

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 resulted 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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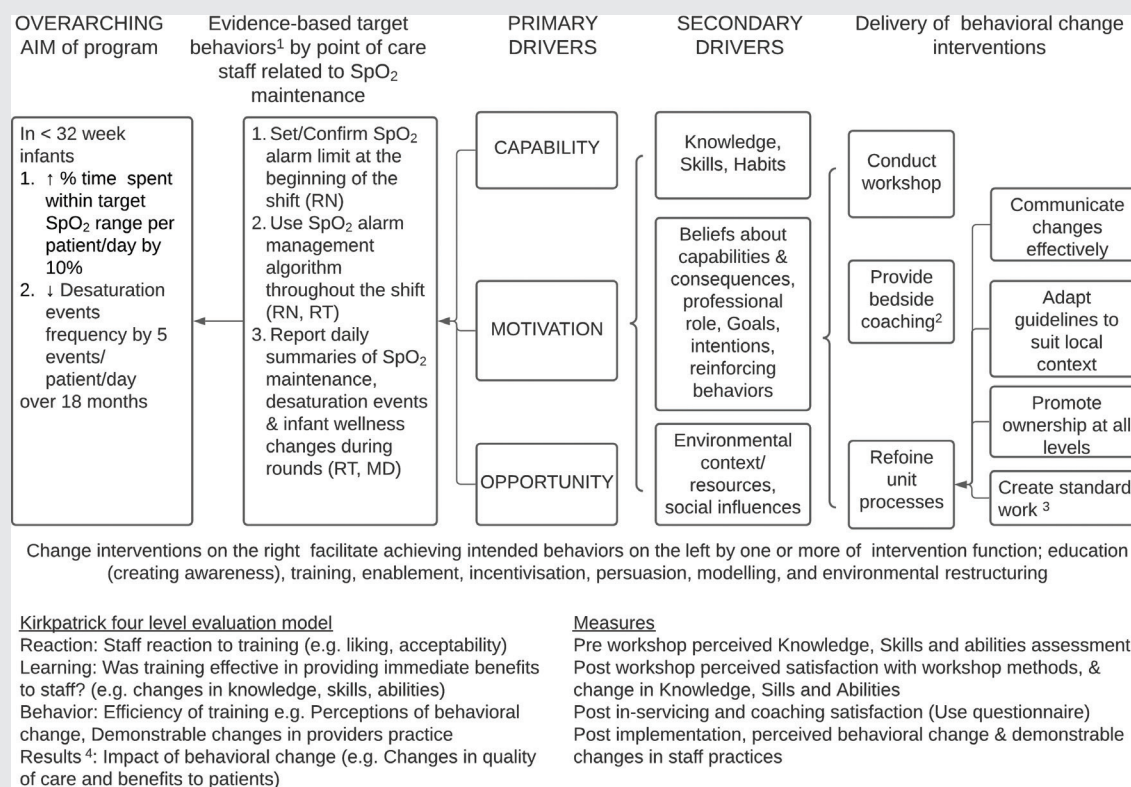
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FIGURE 1**Key driver diagram for changing staff behaviors and the evaluation model.**

1 = Behaviour is the activity/ies that occur when individuals interact with their surroundings: other individuals, things, systems, etc.; 2 = 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 = Steps to ensure guidelines, tools and SpO₂ daily summary printouts are readily accessible and their use is integrated into NICU daily routine; 4 = Out of scope of this study.

SpO₂ = Saturation of Oxygen, RN = Registered nurse, RT = Registered Respiratory Therapist, MD = Medical Doctor.



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 SpO₂ maintenance and frequency of desaturation, i.e., SpO₂ histogram and event review (20% patient days) [14–17]; wide alarm limits and lack of guidelines on SpO₂ targets; and how to respond consistently to high, low, and multiple high and low SpO₂ 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 SpO₂ 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 SpO₂ 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 SpO₂ maintenance and event management

Before the initiation of the QI project, our unit alarm targets for SpO₂ since 2006 were 84%–93% and 84%–100% for infants without and with oxygen supplementation, respectively, based on prevalent evidence [20]. Reporting daily SpO₂ histogram event review reports during bedside rounds, tracking SpO₂ 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 SpO₂ 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 SpO₂ target and alarm limits [3, 9], SpO₂ alarm management algorithms [12], reporting of SpO₂ histogram and event reviews during rounds, and a standard tool to track infant wellness based on daily SpO₂ histogram and event reviews (consensus based locally developed tool). Our QI sub team had two physicians, a nurse practitioner,

TABLE 1

Details of workshop and bedside coaching events and participants

Professional	Number (%) of workshop participants ^a , <i>n</i> = 234	Number (%) bedside coaching participants ^a , <i>n</i> = 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 ^c	5 (2)	4 (2)
Students ^d	11 (5)	

^a87% of scheduled staff (*n* = 275), No. of workshops 13, Average no. of participants/session = 14.

^b80% of scheduled day staff (*n* = 210), 60% of them had two or more coaching encounters.

^cOccupational therapist, Dietitians and Pharmacists.

^dMedical, nursing, and respiratory therapy students.

a nurse educator, a respiratory therapy (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 alarm management algorithms, and reporting daily SpO₂ histogram and event review reports during rounds (Supplementary Table 1^b). 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 show 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^b). 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 wellness assessment tool 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^b).

¹Supplementary materials are available at <https://www.cjrt.ca/wp-content/uploads/Supplement-cjrt-2021-075.docx>.

TABLE 2

Observed target behaviors of providers related to oxygen saturation maintenance

	Pre-intervention, no. of occasions/total observations (%)	Post-intervention, no. of occasions/total observations (%)	<i>P</i>
Alarm limit set on monitors according to the unit guideline	384/480 (80)	490/510 (96)	<0.0001
Use of SpO ₂ management algorithms	0/80 (0)	58/90 (64)	<0.0001 ^a
Reporting of daily SpO ₂ maintenance during rounds	16/80 (20)	500/714 (70)	<0.0001

Note: χ^2 , *p* < 0.05 is significant.

^aFischer's exact test.

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 χ^2 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**Roll-out 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 ^a
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 ^b	
• 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)

^aLikert scale: 1 = Strongly Disagree, 7 = Strongly Agree.

^bKnowledge and skills pertaining to oxygen saturation maintenance and reducing frequency of desaturation events, survey tool provided as Supplementary Table 3¹.

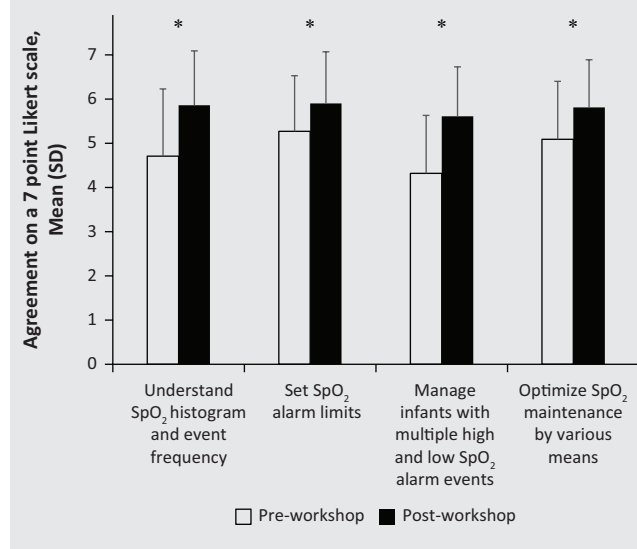
FIGURE 2

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

Perceived change in knowledge and self-confidence following workshop (1 = Low, 7 = high).

**P < 0.05 and statistically significant.*

Pre- (n = 71) and post-workshop respondents (n = 44), online through survey monkey. Survey questionnaire provided as Supplementary Table 4¹.



(September–December 2014). Evaluation of bedside coaching, usability of tools, and perceived and observed changes in staff practices occurred once in June 2015 and once in July 2015. Two hundred and thirty-four staff members from all professional groups attended the 13 IPL training workshops (87% of scheduled staff), and 168 staff received bedside coaching, i.e., 60% of scheduled day staff during 714 patient days (Table 1).

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 3¹). 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 4¹). 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 5¹).

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

TABLE 4

Providers' perceived usability of intervention tools and satisfaction with bedside coaching

Statements	Number (%) of respondents who rated 5 or more level of agreement with statements on a 7-point Likert scale ^{a,b}
SPO₂ ALARM MANAGEMENT ALGORITHMS	
I follow SpO ₂ alarm management algorithm routinely in my daily practice	51 (81.0)
It is useful	56 (88.9)
It is easy to use	52 (82.5)
I learned to use it quickly	56 (88.9)
I am satisfied with it	47 (74.6)
INFANT WELLNESS ASSESSMENT TOOL (ROSE TOOL)	
It helps me to objectively assess infants' daily wellness	49 (79.0)
It helps me to identify an unstable infant early	55 (88.7)
It helps me to assess response of an infant to an intervention	49 (79.0)
It helps me to communicate infant wellness in a standardized manner	45 (75.0)
It is easy to use	49 (79.0)
I learned to use it quickly	51 (82.2)
I am satisfied with it	50 (86.7)
BEDSIDE COACHING AND IN-SERVICING^c	
They helped me to use SpO ₂ alarm management algorithm quickly	51 (83.6)
They helped me to use infant wellness assessment tool quickly	51 (85.0)
They were useful for seeking clarification on use of tools	47 (78.3)
They were useful for adopting tools in my daily practice	49 (81.7)
I am satisfied with them	49 (81.7)

^aLikert scale: 1 = Strongly Disagree, 7 = Strongly Agree. Percentage was calculated by dividing respondents who rated as 5, 6, or 7 by total number of respondents.

^bSurvey questionnaire provided as Supplementary Table 5¹.

^cBedside in-servicing and coaching during that 3-month period. 32 calendar days, 714 patient days.

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 2¹). 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 pre-conceived 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 algorithms)
- 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
- Facilitates conversation on further work up and clinical management in response to infant wellness changes
- 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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