Responding to an Alarming Problem: Decreasing Burden & Increasing Safety

Wendy L. Timpson, MD[1, 2], Thomas Heldt, PhD[3], Karen Waldo, RN[1], Susan Young, RN[1], Munish Gupta, MD[1,2]

1. BIDMC; 2. Harvard Medical School; 3. Institute for Medical Engineering and Science, MIT

The Setting

- 600 to 700 newborns are admitted annually to the BIDMC Neonatal Intensive Care Unit, a 48-bed, Level IIIb NICU that supports 5,000 deliveries per year
- Infants admitted to the NICU are placed on continuous cardiorespiratory monitoring due to severity of illness and/or risk for apnea of prematurity
- Preterm infants are at risk for complications of hypoxemia as well as hyperoxemia, which prompts meticulous oxygen targeting and tight saturation alarm limits

The Problem

- Widespread CR monitoring in addition to narrow oxygen alarm limits results in a plethora of audible alarms in the NICU
- A large retrospective cohort study in our NICU demonstrated an average alarm rate of 177 per patient day or one alarm per infant every 8 minutes[1]
- Prospective data collection confirms an average monthly rate ranging from 107 to 193 alarms per patient day or between 130,000 and 270,000 alarms per month
- On average 32% of alarms are technical (InOp); these non-physiological alarms offer an opportunity to reduce burden
- The proliferation of bedside alarms create a stressful environment that is burdensome to staff and families and can result in alarm fatigue, a potential safety hazard

Competing Key Drivers

Project Aims

Primary Aim: Reduce audible Cardio-Respiratory (CR) alarm burden for all patients by 20% between September 2015 & December 2017.

Secondary Aim: Increase proportion of VLBW infants who are within their target saturation range 80% of the time by 20% during the same epoch.

The Team

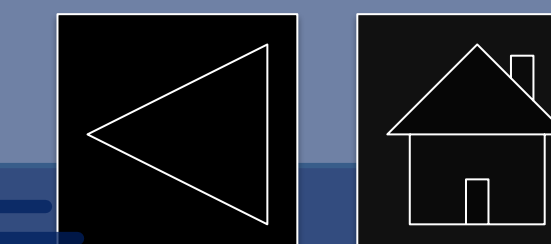| Discipline	Champions
Advanced Practitioners	Rosanne Buck NNP, Nicole Flaherty PNP, Kate Patnode NNP
Clinical Engineering	Wesley Ramkissoon (Manager), Karbin Sanchez (Technician Specialist), Jeff Smith (Project and Resource Specialist)
Data Management	David Miedema, Neonatology Department Data Engineer
Family Representatives	Molly Wylie (NICU Family Program Director), Rachel Daley (NICU Graduate Parent)
MIT Collaboration	Thomas Heldt PhD , Tiffany Ho MPH, James Lynch BS, Minoru Matsushima PhD
Nursing	Britt Days RN (Clinical Advisor), Jamie Perkins RN, Jennifer Reader RN, Jocelyn Rossi RN, Jenna Salvucci RN, Brenda Sheridan RN (UBE), Jane Smallcomb RN (Director of Perinatal Services), Jessica Smith RN, Kathy Tolland RN (Nursing Director), Karen Waldo RN (Clinical Advisor), Susan Young RN (Nurse Specialist)
Physician Leadership	Munish Gupta MD (Director of Quality Improvement)
Respiratory Care	Nina Koyama RRT, (NICU Respiratory Supervisor), Kara Ssembitto RRT

Our Interventions

- Gathered our team, identifying key stakeholders and involving frontline practitioners (February 2015)
- Developed aim statements and key driver diagram (April 2015)
- Established data collection technique (December 2015)
  - Monthly manual downloads from Philips central monitors by CE Team
- Developed and implemented tests of change:
  - Staff education: utilizing pause and silence features (January 2016)
  - Sounds of Silence Campaign (September - November 2016)
  - Utilizing saturation histograms to optimize oxygen targeting (November 2017)
  - Increasing utilization of pause alarm feature (February 2018)
  - Increased advisory tachycardia threshold (March 2018)
- Utilized MIMIC-II Data set to develop metrics for measuring time in target saturation range
- Upgraded Data Collection to Data Warehouse Connect (December 2017)
  - Pseudo-real time streaming of all waveform data to server in central MA
  - MIT Team access to data established (January 2018)
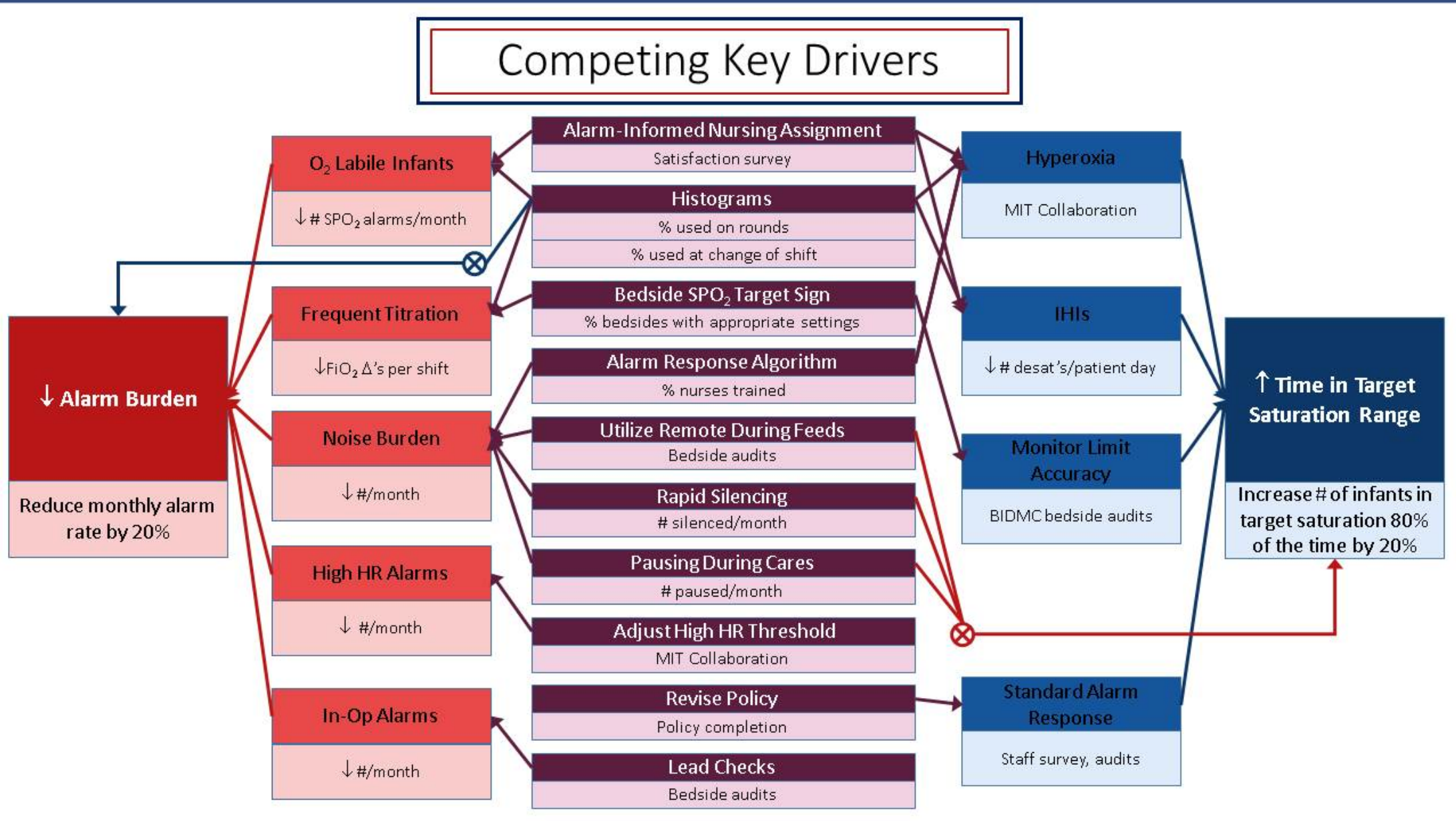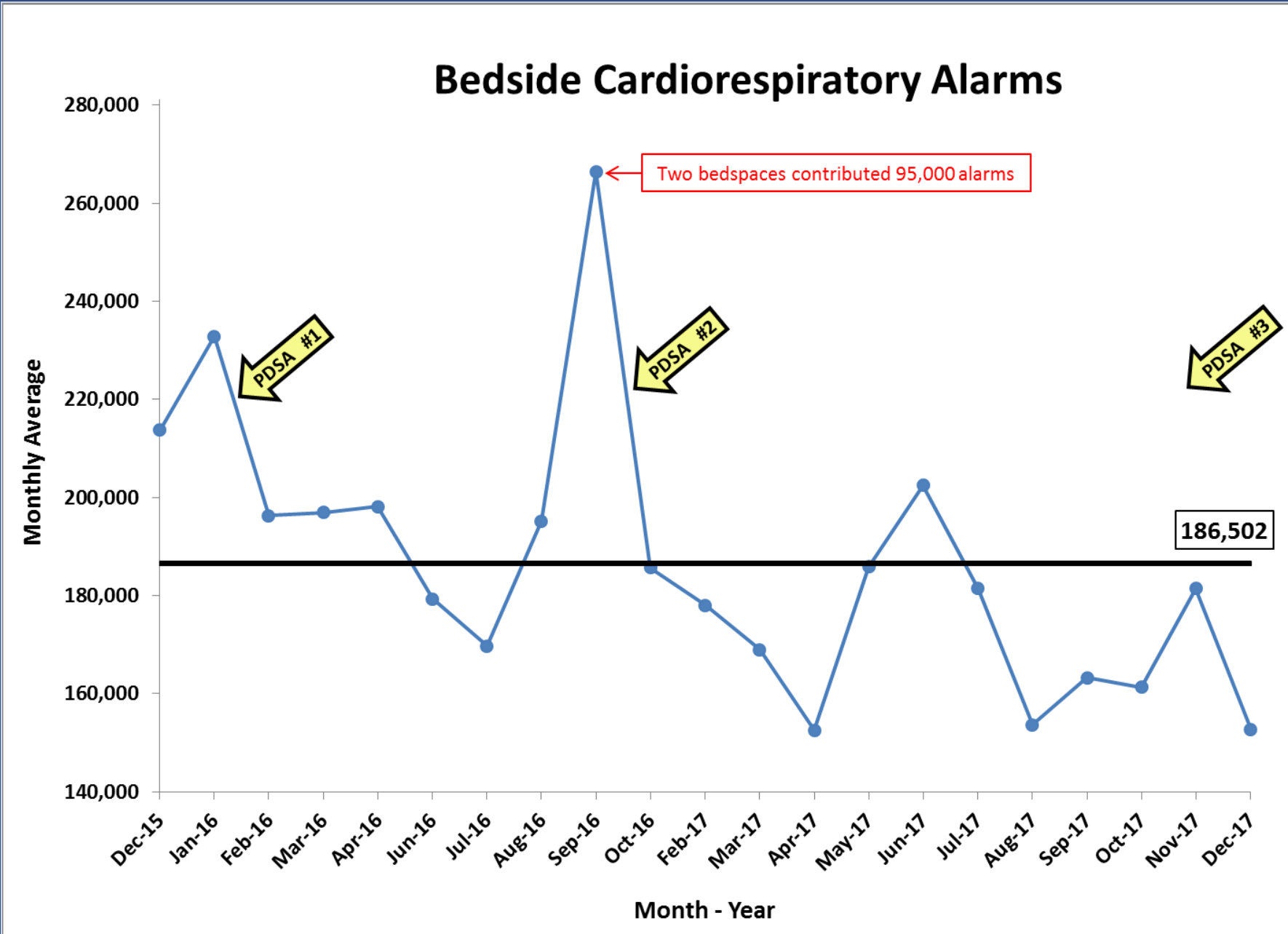
For more information, contact:

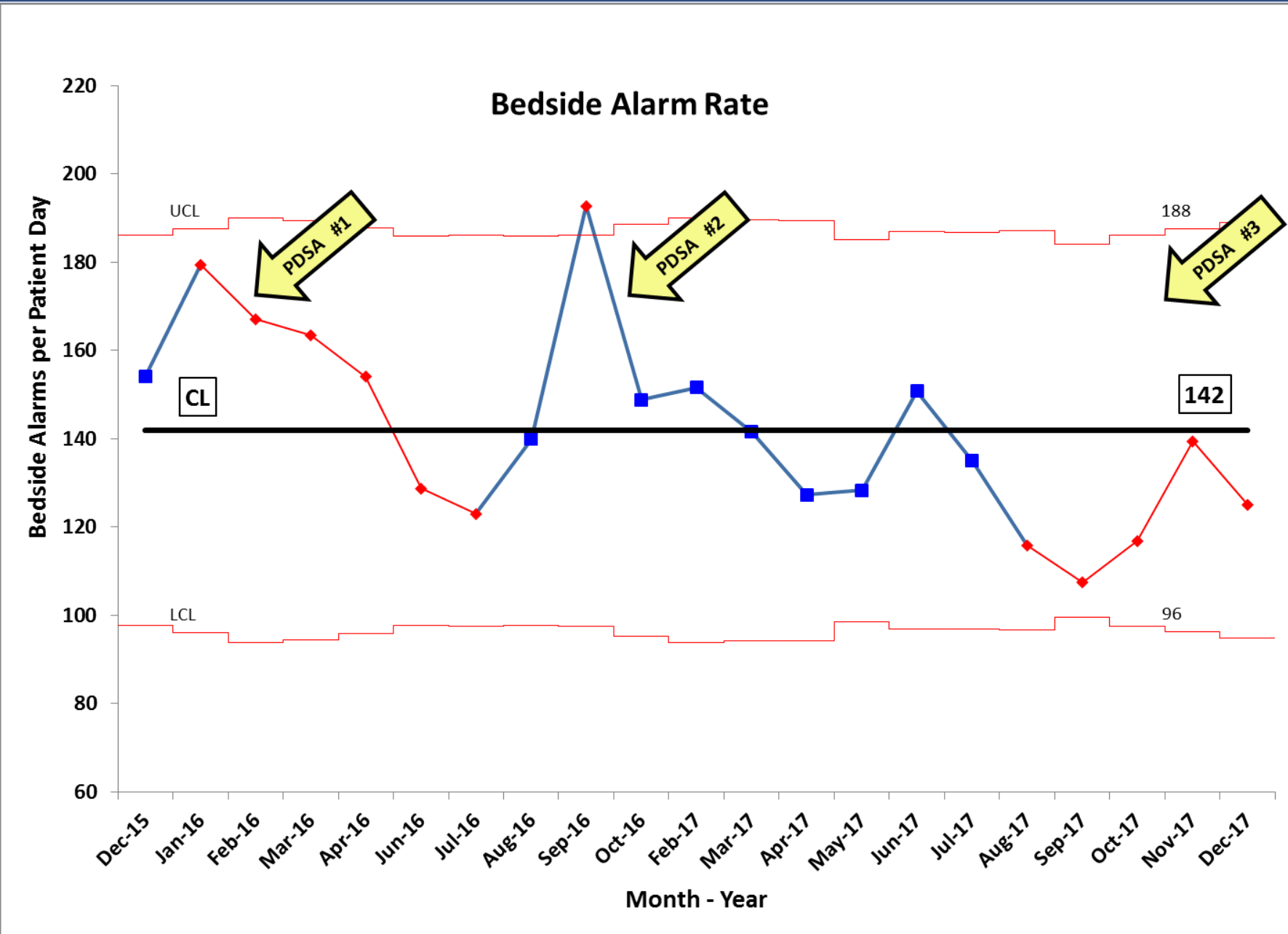**Wendy Timpson, MD, Associate Director, Quality Improvement: wtimpson@bidmc.harvard.edu**

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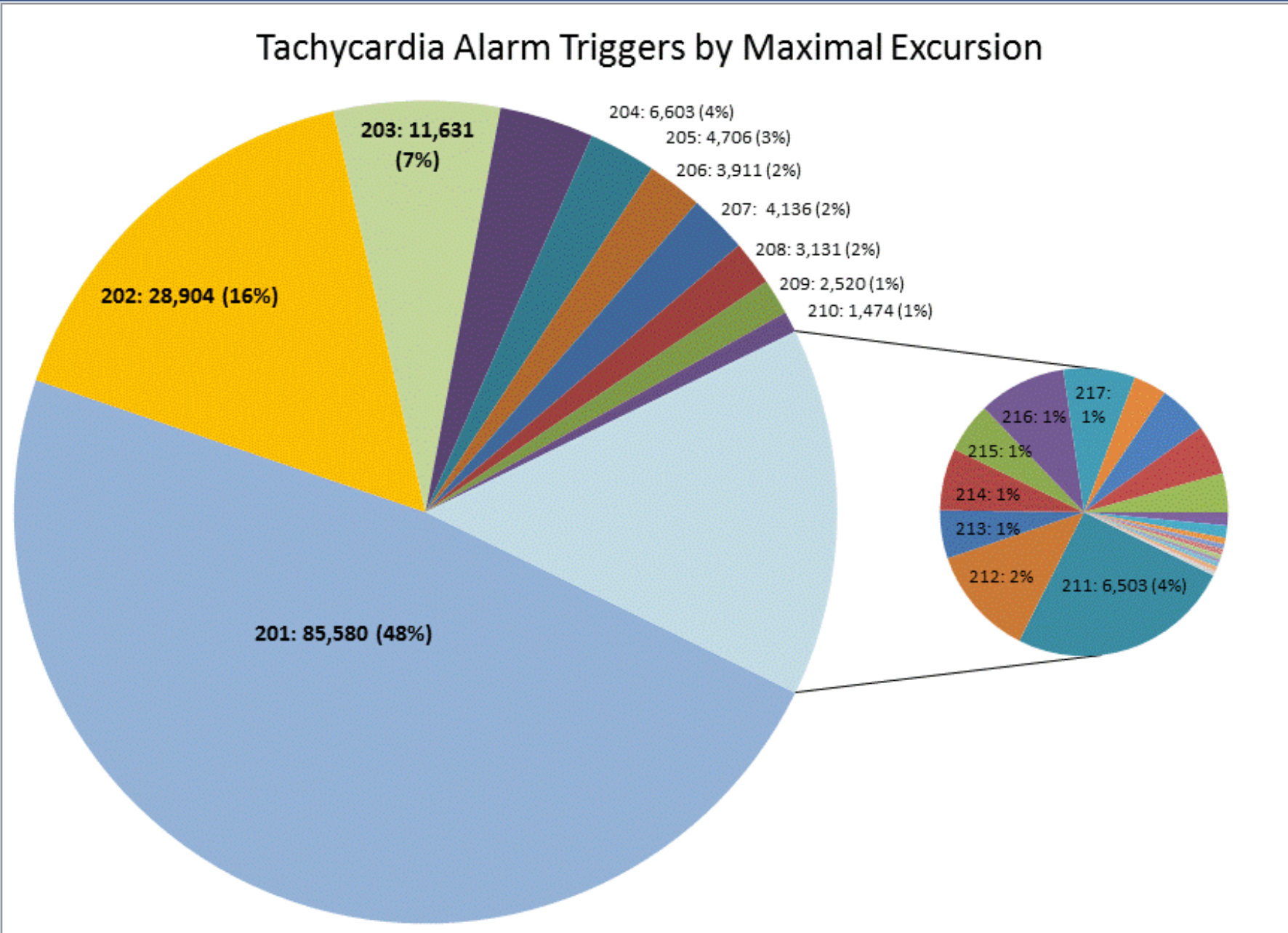1. BIDMC; 2. Harvard Medical School; 3. Institute for Medical Engineering and Science, MIT
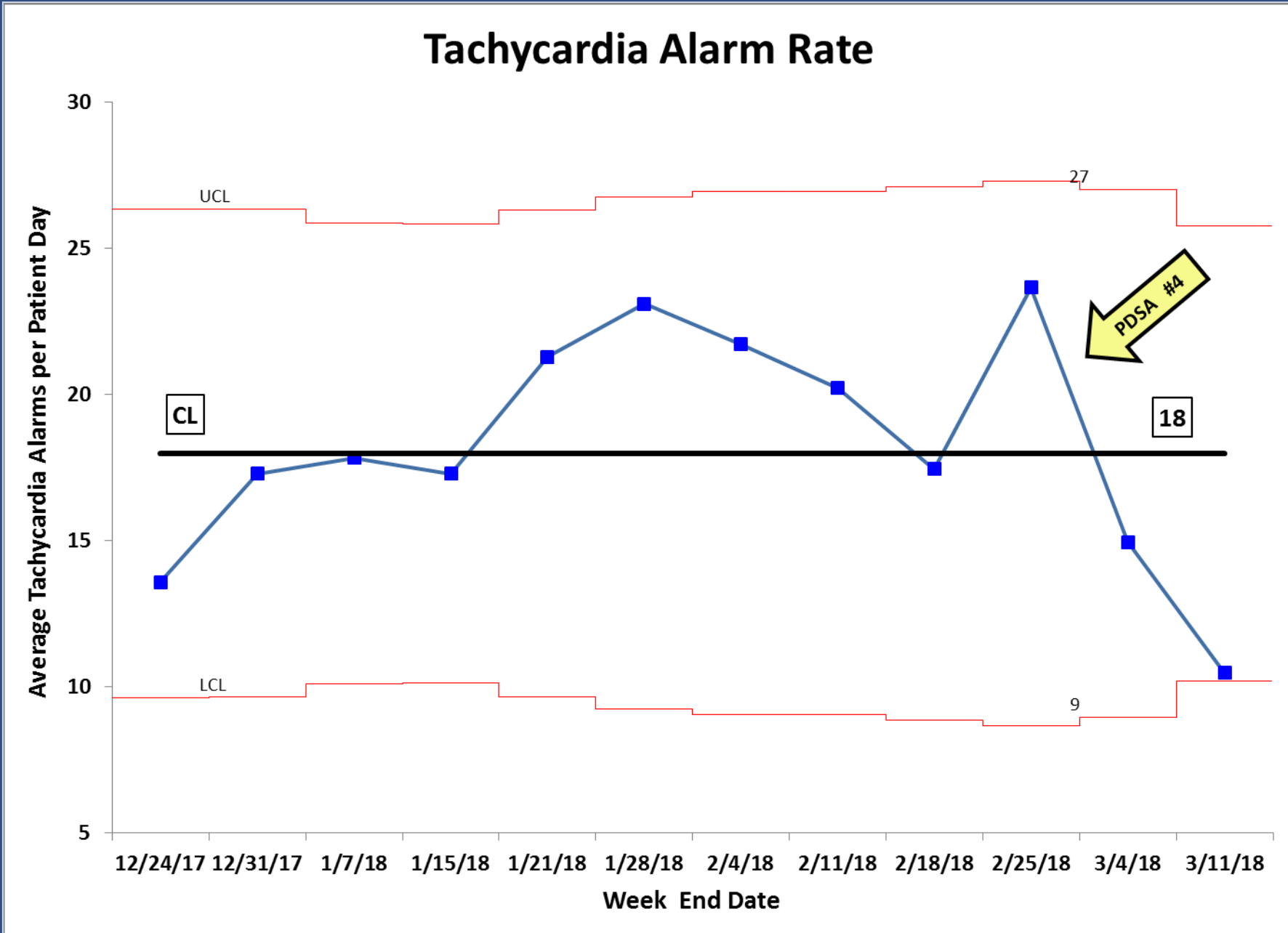
Progress to Date

Total Alarm Burden Run Chart
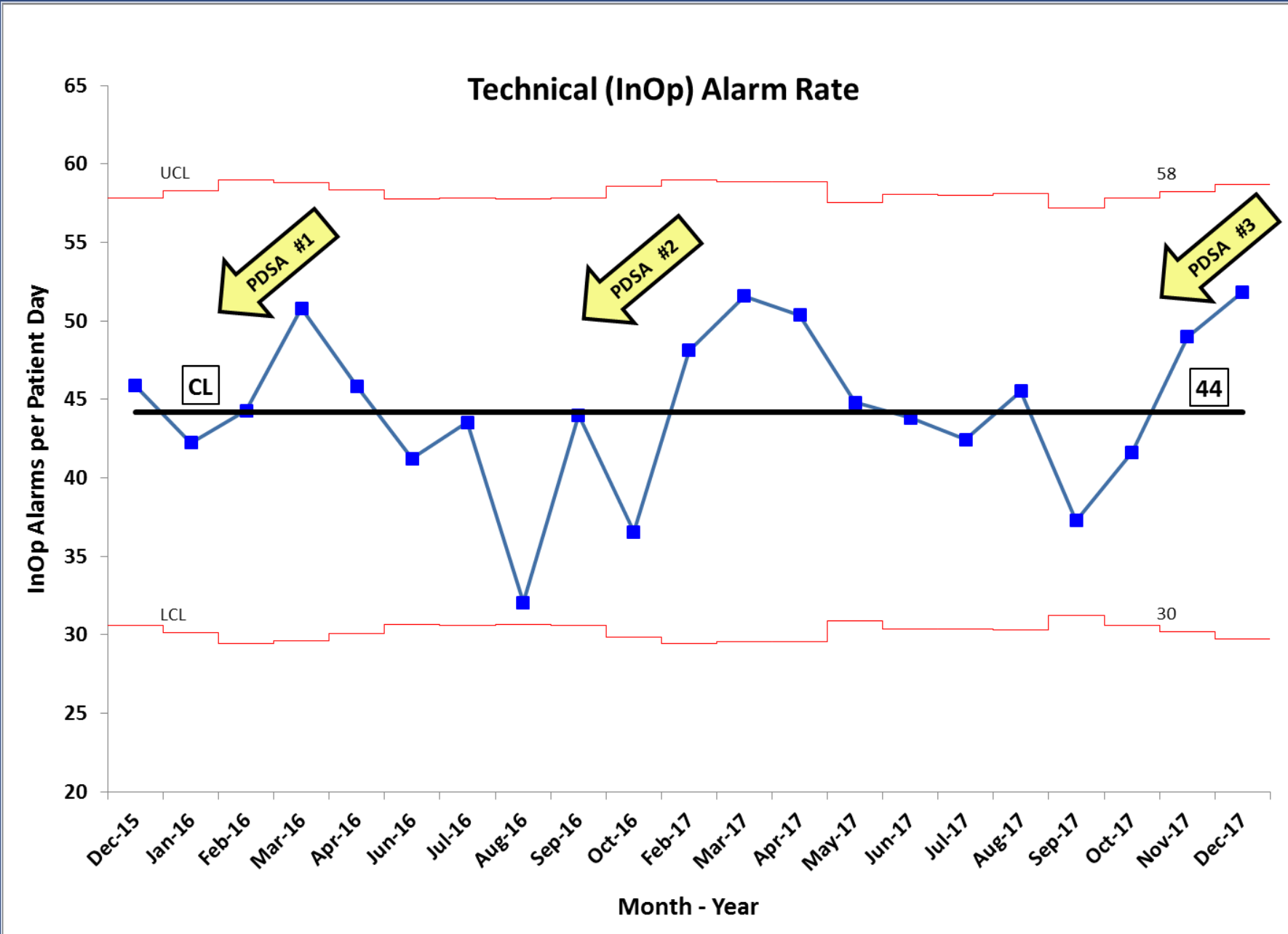
Total Alarm Rate U Prime Chart

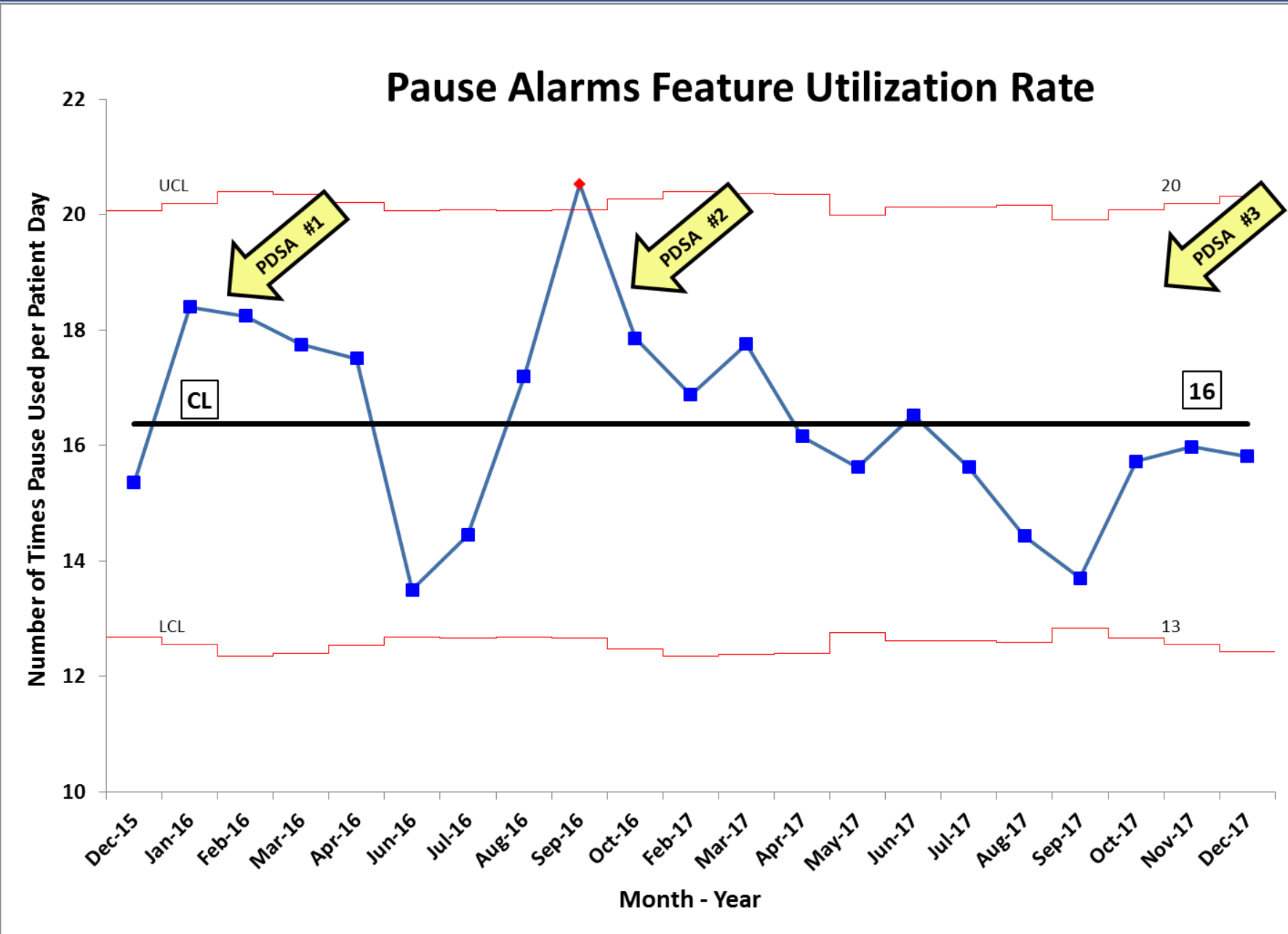**Advisory Tachycardia Alarms: 86% are <210**

Tachycardia Alarm Rate U Prime Chart

PDSA#1: Education; PDSA#2: Sounds of Silence Campaign; PDSA#3 Histogram Utilization

PDSA#4: Tachycardia Threshold Increase from 210 to 220 & Tachycardia Safety Checks

Technical Alarm Rate U Prime Chart

Pause Utilization Rate U Prime Chart

Lessons Learned

➤ Individual patient factors are major drivers of alarm rate; understanding these further is critical
➤ Preliminary results demonstrate a possible reduction in alarms following our first 2 PDSAs, though we did not observe a corresponding decrease in technical alarms or increase in pause utilization

Next Steps

➤ Utilize big data via DWC to track effects of recent changes on these and other measures
➤ Apply newly designed saturation metrics to DWC data to analyze effect of patient and unit variables
➤ Spread and standardize the use of saturation histograms to improve oxygen targeting
➤ Implement Staff and Family surveys to asses educational practices and qualitative burden of alarms
➤ Standardize approach to alarm documentation
➤ Measure and reduce audible burden with use of decibel meter and reduction of alarm volume

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