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Implementation Science Communications (2024) 5:132
https://doi.org/10.1186/s43058-024-00668-8

Implementation Science Communications

SHORT REPORT

Open Access

Implementation mapping to plan for the Supraglottic Airway for Resuscitation (SUGAR) trial

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Abstract

Background Positive pressure ventilation (PPV) is an essential component of neonatal resuscitation. Meta-analytic evidence suggests that, among late preterm and term newborn infants who require resuscitation after birth, a supraglottic airway (SA) device is more effective than a face mask at reducing the probability of PPV failure and reducing the need for endotracheal intubation. However, SA devices are rarely used in routine practice in hospital delivery room settings within the United States.

Methods In preparation for a pragmatic hybrid effectiveness-implementation trial, we used implementation mapping to identify barriers and facilitators to SA use; develop a logic model; identify and operationalize implementation strategies targeting key barriers and facilitators; and refine strategies based on iterative feedback from clinicians and administrators (e.g., physicians, nurse practitioners, nurse managers, and respiratory therapists). We used the Consolidated Framework for Implementation Research (CFIR) to organize barriers and implementation strategies.

Results Across open-ended survey responses and focus groups, identified barriers included: (1) mixed perceptions of the advantages or disadvantages of SA compared to alternatives; (2) insufficient education and training in SA use; and (3) lack of perceived need for an alternative to intubation as a standard practice. The research team's understanding of these barriers and selection of implementation strategies to address them were refined throughout the iterative implementation mapping process, which resulted in the selection of two sets of implementation strategies to be tested in a hybrid trial.

Conclusions The implementation mapping process described in this paper provides an exemplar of a systematic and partner-engaged process to identify and select implementation strategies for the purpose of hybrid trial design.

Keywords Neonatal resuscitation, Implementation mapping, Supraglottic airway

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Contributions to the literature

- There is strong evidence supporting the use of a supraglottic airway (SA) device to ventilate the lungs of newborns who require resuscitation after birth. However, SAs are rarely used during resuscitation in routine care settings within the United States.
- Implementation mapping is a systematic, partner-engaged approach to developing and selecting implementation strategies. There is limited literature on the application of this process in the neonatal health literature.
- This paper fills a gap in the literature by describing the process and output of implementation mapping to inform the design of a hybrid effectiveness-implementation trial to compare two sets of implementation strategies to support SA use within US hospital delivery rooms.

Implementation mapping to Plan for the Supraglottic Airway for Resuscitation (SUGAR) trial

Among the infants born in the United States each year, approximately 10% require resuscitation after birth. Positive pressure ventilation (PPV) is an essential component of neonatal resuscitation [1, 2]. Using a supraglottic airway (SA) device (or "laryngeal mask") to ventilate the lungs of late preterm and term newborn infants who require resuscitation after birth is an evidence-based practice. Specifically, meta-analytic evidence suggests that, among this population of infants, a laryngeal mask is more effective than a face mask at reducing the probability of PPV failure and reducing the need for endotracheal intubation [3]. This is important because endotracheal tube (ETT) intubation is invasive and risky, with 20% of neonatal intubation procedures resulting in adverse events [4]. Relevant resuscitation organizations, including the American Heart Association and American Academy of Pediatrics, endorse the SA to provide PPV to newborn infants born ≥ 34 weeks' gestation [5].

However, despite this strong evidence and supporting guidelines, SAs are rarely used during resuscitation in routine care settings within the United States. In a national survey of more than 5,000 Neonatal Resuscitation Program (NRP) Providers and Instructors across the US, only 12% of respondents had ever used a SA device for neonatal resuscitation [6]. The most frequently reported barriers were insufficient experience (46%), preference for other interfaces (25%), not thinking about using a laryngeal mask during resuscitation (21%), and insufficient training (21%).

Given this evidence-to-practice gap, implementation strategies are needed to support the adoption, implementation, and sustainment of SA use within routine delivery room settings. It is critical to determine the optimal intensity of implementation strategies. Therefore, our team is preparing for a pragmatic hybrid effectiveness-implementation trial to compare two sets of implementation strategies to support SA use within US hospital delivery rooms. We used implementation mapping to select the implementation strategies to be tested. Implementation mapping involves specific iterative steps to ensure that implementation strategy selection is informed by an understanding of the context; theory and hypothesized mechanisms; as well as meaningful input from interested parties [7, 8].

Despite the increasing use of implementation mapping to develop and select implementation strategies [8], to our knowledge there are no published examples of this process in the neonatal health literature, nor are there examples from inpatient hospital settings. There are also few published examples of implementation mapping used for the purpose of designing hybrid trials, which is an important gap in the literature as study teams increasingly aim to use structured, participatory processes such as implementation mapping at the stage of study design. In this article, we describe the process and output for each step of implementation mapping, with the goal of serving as an exemplar to other investigators using implementation mapping to inform hybrid trial designs.

Methods

In the current study, we applied implementation mapping to: (1) conduct a needs assessment to identify barriers and facilitators to SA use; (2) develop a logic model; (3) refine, operationalize, protocolize and select implementation strategies based on iterative feedback from health care professionals and administrators, with the ultimate goal of incorporating key partner input into the design of a hybrid implementation effectiveness trial. We partnered with the Delivery Room Intervention and Evaluation (DRIVE) Network, a novel network that convened with the American Academy of Pediatrics (AAP) who aimed to study and enhance neonatal resuscitation practices. Six founding and four additional sites were invited to participate across the implementation mapping process mapping to represent a diverse and inclusive population of infants born across various delivery rooms in the United States. We engaged key partners (e.g., physicians, nurse practitioners, nurse managers, and respiratory therapists) from these sites across the implementation mapping process. We used the Consolidated Framework for Implementation Research (CFIR) [9] as an organizing framework. Figure 1 displays a schematic diagram of the

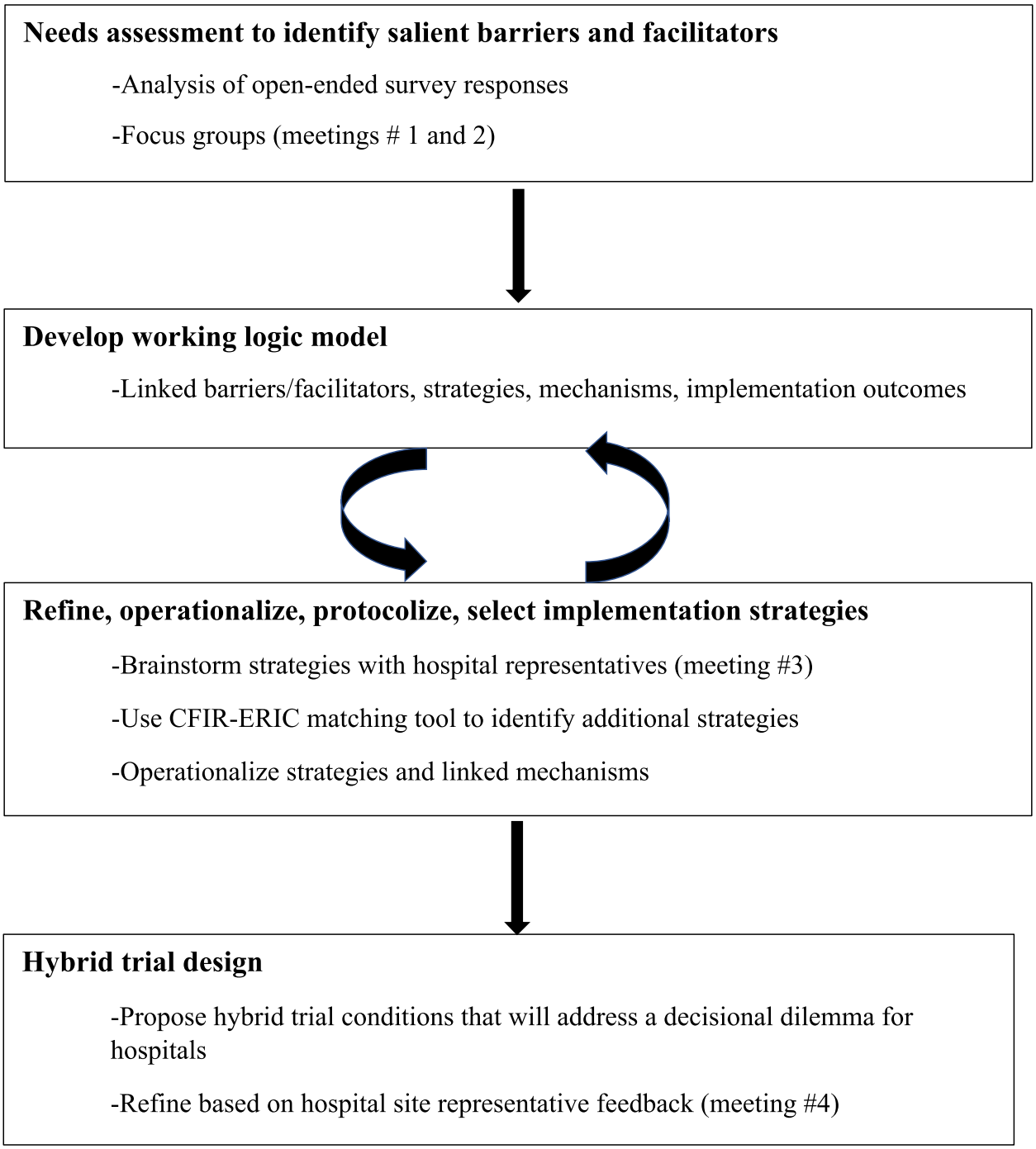

Fig. 1 Schematic overview of implementation mapping process as applied to inform hybrid trial design

Notes. CFIR = Consolidated Framework for Implementation Research; ERIC = Expert Recommendations for Implementing Change

overall implementation mapping process, and each step is described in more detail below.

Step 1. Conduct a needs assessment

We began by conducting a needs assessment to identify barriers and facilitators to SA use), and to explore the extent to which these barriers and facilitators vary based on site-level characteristics or provider roles.

First, we analyzed open-ended responses from a national survey of > 5,000 Neonatal Resuscitation Program Providers and Instructors [6]. The electronic survey addressed providers' training, practice, knowledge, and

attitudes around supraglottic airway use during neonatal resuscitation. Respondents were asked to identify barriers to supraglottic airway use from a pre-populated list, with an option to enter free text responses. There were 565 free text responses; we used a deductive and descriptive approach to thematic analysis [10] to code and analyze these open-ended responses. We used the 2022 version of the CFIR [9] as the guiding framework to identify specific themes related to barriers and facilitators, organized by CFIR constructs. Responses within themes were grouped by professional role (i.e., physician, advanced practice provider, nurse, respiratory therapist, emergency medical technician, midwife) and practice setting (i.e., pre-hospital, neonatal level I through IV hospital, patient home, birth center). Coding and analysis was led by one coder (AM) and vetted and revised through an iterative process of discussion and debriefing, including discussing any discrepancies in interpretation, with two additional team members (CB, GL) to interpret and assign context and meaning to the data.

Then we conducted two virtual focus groups with representatives from delivery hospital sites committed to participating in the hybrid trial being planned. Participants were recruited by emails sent to site principal investigators, with an effort to include diverse hospital systems and recruit interdisciplinary team members within those institutions. We invited participants in diverse clinical roles, including clinical leadership positions, but not those in non-clinical hospital administrative positions. Table 1 summarizes the roles of the individuals who participated in the focus groups, as well as the subsequent meetings. A total of five sites were represented across the focus groups, including a range of hospital types (i.e., large and small volume; teaching and community). The focus groups were guided by a semi-structured guide (see supplemental materials), organized by CFIR domains (i.e., innovation, outer setting, inner setting, individuals, implementation processes). We developed this semi-structured guide to explore barriers and facilitators within CFIR constructs that were salient in the open-ended responses. Both focus groups lasted approximately 60 min and were co-facilitated by an expert in qualitative focus group facilitation and a physician researcher with expertise in neonatal resuscitation. We used rapid analysis (RA) to reduce the structured notes taken during the focus groups to a focused and organized summary template [11]. Consistent with previous work [12], our RA approach was guided by CFIR to organize the data. We also reviewed the recorded meeting for clarity when necessary.

Step 2. Develop working logic model

We used the Implementation Research Logic Model (IRLM; [13]) to develop a working logic model with barriers, implementation strategies linked to barriers, mechanisms, and outcomes. We used the most salient barriers identified in Step 1, organized by CFIR domain, as inputs in the logic model. The research team iteratively revised the working model, with the goal of identifying a set of implementation strategies, linked to barriers, to operationalize and further refine based on partner feedback.

Steps 3–5. Refine, operationalize, protocolize and select implementation strategies

Next, we held a virtual meeting with representatives from six hospital sites to gather feedback on our interpretation of the needs assessment data and discuss potential implementation strategies (see Table 1). The meeting lasted approximately 60 min. During the meeting, the research team shared a list of seven key barriers identified through

Table 1 Description of focus group and hospital representative meeting goals and participants

Meeting Title	Implementation Mapping Step	Goal	Number of participants from hospital sites	Roles of hospital site participants
Focus group 1	Needs assessment	Identify key barriers and facilitators	8	3 nurse practitioners, 2 respiratory therapists, 2 physicians, 1 nurse manager
Focus group 2	Needs assessment	Identify key barriers and facilitators	11	7 nurse practitioners, 3 physicians, 1 respiratory therapist
Site representative meeting 3	Refine, operationalize, protocolize, and select implementation strategies	Gather feedback on interpretation of needs assessment; Identify potential implementation strategies	9	6 physicians, 2 neonatal nurse practitioners, 1 nurse manager
Site representative meeting 4	Refine, operationalize, protocolize, and select implementation strategies	Gather feedback on implementation strategies and proposed hybrid trial design	13	6 physicians, 2 neonatal nurse practitioners, 1 pediatric nurse practitioner manager, 2 pediatric nurse practitioners, 2 respiratory therapists

the needs assessment, with the goal of checking understanding regarding these barriers with the meeting participants and gathering feedback regarding additional barriers. We then facilitated a discussion to brainstorm potential implementation strategies to address four of the barriers. We used a rapid approach [11] to analyze the structured notes taken during the meeting.

We used our reflections and notes from the first meeting with hospital site representatives to refine the working logic model. Specifically, we revised the implementation barriers based on clarifications from meeting participants and added additional linked implementation strategies generated in the meeting to the logic model. We continued to refine the logic model by operationalizing strategies and mechanisms based on behavior change theories (e.g., Theory of Planned Behavior [14]; Slaghuis Framework for Sustainability [15]). For example, we specified how implementation strategies might target specific mechanisms aligned with these theories (e.g., using the Slaghuis framework, we hypothesized that the facilitation strategy would boost routinization and institutionalization, thereby serving as a mechanism by which the Enhanced-plus strategy will produce superior sustainment) and used this to further operationalize the implementation strategies (e.g., who delivers, dosage, temporality) in line with the hypothesized mechanisms. We also used the CFIR-ERIC matching tool [16], which can be used to identify implementation strategies from the Expert Recommendations for Implementing Change (ERIC; [17] matched to barriers identified using CFIR, to ensure that we had not omitted any potentially important implementation strategies.

We held a final 60-minute virtual meeting with representatives from hospital sites to gather feedback on the final set of implementation strategies, mapped to barriers and mechanisms, and on the proposed hybrid trial design. See Table 1. After this final meeting, we made final revisions to the proposed experimental design (i.e., implementation strategies to include in both conditions) based on the implementation mapping process, incorporating participant feedback, theory, and data from the needs assessment.

Results

Step 1. Conduct a needs assessment

We identified several themes of barriers to SA use from the open-ended survey responses, and focus here on the three most salient themes. First, many respondents indicated that insufficient education, training, and opportunity leads to lack of experience, confidence, and use. This theme was reported across professional roles and practice settings. For example, one respondent indicated, "Since [SA devices] are not used often, confidence is decreased from lack of practice." Others specifically reported lack of confidence with "making the right decision to use it" as well as "with placement." Second, respondents across roles and settings indicated that a lack of appropriately sized and readily available SA devices discourage use. For example, one respondent said, "There are neonatal [SA devices] available at our hospital, but they are not as readily available as ET tubes. I asked for one during a mock code and no one could find it." Third, respondents shared that intubation, rather than SA use, is the preferred practice within their units. Many respondents highlighted that attempting intubation first is the "culture" or the "expectation" within their units. Within this theme, others reported a more specific concern that SA use would prevent opportunities to maintain intubation skills; as one physician stated: "My biggest concern is that if I place [SA devices] I will essentially never get the opportunity to maintain my skills in ETT placement." Themes were generally apparent across respondent roles and hospital settings.

During the focus group discussions, participants, particularly those from Level III/IV hospitals, shared mixed perceptions of the advantages or disadvantages of SA compared to alternatives, such as ETT. Additionally, some participants shared that there is a general perception in their settings that intubation is the "go-to practice" and in some cases, that there is little need for an alternative. This viewpoint seemed to vary by hospital setting, with participants from rural or less resourced hospitals more likely to describe a clear need for SA. For example, one participant from a rural hospital noted that their hospital has been eager to adopt SA because they do not have immediate access to staff trained in neonatal intubation. Additionally, many participants shared that they or their colleagues were unaware of the evidence base for SA. Focus group participants shared that evidence is very important to them and their colleagues and indicated being open to changing practice if supported by the evidence.

Across the open-ended survey responses and the focus group discussions, we identified 10 key barriers or facilitators to SA use, summarized in Table 2. Table 2 provides a brief description of each identified barrier or facilitator, organized by CFIR domain. Table 2 also indicates with asterisks the barriers, selected based on overall salience, that the research team selected to share back with hospital site representatives at the subsequent meetings, with the goals of: (1) confirming the research team's understanding of the barriers, and (2) brainstorming potential implementation strategies to address them.

Table 2 Key barriers and facilitators identified from needs assessment

CFIR Construct	Barrier/Facilitator Description
Innovation Domain	
Innovation relative advantage	[a]Mixed perceptions regarding the advantages and disadvantages of SA compared to alternatives
Innovation evidence base	[a]Many providers unaware of evidence base for SA
Innovation cost	Some perceptions that cost of SA is prohibitive
Inner Setting	
Access to knowledge and information	[a]Many providers have insufficient education and training in SA use
Tension for change	[a]General perception that ETT is the "go-to" practice when possible; lack of identified need for alternatives
Materials and equipment	[a]Availability or lack of availability of LMA supplies at hand in the moment they would be used (including correct size, accessibility, knowing where to find them)
Compatibility	[a]Hospital policies/workflows/norms that are incompatible with LMA use
Culture – recipient-centeredness	Shared values, beliefs, and norms among units/teams about the importance of using evidence-based practices
Outer Setting	
Policies and laws	[a]Policies related to scope of practice for particular providers; liability concerns
Local attitudes	Shared professional attitudes about following evidence base and doing what is best for recipients

[a] indicates barrier that was shared with hospital site representatives during Steps 3–5

Step 2. Develop working logic model

The working logic model included columns for CFIR domains, barriers, potential implementation strategies, potential mechanisms, and outcomes. Table 3 displays the working logic model content for one barrier (i.e., innovation relative advantage), as a brief example to illustrate the working logic model. The working logic model was used as the basis for discussion and refinement throughout the subsequent steps.

Steps 3–5. Refine, operationalize, protocolize and select implementation strategies

At the first meeting, participants confirmed the research team's interpretation of salient barriers. One meeting participant expanded on the "tension for change" barrier by identifying that many hospital sites have been investing in approaches to improve intubation safety, which makes an alternative less attractive. Participants also shared that perceived relative advantage of SA compared to ETT varies significantly by setting. The discussion generated the following ideas for implementation strategies: training in SA with a hands-on component; train-the-trainer models (e.g., "training local super-users who then train others"); development and dissemination of clinical pathways; education about the evidence base (i.e., risks of ETT, benefits of SA); and including SA supplies within the "airway bundle." The discussion also highlighted the importance of implementation strategies including providers from all relevant disciplines in addition to hospital leadership. We revised the working logic model to reflect this feedback.

These revisions resulted in a core set of eight implementation strategies, which were shared with hospital site representatives at the second meeting for feedback and refinement. Table 4 displays these eight implementation strategies, as well as the most relevant linked barriers and corresponding CFIR domain for each strategy. Participants shared that the proposed strategies generally seemed like a good fit to address the identified barriers and offered several specific suggestions for refinement. In particular, they emphasized the importance of training including video (e.g., showing SA placement) to demonstrate the safety of SA and build providers' confidence. They also emphasized the importance of learning from others' successful implementation of SA; for example, several meeting participants shared that it has been valuable for their units to learn from others' successful implementation of SA use in the neonatal intensive care unit for other purposes.

Finally, the research team also shared with meeting participants a proposed hybrid trial experiment (i.e., set of implementation strategies to be included in a moderate intensity condition, i.e., "Enhanced," and in a higher intensity condition, i.e., "Enhanced Plus") and requested feedback on its acceptability. Meeting participants generally reported that the proposed design was acceptable; additionally, all sites who had initially expressed their interest in participating in the SUGAR trial remained committed to the trial (i.e., provided a letter of support) after the proposed hybrid trial design was shared. The experiment was designed based on the logic model and theorized mechanisms, the broader scientific literature, and participant input throughout the implementation

Table 3 Working logic model content for the barrier of innovation relative advantage

Domain	Barrier	Potential Implementation Strategies	Potential Mechanisms	Potential Implementation Outcomes
Innovation	**Innovation relative advantage**: Mixed perceptions regarding the advantages and disadvantages of SA compared to alternatives	-Trainings/educational meetings (including info about evidence base) -Learning collaboratives/ peer facilitation - interactive problem solving & support in context of need for improvement -Inform local champions/opinion leaders - Change physical structure and equipment (use a device that does not require cuff inflation and can be used as a conduit for endotracheal intubation) -Tailoring strategies (e.g., to site type, given this is particularly salient barrier for level III/IV hospitals)	Theory of Planned Behavior: implementation strategies specifically target attitudes (e.g., evidence-base; valuable use-cases); descriptive & injunctive norms (e.g., messaging from leaders and others in unit/other units); self-efficacy (e.g., via problem solving) to support perceived relative advantage and lead to adoption and penetration Routinization/Institutionalization: strategies include embedding SA into practice routines to support perceived advantage and lead to adoption, penetration and sustainment	Initial adoption; Penetration; Sustainment; Fidelity

SA supraglottic airway

Table 4 Implementation strategies shared at second meeting with hospital site representatives

Strategy Shared with Meeting Participants	CFIR Domain	Most relevant barriers
"Local champions across different professions"	Innovation Inner Setting	Innovation relative advantage; Innovation evidence base; Tension for change; Compatibility
"Educational outreach digging into the evidence"	Innovation	Innovation evidence base; Innovation relative advantage
"Trainings with hands on component (simulation, skills lab)"	Inner Setting	Access to knowledge and information
"Provide materials and checklists"	Inner Setting	Materials and equipment
"Provide SA devices and/or help teams acquire devices"	Inner Setting	Materials and equipment
"Conduct audit & feedback on similar-site performance"	Inner Setting	Tension for change;
"External interprofessional peer facilitation - interactive problem solving & implementation support; set achievable benchmark"	Innovation Inner Setting	Innovation relative advantage; Access to knowledge and information; Tension for change; Compatibility
"Update guidelines with more clarity and direction"	Outer Setting	Policies and laws

SA supraglottic airway

mapping process. Specifically, we used strategies that had been identified in the implementation mapping process across both comparator arms; we configured the arms such that the results would advance the science of implementation (i.e., test the added benefit of strategies targeting routinization and institutionalization) and be practically useful to for supporting the use of evidence-based practices to improve maternal and neonatal health outcomes (i.e., inform decisions about the optimal strategy intensity). The planned experimental design is shown in Table 5.

Discussion

We applied implementation mapping [7] as a structured, partner-engaged process to identify theory-driven implementation strategies, linked to salient barriers and facilitators, to support SA use. The goal of this process was to inform the design of a hybrid effectiveness-implementation trial comparing two sets of implementation strategies. Results from the needs assessment highlighted salient barriers to SA use across CFIR domains, including providers having insufficient training and education in SA use, and mixed perceptions regarding the advantages and disadvantages of SA compared to alternative practices. These results are consistent with the quantitative survey results from this national survey [6], and provide additional depth and nuance. The needs assessment results also highlighted potential facilitators that implementation strategies could leverage, such as shared values about the importance of using evidence-based practices.

The results described here highlight the strengths of implementation mapping as a process to integrate feedback from interested parties, theory (i.e., theories of change and hypothesized mechanisms), and data (i.e., barriers and facilitators) to inform the selection of implementation strategies. Although the implementation strategies brainstormed during the meetings with hospital site representatives were largely similar to those identified in the literature and through the CFIR-ERIC matching tool (e.g., "educational materials"), participants provided additional nuanced insights into what would make these strategies meaningful and effective (e.g., using educational videos to demonstrate the safety of SA placement; providing opportunities to learn from other sites' successful implementation). However, it is also important to note that studies have observed discordance between implementer preference and strategy effectiveness [18], which highlights the importance of also drawing on theory and the existing literature.

We note several limitations. Although we convened multiple meetings that included multiple professions and settings, the attendees may not have been fully representative of all delivery room care settings. In addition, we note that there is very little guidance in the optimal configuration of comparator implementation strategy arms. Our final configuration represented our best attempt to test two sets of competing arms based on the information gathered during the implementation mapping process. It will be important to develop further guidance for integrating information from needs assessments, partner feedback, theory, and the scientific literature to inform hybrid trial design.

Conclusion

Despite these limitations, the current study advances the literature by providing a case example of the application of implementation mapping applied within the

Table 5 Implementation strategies in both arms of the proposed Supraglottic Airway for Resuscitation (SUGAR) hybrid trial

Enhanced and Enhanced—Plus Arms		
Implementation strategy (i.e., applicable ERIC category)	**Description**	**Core function**
Distribute educational materials; Conduct educational meetings	Slide deck, posters, patient-facing materials, resuscitation checklist, videos distributed to sites Expectation that site teams will educate neonatal resuscitation providers until they reach ≥ 80% of relevant staff	Sharing evidence and guidelines supporting SA use in both synchronous live and asynchronous recorded sessions; Describing how to use SA during resuscitation
Identify and prepare champions	Each institution will name SUGAR champions from professional roles that involve placing or supporting placement of SA during neonatal resuscitation	Eliciting concerns or resistance to SA adoption from other clinicians and sharing those with local SUGAR leadership; Promoting a positive attitude toward SA use; Setting the tone locally that SA use is the new norm
Use train the-trainer strategies	Each site will nominate one site training lead to attend a half-day, in-person, hands-on "train the trainer" bootcamp convened during a well-attended national neonatal meeting. After the in-person training, each trainer will return to their institutions to conduct SA training educational sessions	Providing training in SA use to staff; Strengthening skills and abilities and perceived behavioral control
Model and simulate change	Two detailed neonatal simulation scenarios and guides will be distributed to sites with expectation that they will conduct simulation training with neonatal resuscitation providers, reaching ≥ 50% of relevant staff	Providing training in SA use to staff; Strengthening skills and abilities and perceived behavioral control
Change physical structure and equipment	SUGAR will provide each site with one 100-count SA starter pack for both training and clinical use. This is intended to be a bridge to each site working with their own supply chains to formalize stocking of Sas in the delivery room	Making SAs available in the delivery room
Enhanced—Plus Arm Only		
Implementation strategy (i.e., applicable ERIC category)	**Description**	**Core function**
Assess for readiness and identify barriers and facilitators	Hybrid (3 remote meetings followed by a 2-day in-person site visit) facilitated by an experienced resuscitation expert from the central SUGAR team to facilitate launch of SUGAR with local partners and assess the site's implementation readiness for implementation of SA use for early rescue	Assessing and facilitating problem-solving across readiness domains (e.g., organizational leadership support, staff engagement, unit stability, competing priorities)
Audit and provide feedback; Facilitation	Central SUGAR facilitators lead monthly 1-hour remote external facilitation sessions (2 meetings offered per month, with Site PI and at least 1 additional site SUGAR Champion expected to attend 1 per month)	Supporting each site to address barriers to SA adoption and penetration, taking context into account; Facilitators work with sites to set implementation penetration goals and highlight additional metrics; Reviewing ongoing penetration data with interactive problem solving for sites with low or delayed penetration; Addressing site-specific challenges in a group setting; Developing local plans for long-term increased uptake and sustainment

ERIC Expert Recommendations for Implementing Change; *SA* supraglottic airway; *SUGAR* Supraglottic Airway for Resuscitation; *PI* principal investigator; *CFIR* Consolidated Framework for Implementation Research; *ERIC* Expert Recommendations for Implementing Change

maternal and neonatal health literature. In this project, we used implementation mapping to inform the design of a hybrid effectiveness-implementation trial to compare groups of implementation strategies to support the use of SA devices for neonatal resuscitation. This trial has been funded through the Patient-Centered Outcomes Research Institute (PCORI). Results illustrate the utility of implementation mapping as applied to hybrid trial design for improving neonatal health.

Abbreviations

CFIR	Consolidated Framework for Implementation Research
ERIC	Expert Recommendations for Implementing Change
ETT	Endotracheal tube
IRB	Institutional Review Board
NRP	Neonatal Resuscitation Program
PCORI	Patient-Centered Outcomes Research Institute
PPV	Positive pressure ventilation
SA	Supraglottic airway
SUGAR	Supraglottic Airway for Resuscitation
US	United States

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s43058-024-00668-8.

Supplementary Material 1.

Acknowledgements
We thank the site leads and staff of the Delivery Room Intervention and Evaluation (DRIVE) Network for providing feedback during the implementation mapping process.

Authors' contributions
CPB and EEF led the conceptualization of the study, design, data collection, and interpretation of findings, and substantially contributed to manuscript drafting. GL collaborated on study design and interpretation of findings, drafted the manuscript, and approved all edits. SL and CB contributed to the design of the study and interpretation of findings. DW and AM led the qualitative data analysis. ES and LDS co-led the qualitative data collection. All authors reviewed and provided feedback for the manuscript. The final version of the manuscript was vetted and approved by all authors.

Funding
This work was supported by the Children's Hospital of Philadelphia Research Institute. While writing this article, Dr. Lawson's research was funded by the National Institute of Mental Health under grant K23MH122577.

Data availability
The open-ended survey responses collected and analyzed during the current study are available from Dr. DeShea on reasonable request with requisite data use agreements in place.

Declarations

Ethics approval and consent to participate
This research was reviewed and granted exemption by the Institutional Review Board (IRB) of the Children's Hospital of Philadelphia (IRB number: IRB# 23-021369). All participants provided informed consent prior to participation.

Consent for publication
Not Applicable.

Competing interests
All other authors declare that they have no competing interests.

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Received: 22 May 2024 Accepted: 17 November 2024
Published online: 27 November 2024

References

1. Aziz K, Lee CHC, Escobedo MB, Hoover AV, Kamath-Rayne BD, Kapadia VS, et al. Part 5: Neonatal Resuscitation 2020 American heart association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Pediatrics. 2021;147(Supplement 1):e2020038505E.
2. Foglia EE, Shah BA, Szyld E. Positive pressure ventilation at birth. Semin Perinatol. 2022;46(6): 151623.
3. Yamada NK, McKinlay CJ, Quek BH, Schmölzer GM, Wyckoff MH, Liley HG, et al. Supraglottic Airways compared with Face masks for neonatal resuscitation: a systematic review. Pediatrics. 2022;150(3):e2022056568.
4. Foglia EE, Ades A, Sawyer T, Glass KM, Singh N, Jung P, et al. Neonatal intubation practice and outcomes: an International Registry Study. Pediatrics. 2019;143(1):e20180902.
5. Yamada NK, Szyld E, Strand ML, Finan E, Illuzzi JL, Kamath-Rayne BD, et al. 2023 American Heart Association and American Academy of Pediatrics Focused Update on Neonatal Resuscitation: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2024;149(1). Available from: https://www.ahajournals.org/doi/10.1161/CIR.0000000000001181. Cited 2024 Apr 15.
6. Foglia EE, Shah BA, DeShea L, Lander K, Kamath-Rayne BD, Herrick HM, et al. Laryngeal mask use during neonatal resuscitation at birth: a United States-based survey of neonatal resuscitation program providers and instructors. Resusc Plus. 2024;17:100515.
7. Fernandez ME, Ruiter RAC, Markham CM, Kok G. Intervention mapping: theory- and evidence-based health promotion program planning: perspective and examples. Front Public Health. 2019;7: 209.
8. Fernandez ME, Powell BJ, Ten Hoor GA, Editorial. Implementation mapping for selecting, adapting and developing implementation strategies. Front Public Health. 2023;11:1288726.
9. Damschroder LJ, Reardon CM, Widerquist MAO, Lowery J. The updated consolidated framework for implementation research based on user feedback. Implement Sci. 2022;17(1):75.
10. Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol Qual Res Psychol. 2006;3(2):77–101.
11. Taylor B, Henshall C, Kenyon S, Litchfield I, Greenfield S. Can rapid approaches to qualitative analysis deliver timely, valid findings to clinical leaders? A mixed methods study comparing rapid and thematic analysis. BMJ Open. 2018;8(10): e019993.
12. Gale RC, Wu J, Erhardt T, Bounthavong M, Reardon CM, Damschroder LJ, et al. Comparison of rapid vs in-depth qualitative analytic methods from a process evaluation of academic detailing in the Veterans Health Administration. Implement Sci. 2019;14(1):11.
13. Smith JD, Li DH, Rafferty MR. The implementation Research Logic Model: a method for planning, executing, reporting, and synthesizing implementation projects. Implement Sci. 2020;15(1):84.
14. Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process. 1991;50(2):179–211.
15. Slaghuis SS, Strating MM, Bal RA, Nieboer AP. A framework and a measurement instrument for sustainability of work practices in long-term care. BMC Health Serv Res. 2011;11(1): 314.

16. Waltz TJ, Powell BJ, Fernández ME, Abadie B, Damschroder LJ. Choosing implementation strategies to address contextual barriers: diversity in recommendations and future directions. Implement Sci. 2019;14(1):42.
17. Powell BJ, Waltz TJ, Chinman MJ, Damschroder LJ, Smith JL, Matthieu MM, et al. A refined compilation of implementation strategies: results from the Expert recommendations for Implementing Change (ERIC) project. Implement Sci. 2015;10(1):21.
18. Gong CL, Hay JW, Meeker D, Doctor JN. Prescriber preferences for behavioural economics interventions to improve treatment of acute respiratory infections: a discrete choice experiment. BMJ Open. 2016;6(9): e012739.

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