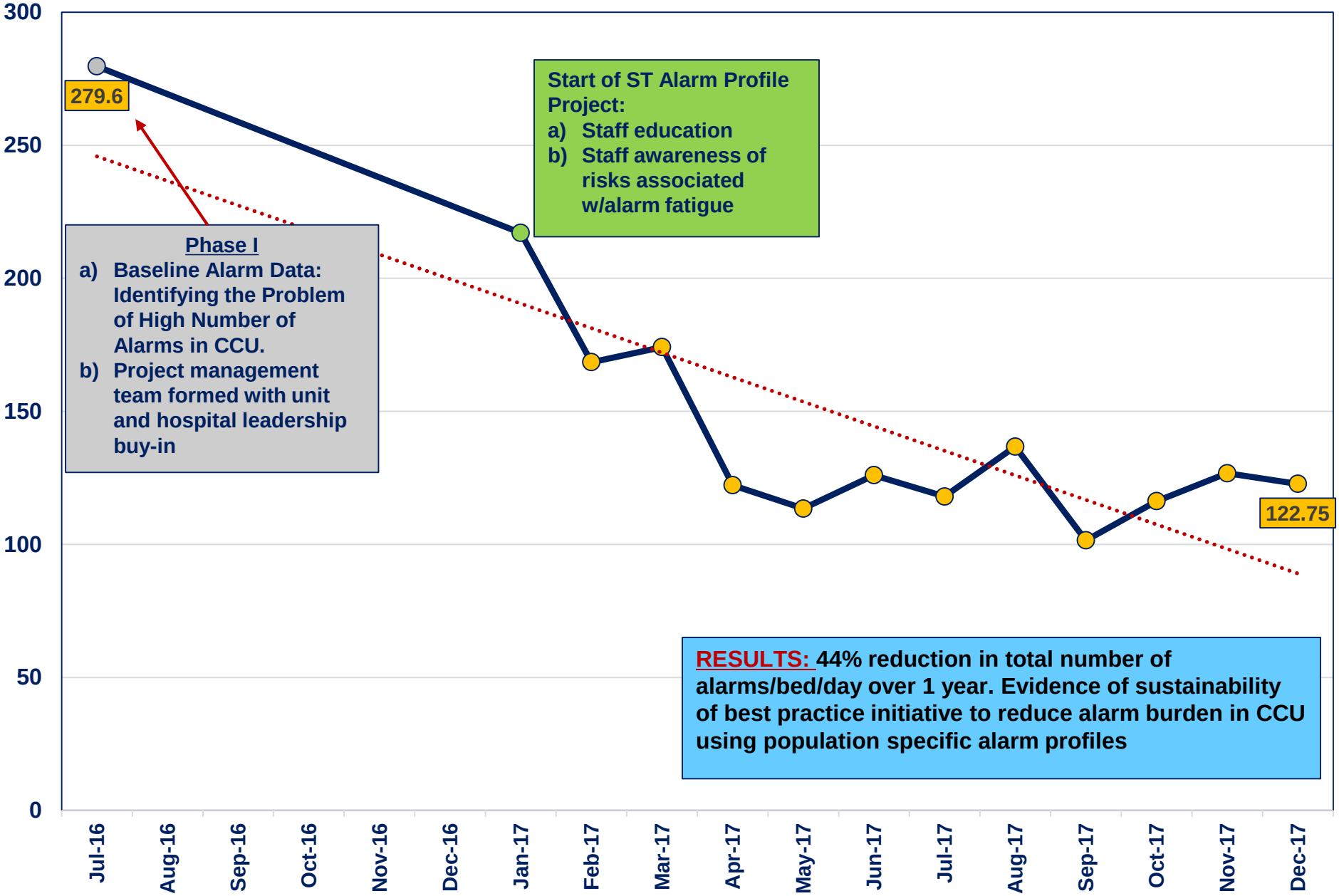
PLAN(S) FOR THE DAY: _____

_____

****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


300
250
200
150
100
50
0
279.6
122.75
Start of ST Alarm Profile Project:
a) Staff education
b) Staff awareness of risks associated w/alarm fatigue
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
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
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17

COMFORT CARE ALARM PROFILE

- 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

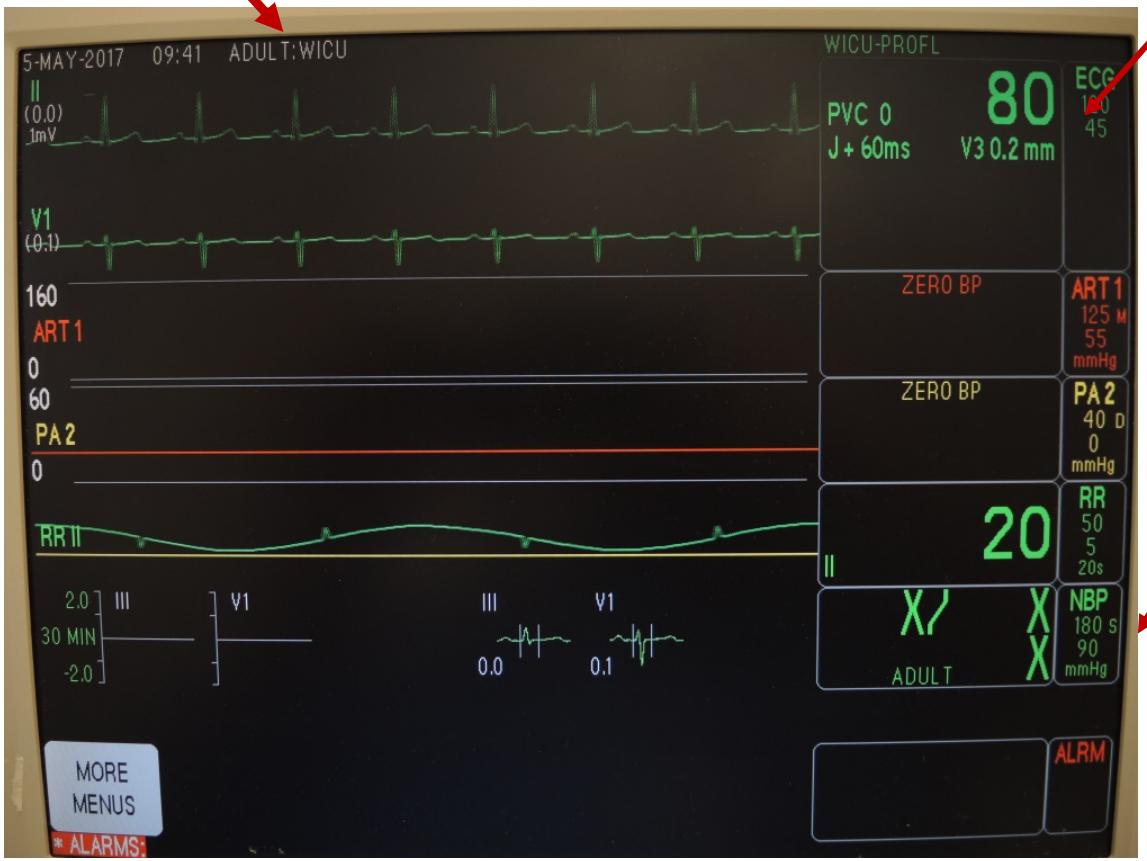
- All patient parameters will be set to extreme limits preventing all parameter alarms except HR Lo, which will be set to 0 BPM
- All Arrhythmia detection will be stopped
- AVOA monitor feeds will be discontinued, so other rooms’ displays will not split for the Comfort Care patient
- AVOA “Receive” is 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

JOHNS HOPKINS MEDICINE

Current default set being used

Regular color scheme



Verify COMFORT CARE profile

JOHNS HOPKINS MEDICINE

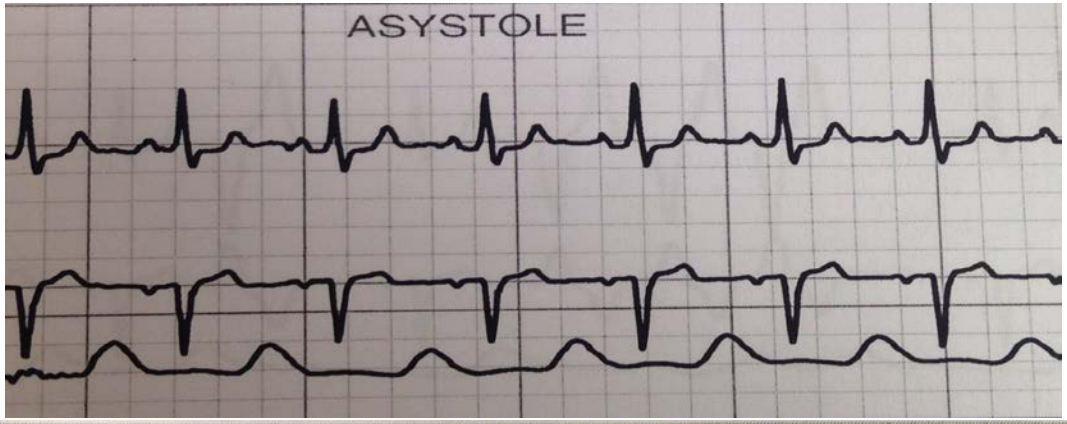
COMFORT CARE profile

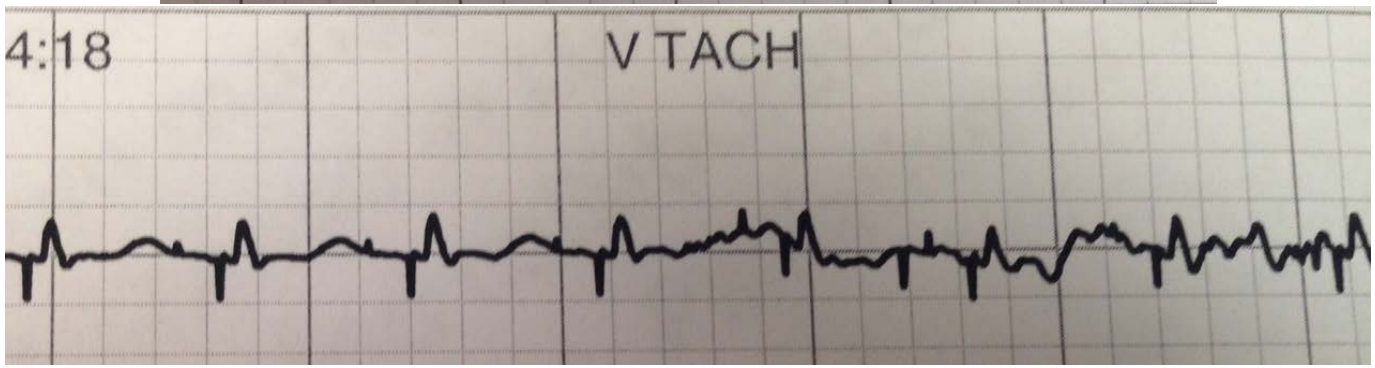
Arrhythmia detection OFF

New color scheme

Limits set to extreme

Barrier to Accurate, Actionable Alarms = Technological Errors

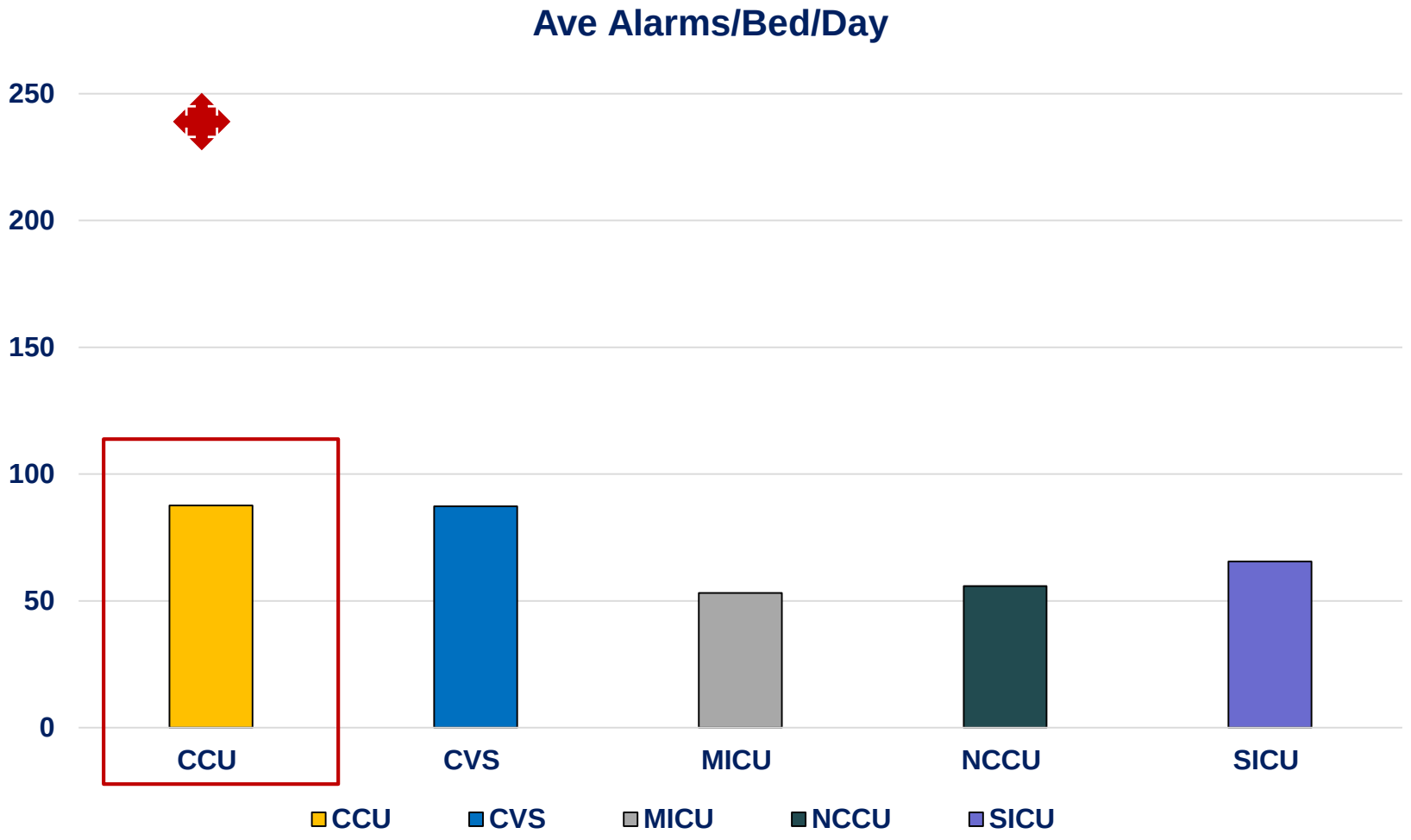




High sensitivity with low specificity = alarm fatigue.

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



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.
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- John Chang and the Johns Hopkins Clinical Engineering team
- Maria Cvach

Questions??

Contact Information

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