**Online-only supplement to:**

**Safety huddle intervention for reducing physiologic monitor alarms:**

**a hybrid effectiveness-implementation cluster randomized trial**

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**Contents:**

**Supplementary Table 1.** Default alarm settings.

**Supplementary Figure 1.** Alarm data dashboard form.

**Supplementary Figure 2.** Diagram of study periods. I indicates intervention, C indicates control.

**Supplementary Table 2.** Alarm types and acuity in the unit-level analysis.

**Supplementary Figure 3.** Unit-wide alarm rates over time in control and intervention units.

**Supplementary Table 1. Default alarm settings.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Infant**  **0-5 months** | **Infant**  **6-11 months** | **Child**  **12 months – 7 years** | **Adolescent/adult**  **8 years and up** |
| Heart rate high | 180 | 180 | 120 | 100 |
| Heart rate low | 100 | 80 | 60 | 55 |
| Respiratory rate high | 70 | 60 | 30 | 30 |
| Respiratory rate low | 20 | 20 | 15 | 12 |
| Oxygen saturation low (%) | 90 | 90 | 90 | 90 |
| Apnea time (sec) | 15 | 15 | 20 | 20 |
| SatSecondsa | 20 | 20 | 20 | 20 |
| a SatSeconds adds a time delay between when the oxygen saturation falls outside of the saturation alarm threshold and when the alarm occurs. It does this by calculating the duration of the event (as it is occurring) multiplied by the number of percentage points that the oxygen saturation has fallen outside of the saturation alarm threshold. | | | | |

## Alarm huddle guide

Unit: \_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_

* Let’s discuss \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in room \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* He/she has had \_\_\_\_\_\_\_\_\_\_\_\_ alarms in the past 4 hours.
* Most of the alarms were for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* (*To bedside nurse*): What seems to be causing the alarms? Are the alarms real, or are they due to movement? Or something else?
* (*To bedside nurse and physician*): How is your patient doing? Overall do they seem to be getting worse or improving?
* (*If getting worse*): Do they need a CAT or CODE call? [If they do- STOP and escalate care]
* (*If no concerns- to bedside nurse and physician*): What are our reasons for monitoring this patient? What do we want the monitor to help us with?
* (*To bedside nurse and physician*): Based on that, when do we want to monitor the patient: always, awake, asleep, when unsupervised, spot checks only?
* It looks like the current settings are:
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* (*To bedside nurse and physician*): Is this where we want the settings to be? What numbers would make us want to take action (for example, when would we start oxygen for low SpO2)?
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* One option, if there are lots of SpO2 alarms going off for very short periods of time, is to increase the SatSeconds delay time from 20 to 30 or 40.
* (To physician): OK, if we all agree to change (setting/monitoring level) to \_\_\_\_\_\_, could you enter that order and we will make the change on the monitor now?

Changes agreed upon in huddle (check all that apply):

|  |  |
| --- | --- |
|  | Patient sick- escalate care |
|  | No changes recommended |
|  | Discontinue continuous monitoring |
|  | Decrease monitoring intensity (asleep and/or unsupervised) |
|  | Widen SpO2 parameters |
|  | Widen HR parameters |
|  | Widen RR parameters |
|  | Increase SatSeconds delay |
|  | Change ECG leads |
|  | Change SpO2 probe |
|  | Other: |

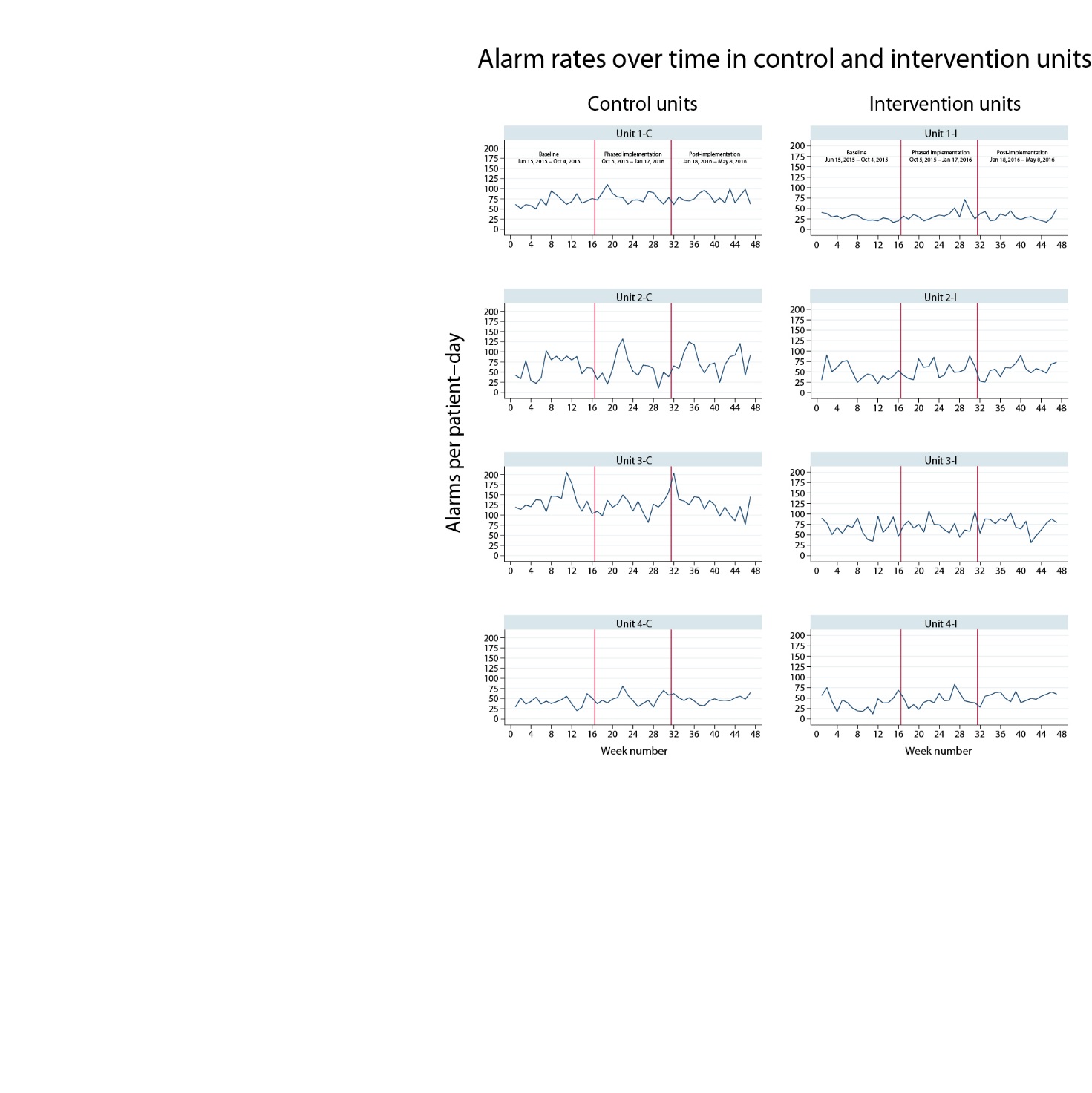
**Supplementary Figure 1. Alarm data dashboard form.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Intervention | Unit 1-I | Baseline  6/15/2015 – 10/4/2015  (16 weeks) | units paired and randomized | Phased implementation  10/5/2015 – 1/17/2016  (15 weeks) | Post-implementation  1/18/2016 – 5/8/2016  (16 weeks) |
| Unit 2-I |
| Unit 3-I |
| Unit 4-I |
| Control | Unit 1-C |  |  |  |
| Unit 2-C |
| Unit 3-C |
| Unit 4-C |

**Supplementary Figure 2. Diagram of study periods. I indicates intervention, C indicates control.**

**Supplementary Table 2. Alarm types and acuity in the unit-level analysis.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Label** | **Condition** | **Acuity level** | **n** | **%** |
| *Critical arrhythmias (0.1%)* | |  |  |  |
| ASYSTOLE | Asystole | Crisis | 3190 | 0.1% |
| V TACH | Run of 6+ beats of ventricular tachycardia | Crisis | 1335 | 0.0% |
| VFIBVTAC | Ventricular fibrillation | Crisis | 24 | 0.0% |
| VBRADY | Run of 3+ beats of PVCs with rate less than age-specific limit | Crisis | 180 | 0.0% |
|  |  |  |  |  |
| *Noncritical arrhythmias (5.4%)* | |  |  |  |
| VT>2 | 3-5 rapid ventricular contractions | Warning | 2766 | 0.1% |
| PVC | Premature ventricular contraction | Advisory | 99,124 | 3.5% |
| IRREGULAR | Irregular rhythm | Advisory | 36,305 | 1.3% |
| COUPLET | Couplet | Advisory | 9197 | 0.3% |
| BIGEMINY | Bigeminy | Advisory | 721 | 0.0% |
| TRIGEMINY | Trigeminy | Advisory | 344 | 0.0% |
| R ON T | Ventricular contraction near T-wave peak | Advisory | 2596 | 0.1% |
| PAUSE | R-R interval exceeds set duration | Advisory | 1487 | 0.1% |
| ACC VENT | Accessory ventricular rhythm | Advisory | 398 | 0.0% |
|  |  |  |  |  |
| *Pulse oximetry (28.7%)* | |  |  |  |
| SPO2 HI | High oxygen saturation | Warning | 798 | 0.0% |
| SPO2 LO | Low oxygen saturation | Warning | 811,904 | 28.6% |
|  |  |  |  |  |
| *Heart rate (18.4%)* | |  |  |  |
| TACHY | Tachycardia using ECG arrhythmia algorithm | Advisory | 122,537 | 4.3% |
| HR HI | Tachycardia using ECG rate algorithm | Warning | 157,840 | 5.6% |
| RATE HI | Tachycardia using SpO2 pulse rate algorithm | Warning | 107,823 | 3.8% |
| BRADY | Bradycardia using ECG arrhythmia algorithm | Advisory | 70,427 | 2.5% |
| HR LO | Bradycardia using ECG rate algorithm | Warning | 28,918 | 1.0% |
| RATE LO | Bradycardia using SpO2 pulse rate algorithm | Warning | 34,805 | 1.2% |
|  |  |  |  |  |
| *Respiratory rate (7.6%)* | |  |  |  |
| RSP HI | Respiratory rate high | Warning | 152,275 | 5.4% |
| RSP LO | Respiratory rate low | Warning | 57,542 | 2.0% |
| APNEA | No breath detected in 15 sec (infant) or 20 sec (child/adult) | Warning | 4669 | 0.2% |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| **Supplementary Table 2. Alarm types and acuity in the unit-level analysis.**  Continued | | | | |
|  |  |  |  |  |
| *Blood pressure (3.7%)* | |  |  |  |
| NBP S HI | Systolic blood pressure high | Advisory | 32,970 | 1.2% |
| NBP M HI | Mean blood pressure high | Advisory | 21,139 | 0.7% |
| NBP D HI | Diastolic blood pressure high | Advisory | 45,292 | 1.6% |
| NBP S LO | Systolic blood pressure low | Advisory | 641 | 0.0% |
| NBP M LO | Mean blood pressure low | Advisory | 222 | 0.0% |
| NBP D LO | Diastolic blood pressure low | Advisory | 3771 | 0.1% |
|  |  |  |  |  |
| *S-T segment (0.1%)* | |  |  |  |
| ST-I HI | S-T segment elevation in lead I | Advisory | 1865 | 0.1% |
| ST-V1 HI | S-T segment elevation in lead V1 | Advisory | 9 | 0.0% |
| ST-AVR LO | S-T segment depression in lead aVR | Advisory | 2 | 0.0% |
|  |  |  |  |  |
| *Temperature (0.0%)* | |  |  |  |
| T1 LO | Temperature probe 1 low | Warning | 22 | 0.0% |
|  |  |  |  |  |
| *Technical alarms (36.0%)* | |  |  |  |
| ARRHY SUSPEND | Arrhythmia processing is suspended | Message | 94,272 | 3.3% |
| ARTIFACT | Artifact is detected in electrocardiographic leads | Message | 12,836 | 0.5% |
| BATTERY ERROR | Problem with battery detected | Message | 698 | 0.0% |
| BATTERY LOW | Low battery | Message | 720 | 0.0% |
| LEADS FAIL | Electrocardiographic lead failure | Message | 95,636 | 3.4% |
| NBP FAIL | Noninvasive blood pressure failure | Message | 79 | 0.0% |
| NBP MAX TIME | Maximum time to measure noninvasive blood pressure exceeded | Message | 1956 | 0.1% |
| NBP OVER PRES | Noninvasive blood pressure cuff pressure exceeded | Message | 413 | 0.0% |
| POWERING DOWN | Monitor powering down | Message | 82 | 0.0% |
| PULSE SEARCH | Pulse oximetry probe searching for pulse | Message | 525,046 | 18.5% |
| RR LEADS FAIL | Respiratory rate lead failure | Message | 22,439 | 0.8% |
| SPO2 PROBE | Oxygen saturation probe is off the patient | Message | 260,895 | 9.2% |
| SPO2 SENSOR | Oxygen saturation sensor is disconnected | Message | 6514 | 0.2% |
| **Total** |  |  | **2,834,724** |  |



**Supplementary Figure 3.** Unit-wide alarm rates over time in control and intervention units. I indicates intervention, C indicates control.