RESEARCH ARTICLE

Designing behavioral interventions using the capability-opportunity-motivation-behavior model and the theoretical domains framework to optimize oxygen saturation maintenance by NICU providers

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Objective: Despite evidence-based guidelines, SpO2 maintenance-related practices of care providers remain inconsistent. Our aim was to evaluate the impact of interprofessional learning workshops, bedside coaching, and neonatal intensive care unit (NICU) level enablers on targeted behavioral change of NICU staff, focusing on SpO2 maintenance.

Methods: NICU is a specialized area of the hospital with sophisticated monitors where multidisciplinary staff provide round-the-clock care for sick and preterm infants. As a subset of a quality improvement project to improve SpO2 maintenance and reduce desaturation events, three targeted evidence-based staff behaviors were deemed as important based on established capability-opportunity-motivation-behavior and theoretical domains framework models: setting SpO2 alarm limits, using SpO2 alarm management algorithms, and reporting daily summaries of SpO2 during rounds. We conducted interprofessional workshops, provided bedside coaching, and altered unit NICU processes (guidelines, automated SpO2 histogram printouts, defined staff standard work) and measured demonstrable changes in staff reaction, learning, and behaviors by direct observation of behaviors and survey questionnaires.

Results: Two hundred and seventy-five (87%) and 210 (80%) of NICU staff attended workshops and received bedside coaching, respectively. The proportion of staff expressing satisfaction with workshop and bedside coaching was 85% and 82%, respectively. The proportion of staff reporting improvement in their knowledge and confidence related to SpO2 maintenance increased significantly following the workshop. Targeted behaviors related to SpO2 maintenance like setting appropriate alarm limits, adhering to SpO2 management algorithm, and reporting daily SpO2 summaries during rounds increased from 80% to 96%, 0% to 64%, and 20% to 70%, respectively.

Conclusion: Focused behavioral change interventions aimed at improving staff capability, opportunity, and motivation in a demonstrable change in targeted staff behaviors related to SpO2 maintenance. Further research is needed to establish ways of optimizing intended staff behaviors while implementing care bundles in a given setting.

Key Words: behavioral change; neonatal intensive care; providers; oxygen saturation; quality improvement

INTRODUCTION

Prolonged periods of time spent above and below target oxygen saturation (SpO2) range and frequency of desaturation events are associated with severe retinopathy of prematurity, bronchopulmonary dysplasia, mortality, and neurodevelopmental impairment [1–7]. Multiple factors like immature breathing control, severity of lung or other organ disease, and variation in responding to SpO2 alarms contribute to difficulty in achieving predefined SpO2 target range and reducing frequency of desaturation [8–11]. Recently, evidence on optimal SpO2 targeting, use of technology to monitor adequacy of oxygen control, and standardizing point-of-care staff response to SpO2 alarms offers opportunities for improvement [12, 13]. Changing healthcare providers’ clinical behaviors, i.e., “individual human activity that involves coordinated contraction of striated muscles controlled by the brain” [14] is crucial. They are the first to respond to SpO2 alarms, decide on corrective steps in real-time, and plan interventions to address the underlying cause of alarms. For any behavior to occur, three factors must be present—capability, opportunity, and motivation—according to the capability-opportunity-motivation-behavior (COM-B) model of behavior. COM-B model and theoretical domains framework (TDF) have been used in characterizing and designing behavioral change interventions to implement evidence into practice [14, 15].

Problem description

At our tertiary perinatal Centre's neonatal intensive care unit (NICU), a clinical audit on infants younger than 32 weeks and a survey of interprofessional care providers (staff) that included physicians, nurses, respiratory therapists (35 patient days, 35 survey responders) showed two significant problems: infants receiving supplemental oxygen spent a mean of 46% of a 24-h period within the unit target SpO2 range, and

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there were 43 desaturation events of <80% per patient per day. The contributory factors were determined using a cause-and-effect diagram. Pareto charting included incorrect alarm limit setting (20% of occasions); inconsistent use of daily summaries of adequacy of SpO\textsubscript{2} maintenance and frequency of desaturation, i.e., SpO\textsubscript{2} histogram and event review (20% patient days) \[14–17\]; wide alarm limits and lack of guidelines on SpO\textsubscript{2} targets; and how to respond consistently to high, low, and multiple high and low SpO\textsubscript{2} alarms. These contributory factors were consistent with the existing literature \[16, 17\].

Behavioral change interventions, including education, training, and enablement in a team-based primary care and hospital setting, have been effective in changing care providers' practice \[14, 18, 19\]. Recognizing the importance of staff behavioral change in implementing evidence-based practices on SpO\textsubscript{2} maintenance, the NICU leadership team commissioned a subset of the care bundle to improve oxygen maintenance and reduce desaturation events quality improvement (CBIOME-QI) team. This team’s function was to identify \(i\) the behavioral changes needed by care providers to implement evidence-based practices and \(ii\) interventions that facilitate adoption of those behaviors by care providers. The aim of the present study is to evaluate the impact of behavioral change interventions such as interprofessional learning (IPL) workshops, bedside coaching, and refinement in unit-level processes on behavioral changes of NICU staff related to SpO\textsubscript{2} maintenance.

**METHODS**

We conducted this project in a 47-bed Level 3 NICU that has 200 preterm (<32 weeks) annual admissions that include both inborn and outborn infants, including those with surgical conditions.

Baseline process of SpO\textsubscript{2} maintenance and event management

Before the initiation of the QI project, our unit alarm targets for SpO\textsubscript{2} since 2006 were 84%–93% and 84%–100% for infants without and with oxygen supplementation, respectively, based on prevalent evidence \[20\]. Reporting daily SpO\textsubscript{2} histogram event review reports during bedside rounds, tracking SpO\textsubscript{2} histograms, and reviewing and reporting events and daily changes and incorporating them in deciding escalation or de-escalation of care practices were not part of the daily workflow.

**QI project**

The broader CBIOME QI team aims were to improve SpO\textsubscript{2} maintenance within the target range and reduce the frequency of desaturation per patient per day at the level of the unit over 18 months, with an overarching goal of reducing morbidity in preterm infants. They provided the new guideline specifying evidence-based SpO\textsubscript{2} target and alarm limits \[3, 9\], SpO\textsubscript{2} alarm management algorithms \[12\], reporting of SpO\textsubscript{2} histogram and event reviews during rounds, and a standard tool to track infant wellness based on daily SpO\textsubscript{2} histogram and event reviews (consensus based locally developed tool). Our QI sub team had two physicians, a nurse practitioner,

| OVERARCHING AIM of program | Evidence-based target behaviors\(b\) by point of care staff related to SpO\textsubscript{2} maintenance | PRIMARY DRIVERS | SECONDARY DRIVERS | Delivery of behavioral change interventions |
|---------------------------|---------------------------------------------------------------|------------------|-------------------|--------------------------------------------|
| In <32 week infants       | 1. \% time spent within target SpO\textsubscript{2} range per patient/day by 10% | CAPABILITY        | Knowledge, Skills, Habits | Conduct workshop                           |
|                           | 2. Desaturation events frequency by 5 events/patient/day over 18 months | MOTIVATION        | Beliefs about capabilities & consequences, professional role, Goals, intentions, reinforcing behaviors | Communicate changes effectively |
|                           | 3. Report daily summaries of SpO\textsubscript{2} maintenance, desaturation events & infant wellness changes during rounds (RT, MD) | OPPORTUNITY       | Environmental context/ resources, social influences | Provide bedside coaching\(b\) |

**Kirkpatrick four level evaluation model**

Reaction: Staff reaction to training (e.g., liking, acceptability) Learning: Was training effective in providing immediate benefits to staff? (e.g., changes in knowledge, skills, abilities) Behavior: Efficiency of training e.g., Perceptions of behavioral change, Demonstrable changes in providers practice Results*: Impact of behavioral change (e.g., Changes in quality of care and benefits to patients)

**Measures**

Pre workshop perceived Knowledge, Skills and abilities assessment Post workshop perceived satisfaction with workshop methods, & change in Knowledge, Skills and Abilities Post in-servicing and coaching satisfaction (Use questionnaire) Post implementation, perceived behavioral change & demonstrable changes in staff practices

![FIGURE 1](image_url)

**Key driver diagram for changing staff behaviors and the evaluation model.**

\[1 = \text{Behaviour is the activity/ies that occur when individuals interact with their surroundings: other individuals, things, systems, etc.;}\]
\[2 = \text{Support staff in making desired behavioral change by helping them (i) understand the reasons for change, (ii) identify challenges and blind spots preventing change, (iii) decide on adopting change and practice new behavior;}\]
\[3 = \text{Steps to ensure guidelines, tools and SpO\textsubscript{2} daily summary printouts are readily accessible and their use is integrated into NICU daily routine;}\]
\[4 = \text{Out of scope of this study.}\]

\(\text{SpO\textsubscript{2}} = \text{Saturation of Oxygen, RN = Registered nurse, RT = Registered Respiratory Therapist, MD = Medical Doctor.}\)
a nurse educator, a respiratory therapist (RT) educator, an RT practice leader, a unit manager, and the project coordinator. Initially, we identified three target behaviors for implementing evidence-based practices for optimizing SpO₂ maintenance: setting SpO₂ alarm limit, using SpO₂ management algorithms, and reporting daily SpO₂ histogram and event review reports during rounds (Supplementary Table 1). Later we used process-mapping, force-field analysis, and COM-B [14, 15, 19] and TDF [19] to identify the specific choice of behavioral change techniques and interventions to be implemented to ensure staff showed desired behaviors in their daily practice. We adopted the four steps for developing a theory-informed implementation intervention: Step 1: Who needs to do what, differently? Step 2: Which barriers and enablers need to be addressed? Step 3: Which behavior change techniques and mode(s) of delivery could overcome modifiable barriers and enhance enablers? Step 4: How can behavior change be measured and understood? [15] (Supplementary Table 2). The change interventions included IPL workshops, bedside coaching, and unit level supportive actions (Figure 1). Specifically, the above interventions aimed at improving providers’ knowledge, skills, intentions, decision-making, and execution. Since broad user adoption is critical in ensuring consistent processes and sustained improvement, the QI sub team aimed for 80% of staff to show the targeted behaviors in their daily practice.

Behavioral change interventions

IPL workshops were 4 h, with a maximum of 18 participants per session, comprising didactic and interactive components including case simulations, a quiz, debriefing with individuals, and small group task-based problem solving. QI-sub team members provided the guidelines and management algorithms to participants as pocket cards at the beginning of the workshop and encouraged their use while carrying out decision-making and performance tasks during the workshop to facilitate new skill acquisition and its use in a simulated environment. Translating daily SpO₂ histogram and event review report data to assign infant wellness into stable, watcher, and unstable categories using a threshold was an essential part of the workshop.

Bedside coaching

Bedside coaching to staff was provided by a QI sub-team member experienced as a project coordinator in Canadian Oxygen Trial study [21] and comprised 10–15-min interactions at the bedside during the day shifts and focused mainly on consolidation of skills learnt during the workshop. The coach also focused on supporting staff in making the desired behavioral change by helping them understand the reasons for change, identify individual challenges and barriers preventing change, and help staff decide on adopting the change and practice new behavior consistently (Supplementary Table 2).

**TABLE 1**

Details of workshop and bedside coaching events and participants

| Professional          | Number (%) of workshop participants, n = 234 | Number (%) bedside coaching participants, n = 168 |
|-----------------------|---------------------------------------------|--------------------------------------------------|
| Nurses                | 155 (66)                                    | 124 (74)                                         |
| Respiratory therapist | 21 (9)                                      | 14 (8)                                           |
| Physicians            | 32 (14)                                     | 17 (10)                                          |
| Nurse practitioners   | 10 (4)                                      | 9 (5)                                            |
| Allied staff          | 5 (2)                                       | 4 (2)                                            |
| Students              | 11 (5)                                      |                                                  |

*87% of scheduled staff (n = 275), No. of workshops 13, Average no. of participants/session = 14.
*80% of scheduled day staff (n = 210), 60% of them had two or more coaching encounters.
*Medical, nursing, and respiratory therapy students.

Refine unit processes to support change

This included communication of practice changes in e-mail, newsletters, posters, and placing laminated SpO₂ management algorithms in every patient chart. We made unit guidelines available on our intranet. Interprofessional stakeholder physician, nursing, RT, and operational leader representatives were engaged in defining staff roles and integrating new practices into their daily workflow as standard work. To facilitate SpO₂ histogram and event review reports use by staff, the printing of daily reports from bedside monitors was automated, and the project coordinator placed the reports at the bedside before rounds. We implemented these interventions systematically using Plan-Do-Study-Act (PDSA) cycles.

Evaluation

We used the Kirkpatrick model to evaluate the impact of our behavioral change interventions [22]. Of the four levels of evaluation, we focused on the first three levels: providers’ reaction, learning, and behavior (applying their training into practice). The primary outcomes were the change in perceived and observed targeted behaviors (Kirkpatrick model level 3); % compliance with (i) setting alarm limits at the beginning of the day, (ii) using algorithms to manage SpO₂ alarm events, and (iii) reporting SpO₂ histogram reports during rounds. The project coordinator assessed alarm limit setting on monitors once every day. The bedside coach assessed staff compliance with algorithms by indirectly observing staff response of silencing the alarms for 3 min and carrying out trouble shooting maneuvers using the 5 Ps (positioning, prongs, patency of airway, probe, and physical assessment) to a desaturation event alarm without bradycardia. Further, the coach assessed compliance with SpO₂ histogram reporting by staff by observing rounds or indirectly by reviewing the patient chart for staff documentation. The secondary outcomes were perceived behavioral change by staff, staff reaction and learning from IPL workshops and bedside coaching (Kirkpatrick model level 1 and 2), and usability of the SpO₂ alarm management algorithm and infant wellness assessment tool. We assessed outcomes using validated questionnaires without respondent identifiers [23] on a 7-point Likert scale [24]. We compared pre- and post-intervention ordinal scores data using Mann-Whitney U test and proportions using χ² test and considered P < 0.05 as statistically significant. The hospital research ethics board performed a partial review, exempted us from taking individual patient consent, and approved this quality improvement project.

**RESULTS**

Rollout and evaluation

Training workshops occurred between September and November 2014 (twice a week for half a day), in anticipation of going live with CBIOME-related guidelines and workflow redesign in the unit between December 2014 and February 2015. Bedside coaching occurred between February and June 2015. Participants’ evaluation occurred pre- and post-IPL workshop.
TABLE 3
Participants’ reaction to the training workshop

| Statements                                                                 | Number (%) of respondents who rated 5 or more level of agreement with statements on a 7-point Likert scale* |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Effectiveness of workshop                                                |                                                                                                             |
| • Overall                                                                 | 200 (85.5)                                                                                                  |
| • Large group discussion                                                  | 183 (78.2)                                                                                                  |
| • Case scenarios                                                          | 191 (81.6)                                                                                                  |
| • Case simulations (individual and team-based)                            | 193 (82.5)                                                                                                  |
| • Debriefing                                                              | 176 (75.2)                                                                                                  |
| Perceived improvement in**                                                 |                                                                                                             |
| • Knowledge                                                               | 196 (83.8)                                                                                                  |
| • Technical skills                                                        | 168 (71.8)                                                                                                  |
| • Communication skills                                                    | 205 (87.6)                                                                                                  |
| • Collaborative skills                                                    | 198 (84.6)                                                                                                  |
| • Critical thinking                                                       | 183 (78.2)                                                                                                  |
| • Confidence                                                              | 171 (73.1)                                                                                                  |

*Likert scale: 1 = Strongly Disagree, 7 = Strongly Agree.
**Knowledge and skills pertaining to oxygen saturation maintenance and reducing frequency of desaturation events, survey tool provided as Supplementary Table 3.

FIGURE 2
Participants perceived immediate benefits of training workshop; change in knowledge and self-confidence.

Pre-workshop (n = 71) and post-workshop respondents (n = 44), online through survey monkey. Survey questionnaire provided as Supplementary Table 4.

Primary outcomes
The project coordinator made 480 and 510 patient-day observations in December 2014 and July 2015, respectively, to assess staff compliance with alarm limit setting, and 80 observations of both daily SpO2 histogram reporting during rounds and any use of an algorithm for SpO2 alarms (December 2014). The bedside coach made 90 observations of bedside staff’s response to SpO2 alarms (May and June 2015), 714 observations of daily SpO2 reporting with or without frequency of desaturation events or infant wellness assessment, and 90 observations of bedside staff’s response to SpO2 alarms in May and June 2015. When compared with baseline, alarm limit setting on monitors, use of SpO2 management algorithms, and reporting of daily SpO2 maintenance during rounds increased significantly (Table 2). Seventeen out of twenty-five (68%) charge nurses and experienced nurses looking after unstable and critical infants in NICU reported 5 or more level of agreement on staff adherence to SpO2 management algorithms on a 7-point Likert frequency scale (1 = never to 7 = always).

Secondary outcomes
Eighty-seven percent of participants (n = 203) responded to the post-IPL workshop survey (September–December 2014). Of them, 85.5% rated 5 or more level of agreement on a 7-point Likert scale on overall effectiveness of IPL workshop. Similarly, 71%–85% of respondents reported 5 or more level of agreement on a 7-point Likert scale on the delivery method and perceived improvement in various skills (Table 3, Supplementary Table 3). There was a statistically significant change in staff perceived knowledge acquisition and self-confidence pertaining to SpO2 maintenance following IPL workshop (Figure 2, Supplementary Table 4). Of the 63 staff members (51% of scheduled staff during evaluation period), 82%, 75%, and 87% expressed satisfaction with bedside coaching, SpO2 alarm management algorithms, and infant wellness assessment tool, respectively (Table 4, Supplementary Table 4).

Staff provided suggestions to improve the integration of daily summaries into daily practice as comments on surveys. These included transitioning from a manual assessment of infant wellness to an automated assessment system, avoiding overreliance on daily SpO2 maintenance and frequency of desaturation events in decision making, and validating decision-making tools for better uptake and spread. We list other comments from participants in Table 5.

DISCUSSION
This is the first study to use the COM-B [14] and TDF models [19] to identify and design behavioral change interventions among interprofessional care providers in a NICU setting, supported by a robust evaluation based on Kirkpatrick four-level evaluation model [22]. Implementing behavioral change interventions systematically using the PDSA cycle resulted in significant improvement in targeted NICU staff behaviors related to SpO2 maintenance in this study. We believe that the observed gains are secondary to change interventions as the change in staff behaviors coincided with intervention implementation (IPL workshop, bedside coaching, unit process changes) and implementation fidelity (relevant content, broad coverage, multiple delivery methods, and high rate of staff participation and responsiveness) [25].

Maintenance of SpO2 among preterm infants’ in NICU is challenging and determined by two modifiable factors: variation (non-standardization) in unit guidelines and clinicians’ practices at the bedside. Reasons for variation in clinicians’ practice include inadequate knowledge on oxygen titration, need for troubleshooting SpO2 alarms on a minute-to-minute basis and the need to address the underlying reasons, and staffing level and workload. The point-of-care staff’s clinical decision-making to troubleshoot SpO2 alarms is challenging because of individual (knowledge, experience, attitudes, beliefs, and intuitions) and contextual factors (availability of evidence-based guidelines, complexity and dynamic nature of patient illness, changing technology, declining resources, stressful environment with competing demands for time). We considered the above factors while using the COM-B model and TDF framework while designing and
implementing behavior change interventions [14, 19]. According to the COM-B model, a specific behavior will occur and a person is motivated to perform a behavior, has capability for the behavior, and engages in a behavior. The greater the capability and opportunity, the more likely a behavior will occur. Further, motivation to perform the behavior is accentuated when an individual becomes more capable or has more belief in one’s capability, and the physical or social environment is conducive to the behavior. Finally, practicing creates a positive feedback cycle, improving capability that will increase motivation to engage in a behavior [14, 26]. We used TDF to specify the intended target behavior [18, 19] (Supplementary Tables 1 and 2). Adult ICUs have used the COM-B model in determining or designing change interventions in the areas of hand hygiene [27], acute stroke [28], or early mobility programs [29]. However, NICUs have not reported using this model to implement care bundles. Researchers believe that such an approach helps in overcoming interprofessional providers’ pessimistic attitudes and beliefs, limiting the implementation and sustainability of change interventions [29, 30]. We believe other ICUs could adopt our approach to achieve staff compliance with desired practice changes, despite contextual limitations.

In this study, staff received the interprofessional workshops and bedside coaching, and reported a significant change in knowledge acquisition and staff confidence. We believe a combination of adult learning principles (experiential, mentorship, orientation, motivation, shifting from preconceived notions), scenarios designed to mimic real-world practice challenges, and active engagement of participants made the IPL workshop sessions effective, as described by others [31, 32]. Bedside coaching to support providers’ practices is cost-effective and successful in improving providers’ adherence to guidelines, prescribing practices, and delivery of newer models of care in primary and secondary care setting [33–37]. Some of the notable key attributes of coaches that improve individual and team capacity, effectiveness, and efficiency in adopting practices are building trusting relationships, managing conflict, fostering collaboration, bringing content expertise, having legitimacy with staff, and having unit level knowledge. Presence of a coach with many of the above attributes may have contributed to high overall satisfaction with coaching in this study. Previous studies have reported benefits of IPL among NICU providers attending ventilation [38] and resuscitation workshops [39]. However, none of those studies had bedside coaching as an intervention and evaluated the impact of training on providers showing desired behaviors in their daily practice [22]. We are planning to use COM-B and TDF principles to identify intended target behavior among physicians in determining the possible underlying cause of frequent desaturation events among preterm infants in a future study. Since changing a large proportion of providers’ behavior plays a key role in adoption of best practices, the COM-B and TDF-based intentional approaches could be used in any other centre or setting.

**Limitations**
First, we reported the desired behaviors before and after change interventions and not at multiple time points during the entire study as a run chart or control chart. Run charts by focusing on time-ordered data allow better visibility of process performance, determining whether changes resulted in improvement and whether gains made were sustained. Second, low response rate to bedside coaching evaluation may induce non-response bias and may not accurately reflect providers’ perceptions [40]. Third, the tool used to track daily infant wellness was not validated, but it was developed locally to ensure standard communication between providers. Fourth, bedside coaches evaluated the use of SpO2 management algorithms during days and response from staff predominantly working during night shifts may not have been gathered. Fifth, we could not evaluate the impact of concurrent physical or cognitive workload on their decision-making process. Finally, we could not measure long-term knowledge retention, adherence to targeted behaviors, or patient outcomes, as they were beyond the scope of the study.

**CONCLUSION**
Focused behavioral change interventions aimed at improving staff capability, opportunity, and motivation resulted in a demonstrable change in targeted staff behaviors related to SpO2 maintenance. We need further research to establish ways of optimizing intended staff behaviors while implementing care bundles in a given setting.

**DISCLOSURES**

**Contributors**
KM and SS contributed to the conception, the acquisition, analysis, and interpretation of data, and creating an initial version of the manuscript. All authors were involved in commenting on the paper and have approved the final version.

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Table 5
Participant comments on interventions and policies

| What they liked                                                                 |   |
|---------------------------------------------------------------------------------|---|
| • Standardization of response to SpO₂ alarms using management algorithms       |   |
| • Standardizing trouble shooting of desaturation events with initial five steps |   |
| • Standardizing infant wellness assessment and team communication using ROSE tool |   |
| • bedside coaching on how to perform tasks, adapt to change, helping them connect |   |
| their point of care work with an infant’s stability                            |   |
| • Visually appealing and simple learning materials (ROSE tool and SpO₂ alarm management) |   |
| • Improved documentation and ability to trend infant wellness over time       |   |
| • Making staff feel important, connected, and useful                          |   |
| • Interprofessional, hands on simulation based immersive and interactive learning |   |
| • Making print outs available at bedside                                      |   |
| • Ability to convey infant wellness at shift handovers                        |   |
| • Activities prompting interprofessional understanding, decision making and problem solving, closely mimicking real-life scenarios. |   |

Suggestions to improve the workshop or coaching/in-servicing

|   |   |
|• Avoid staff moving to two different workshop venues after mid-break         |   |

Suggestions to improve the integration

|   |   |
|• Move from manual infant wellness assessment and documentation to automated electronic process to reduce workload, use of paper, and errors |   |
|• Direct downloading of histogram and event reviews to patient electronic health records |   |
|• Avoid decision-making based solely on histogram and event reviews           |   |
|• Physicians taking ownership of using daily summaries of SpO₂ histogram and events |   |
|• Clarify whether infant is on supplemental O₂                              |   |
|• Be skeptic about daily summaries capturing false alarms or equipment issues |   |
|• Validate the tools for better uptake and spread                           |   |

Observations by bedside coach

| Challenges, what didn’t go well                                                                 |   |
|• Daily summaries not made available at the bedside during weekends, preventing their use |   |
|• Unit printers did not print automatically daily summaries on infants on pre- and post-SpO₂ monitoring |   |
|• Perception of increasing workload with no apparent benefit for staff        |   |
|• No fixed spot to document histogram and event review reports on nurse and RT flow sheets, making it difficult to track trends |   |
|• SpO₂ high alarms checking is not part of the standard work during staff shift handover |   |
|• Not knowing how to use ROSE tool when an infant was on intermittently receiving supplemental O₂, for example, during procedures |   |
|• Documenting total desaturation events in 24 h, when an infant reached the monitor’s maximum capture ability of 50 events in 6–8 h. |   |
|• Sustainability:                                                             |   |
| ° Manual printing, distribution, reviewing, plotting, and documenting of daily SpO₂ and desaturation event summaries |   |
| ° Ongoing staff practices monitoring                                         |   |
| ° Orienting learners and new staff                                           |   |
| ° Validation of tools with relevant patient or process outcomes              |   |

Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years; no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval

Ethical Requirement of Research Ethics Board approval for this project was formally waived by the institution after reviewing the proposal and considering it as a quality improvement project.

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