

# Rapid Cycle Implementation and Retrospective Evaluation of a SARS-CoV-2 Checklist in Labor and Delivery

**Liana Zucco**

Beth Israel Deaconess Medical Center <https://orcid.org/0000-0003-2020-2809>

**Nadav Levy**

Beth Israel Deaconess Medical Center

**Yunping Li**

Beth Israel Deaconess Medical Center

**Toni Golen**

Beth Israel Deaconess Medical Center

**Scott A Shinker**

Beth Israel Deaconess Medical Center

**Philip E Hess**

Beth Israel Deaconess Medical Center

**Satya Krishna Ramachandran** (✉ [skrama@bidmc.harvard.edu](mailto:skrama@bidmc.harvard.edu))

<https://orcid.org/0000-0002-7176-6375>

---

## Research article

**Keywords:** Consolidated framework for implementation research, COVID-19, perioperative checklist, labor and delivery.

**Posted Date:** January 20th, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-45010/v2>

**License:** © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

**Version of Record:** A version of this preprint was published at BMC Health Services Research on August 6th, 2021. See the published version at <https://doi.org/10.1186/s12913-021-06787-5>.

# Abstract

**Background:** Preparedness efforts for a COVID-19 outbreak required redesign and implementation of a perioperative workflow for the management of obstetric patients. In this report we describe factors which influenced rapid cycle implementation a novel comprehensive perioperative checklist for care of the COVID-19 parturient.

**Methods:** Implementation of a novel workflow for the COVID-19 parturient requiring perioperative care was accomplished through rapid cycling, debriefing and on-site walkthroughs. Post-implementation, consistent use of the workflow was reported for all obstetric COVID-19 perioperative cases (100% workflow checklist utilization). Retrospective analysis of the factors influencing implementation was performed using a group deliberation approach, mapped against the Consolidated Framework for Implementation Research (CFIR).

**Results:** Analysis of factors influencing implementation using CFIR revealed domains of process implementation and innovation characteristics as overwhelming facilitators for success. Constructs within the outer setting, inner setting, and characteristic of individuals (external pressures, baseline culture, and personal attributes) were perceived to act as early barriers. Constructs such as communication culture and learning climate, shifted in influence over time.

**Conclusion:** We describe the influential factors of implementing a novel comprehensive obstetric workflow for care of the COVID-19 perioperative parturient during the first surge of the pandemic using the CFIR framework. Early workflow adoption was facilitated primarily by two domains, namely thoughtful innovation design and careful implementation planning in the setting of a long-standing culture of improvement. Factors initially assessed as barriers such as communication, culture and learning climate, transitioned into facilitators once a perceived benefit was experienced by healthcare teams. These results provide important information for the implementation of rapid change during a time of crisis.

## Contributions To The Literature

- In this study, we describe the factors influencing rapid implementation of a comprehensive perioperative checklist for the COVID-19 parturient.
- In the setting of the COVID-19 pandemic, implementation outcomes were positively influenced most by thoughtful innovation design and implementation planning, rather than the learning climate and organizational culture. Factors initially perceived to be barriers such as communication, culture and learning climate transitioned into facilitators once a perceived benefit was experienced by healthcare teams.
- These findings provide important data for strategies that promote implementation success in the setting of a pandemic.

# Background

## Obstetrics & COVID-19

The Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), which causes the disease COVID-19, was first detected in Massachusetts, USA on 1 February 2020. Statewide spread of the virus was observed in early March and coincided with the declaration of SARS-CoV-2 pandemic by the World Health Organization on 11 March, 2020 (1). As reports of exponential community transmission became apparent, health care organizations, including hospitals and labor and delivery (L&D) units were prompted to evaluate existing workflow patterns and develop innovations to mitigate risk of viral exposure to patients and staff (2). The layout and dynamics in L&D units are designed to create a shared experience for family members, while maintaining high levels of readiness for acute deterioration requiring operative delivery. Thus, labor rooms are typically in close proximity to both operating rooms and communal spaces such as the nursing stations and are subject to significant overlapping foot traffic (2). A single COVID-19 parturient presenting for care at L&D units would pose a considerable risk of viral exposure and spread to other healthcare workers and possibly even other patients, in particular if they required an emergency cesarean delivery.

While clinical guidelines and checklists are core components of patient safety efforts within L&D units (3), the implementation of new guidelines or workflow processes within healthcare is challenging and often hampered by several expected and unexpected barriers (4–6). The identification of barriers and facilitators is vital in establishing an efficient strategy for change (7), as described in established frameworks such as the Consolidated Framework for Implementation Research (CFIR) (8–10) and Expert Recommendations for Implementing Change (ERIC) (11,12). Typically, these analyses are performed prior to the implementation of an innovation. However, formal pre-implementation assessments may not be feasible in crisis situations given the need for urgent implementation of change. Retrospective evaluations of implementation have previously been used to help explain success or failures (13). The retrospective post-implementation use of CFIR to assess factors influencing implementation outcome has been reported previously (14), but not in the setting of rapid change implementation to manage pandemic spread within hospital units. There is a paucity of literature on factors influencing rapid change implementation during pandemics such as COVID-19, therefore such knowledge may benefit organizations in future planning and preparedness measures.

The aim of our study was to therefore identify the factors that influenced implementation of the perioperative workflow checklist for care of the COVID-19 parturient, by performing a retrospective analysis using CFIR.

## Methods

### i. Design

A qualitative design using a validated assessment tool was chosen in order to better understand the factors that influenced implementation of a novel workflow. The study was approved by our Institutional Review Board (IRB) at the Beth Israel Deaconess Medical Center. As this was a qualitative study identifying the factors that influenced implementation, and did not constitute human subject research, the requirement for written informed consent was waived. This manuscript conforms to the Standards for Quality Improvement Reporting Excellence (SQUIRE) guidelines and the Template for Intervention Description and Replication (TIDieR) checklist (15,16).

## **ii. Description of Workflow Checklist Implementation (obstetric workflow redesign)**

### *Context:*

Initial reviews of COVID-19 pandemic preparedness in our hospital identified the need for the redesign of a L&D site-specific perioperative workflow for managing a COVID-19 parturient. Our L&D unit serves as a regional referral center serving an urban, metropolitan area of approximately 4.6 million people, and is the academic teaching hospital for Beth Israel Lahey Health, a state-wide hospital network representing more than 15,000 births annually. As a center for high-risk patients, we anticipated a higher traffic of both diagnosed and suspected COVID-19 patients, in common with earlier experiences at similar units in New York State.

### *Innovation design:*

We reviewed the available literature on both SARS-CoV-2 and other related viruses (17), including recommendations on the standards of care from government and professional bodies such as the American College of Obstetrics and Gynecology (ACOG), the Society for Obstetric Anesthesia and Perinatology (SOAP) and the Anesthesia Patient Safety Foundation (APSF) (18–20). We combined these recommendations with our own organization's newly designed perioperative workflows for COVID-19 patients to create the L&D workflow for the COVID-19 parturient requiring perioperative care. It was produced as a single page document, formatted as a sequential checklist with the intention to be used in real time as a cognitive aid (2). The checklist was an intentional design decision, documented as an effective means of detailing sequential steps in care (21); it also fit in with existing local practice of checklist use for pre-operative briefings for all patients going to the operating room on L&D. The intended users of the checklist were staff from nursing, maternal-fetal-medicine, obstetrics, anesthesia and neonatology.

### *Implementation of workflow change:*

Implementation of this innovation took place through a process of rapid cycling over a period of 2 weeks (22–24), described in detail by Li et al, 2020 (2). The initial workflow draft was disseminated among clinical leaders and stakeholders and underwent one cycle of cognitive redesign. Prior to further refinement, planned testing or wide-scale dissemination amongst providers, its use was urgently requested by clinical leaders to assist in the management of our first live COVID-19 obstetric case. At this

time, staff members involved in the case had no formal input into the design of the checklist or training in its use but were coached in real-time to work through the checklist elements. By following the sequence of the checklist, staff were able to safely perform the standard operating procedures, as indicated. Following our first live case, a formal debriefing with all members of the obstetric, anesthesia and perinatal team was conducted using video-conferencing, and specific steps were identified for checklist optimization. Subsequent inter-professional input from the departments of obstetrics, nursing and anesthesia, virtual event debriefings and on-site walkthroughs, several iterations of workflow re-design resulted in our final refined product (Figure 1). Post-case debriefings were performed routinely after-hours and led by the division chiefs of obstetrics, and included staff from nursing, maternal-fetal-medicine, obstetrics, anesthesia, neonatology, and quality and safety. Details on the individual cycles for change are listed (Supplemental Table 1). Our finalized workflow materials are freely available to access online. (2,25).

#### *Outcome of implementation:*

Adoption of this new workflow was quantitatively defined by documentation of its use during the care of successive COVID-19 parturients over the subsequent weeks, in the medical record. We modified the anesthesia information management system to capture three elements of workflow utilization in a binary (yes/no) fashion: a) patient transport per COVID checklist protocol, b) the intraoperative use of COVID checklist protocol, and c) early postoperative recovery per COVID checklist protocol. Following implementation, we report consistent use of this new workflow for all obstetric COVID-19 perioperative cases; 100% workflow utilization was observed and documented for a total of 23 cases (10 patients who required perioperative care, 13 who required labor analgesia), between March and August 2020. Repeated verbal feedback from frontline clinicians was that the checklist helped with ensuring proper use of PPE, created an environment of safety, and improved coordination and communication among the teams.

### **iii. Identification of Factors Influencing Implementation**

#### *Material:*

To identify factors influencing implementation of the redesigned perioperative workflow checklist on L&D, we conducted a detailed retrospective analysis using the CFIR (8,26,27). CFIR classifies operationally defined domains that have been shown to influence implementation success (8), namely, intervention characteristics (e.g.; adaptability, design quality and cost), the outer setting (e.g., external policy, peer pressure), the inner setting (e.g., culture, climate and readiness for implementation), the characteristics of individuals (e.g., knowledge and beliefs about the intervention) and the process of implementation (e.g., planning, engaging, executing and reflecting).

#### *Participants:*

Our assessment of the implementation experience was mapped against the CFIR constructs and ranked by a panel of 6 experts within our organization. The panel included members of the multidisciplinary

team; obstetricians, anesthesiologists and our quality and safety faculty, who are included authors in this study. The first and last authors of this study (LZ and SKR) are not members of the L&D unit.

### *Procedure:*

We opted to use a group deliberation approach because of the extensive history of collaborative work that existed in the L&D unit. Given this previous shared knowledge of local context, each construct was evaluated by the group with respect to its likely influence on implementation, and ranked as a facilitator or barrier, having no effect or not applicable to implementation. Virtual group deliberations took place over several days, initially each member of the panel of experts independently reviewed each construct, then as a collaborative discussion facilitated by the senior author and chair of quality and safety division. Disagreements were discussed in two settings, initially through email and then again in person, facilitated by the lead author.

### *Analysis:*

In order to compare the relative contribution of each equally weighted construct within each domain at baseline, we transformed these results into a quantitative assessment by allocating a numerical score of 1 to a construct if it acted as a facilitator and 0 if it was considered a barrier or not influencing implementation success. The denominator included all constructs within each domain, apart from those deemed not applicable to the study.

## **Results**

Evaluation of the implementation experience using CFIR demonstrated the significance of the following domains, when ranked in order of influence as facilitators of implementation success (expressed as a percentage of constructs within each domain): process (89%), innovation characteristics (88%), inner setting (64%), characteristic of individuals (40%) and the outer setting (0%). Constructs not applicable to this study included cosmopolitanism, organizational incentives and rewards, and external change agents.

### *Facilitators of implementation:*

Constructs which **positively** influenced the implementation of this workflow redesign spanned all domains, except the outer setting. The domains of implementation process (Table 1) and innovation characteristics (Table 2) demonstrated the greatest proportion of facilitating constructs. Constructs within the process domain which had a positive influence on implementation included planning and execution, engagement from opinion leaders and key stakeholders, the presence of formally appointed internal implementation leaders and unit champions and repeated reflection and evaluation. Constructs within the domain of innovation characteristics which revealed a positive influence on implementation included the internal trusted source of the innovation, its adaptability, immediate trialability, easy to use checklist design and low cost. Constructs within the inner setting which had a strong influence in facilitating implementation included the structural characteristics of the unit, the implementation climate

(tension for change, compatibility, relative priority, goals and feedback) and the readiness for implementation (leadership engagement, available resources) (Table 3).

*Barriers to implementation:*

Several constructs were felt to **negatively** influence implementation in this study, particularly those from within the outer setting (Table 4). Additional barriers to implementation included the complexity of the change (innovation characteristics, Table 2), baseline culture, climate and communication (inner setting, Table 3) and personal attributes (characteristics of individuals, Table 5).

External pressures created by peer pressure, both locally and internationally, were evident as an early barrier to implementation. Local peer pressure was created by a departmental policy within anesthesia on the appropriate personal protective equipment (PPE). The timing of this change preceded policy change in the L&D unit by a couple of weeks, resulting in general anxiety, disagreement and inconsistencies in inter-departmental guidance that impacted staff behaviors and overall readiness for alignment. Furthermore, external influences from international peer groups, in particular communications from colleagues in China, Italy and other centers across the USA including the Center for Disease Control (CDC), demonstrated a considerable disconnect between the recommendations for care and clinical practice. This affected expectations and resulted in a delay in establishing a shared mental model.

*Constructs which demonstrated a change over time:*

Evaluation of our implementation revealed some constructs which demonstrated a temporal change over time, the majority of which were within the inner setting (Table 3). At baseline, constructs such as communication, culture and learning climate initially acted as a barrier to implementation, but then progressed to become facilitators within the space of a few weeks.

With respect to this innovation, clear lines of communication and knowledge of where to access the most up to date information were not evident initially within the organization, which resulted in frustration. This was rectified over the course of implementation and communicated through the hospital's COVID intranet. Further communication improvements at the local departmental levels, via intranet, email and teleconferencing permitted inter-professional collaborative work.

The group deliberation process revealed that while the culture within the L&D unit was accustomed to the use of checklists, standard operating procedures, and iterative cycle improvement, additional internal forces such as recent staffing changes along with external pressures, fears and anxiety were present that may have influenced the cohesion of the unit. Individual constructs such as "knowledge and beliefs about the intervention" as well as "individual stage of changes" were a source of further deliberation. Stakeholders may initially have shared a belief that an intervention was necessary. However, pre-existing egotism and individualism may have impacted the early learning climate and further impacted implementation negatively. Since both these views provided opposing unweighted impact on the implementation, the arbiters (LZ and SKR) chose to score them as no impact. Yet, we also believe that

individual knowledge and beliefs positively influenced sustainability of the workflow implementation, as staff became comfortable with the workflow elements and may indeed have provided a central focus for team behaviors. Additionally, in view of the urgency of COVID-19, assistance outside of the L&D unit was sought and welcomed over the course of the implementation. This openness to external inputs likely influenced individual attitudes as well. Leaders within L&D valued the input of all inter-professional team members during the implementation period. Additionally, through the debrief mechanism, involved staff members felt like a valued partner in the change process. Finally, within the outer setting, the patient's needs and resources also shifted in influence over time (Table 4).

## Discussion

This paper describes the identification of factors that impacted implementation of a new obstetric workflow checklist, specific for COVID-19 patients in the perioperative setting, through retrospective evaluation using the CFIR established framework.

In our study, constructs within the domains of process implementation and innovation characteristics were overwhelming facilitators of implementation. We believe that transparency in the development and implementation plan along with the design and content of the tool itself were significant influencers. Innovation characteristics found within the tool included the sequential steps of the checklist which ensured that front-line clinicians were able to perform standard operating procedures. Despite the initial impression that our tool was complex, the ability of staff to successfully use the checklist without prior, and extensive, training demonstrates construct validity of the innovation (28). The immediate and regular testing of our workflow checklist during real COVID-19 obstetric cases by front line staff, enabled us to adapt the tool to meet local requirements (28–30). In general, cognitive aids should be as concise and clear as possible, and their implementation in other units or environments must include local testing and adaptation for success.

Constructs within the inner setting, such as implementation climate and readiness for implementation, likely acted to support the time pressure. Our institution's L&D unit is a world-leading center for teamwork and excellence in obstetrics and anesthesia and is a well-established division within the medical center. The unit has a history of clear processes in place to facilitate multidisciplinary quality improvement. A lack of safety culture, policy guideline and senior leadership support have been reported as barriers to implementation during the COVID-19 pandemic (31). Therefore, we believe that clarity in the prioritization of implementing this innovation along with a readiness demonstrated by senior leaders and stakeholders within our L&D unit and organization facilitated rapid change implementation. A culture of inclusion and teamwork promotes alignment during rapid change, as leaders actively reach out to each other for input (32). Crisis is a challenging time to develop trust, inclusion and teamwork; a pre-existing culture that includes these characteristics makes it easier to incorporate change, even though staff members within these units may be at different individual stages of change. The effectiveness of implementation in our unit demonstrates that developing a culture of quality improvement, multidisciplinary alignment, and trust has true long-term value. Based on our findings, preparedness measures for rapid change

implementation amid a crisis should include an evaluation by organizations of their own inner setting to optimize the learning climate and safety culture.

Implementation in the setting of L&D has generally been previously hampered by individual reluctance to change, pre-existing hierarchical structures and a lack of organizational policy or regulation (33). Given the context of the pandemic, the influence of some of these usual barriers to implementation may have been lessened. Early publications from international centers and anecdotal reports surrounding COVID-19 left significant room for confusion and interpretation. This may have led to a greater sense of anxiety amongst providers and delays in strategic alignment. This would have typically had a negative impact on implementation, however, in our study a significant observation was that the use of the checklist shortened the preparatory time needed for clinical care, as it provided clarity and unified thinking amongst staff with regards to implementation of clinical recommendations. Thus, the workflow checklist tool was adopted because of the absence of clear global policy. Through this process, it enabled rapid local adoption of the shared mental model and facilitated implementation, despite ongoing conflicting guidance from various national and international sources.

Reflecting on how the pandemic affected implementation outcome, it is worth noting that even in the context of an originally perceived barrier, the urgency and time pressure applied by the threat of an outbreak enabled a rapid transition of impact to facilitate change. The finding of implementation success, despite the presence of perceived barriers within the outer setting, inner setting and amongst the characteristics of individuals, was unexpected. This may be a reflection of the urgency brought about by the COVID-19 pandemic, or perhaps an indication that in the time of crisis, the influence imparted by constructs within these domains are minimal. Furthermore, we noted that drivers for change during the COVID-19 pandemic within our organization are different than during times of routine care. For instance, anxiety around healthcare worker infection rates, the associated stress of rapidly changing local policies and the unknown value of the innovation may negatively impact adherence to guidelines (5). In contrast, our agile team-centered implementation approach resulted in greater engagement and acceptance of the checklist as a central cohesive factor in enhancing care of these patients.

## **Strength and Limitations**

In this study we did not perform a comparative pre-post analysis, our evaluation is therefore limited to the post-implementation period. Retrospective evaluations of implementation are often performed to help explain success or failures; they are done at the end of the project and rely on key stakeholder experiences (13,34,35). Rankings of individual constructs was performed through a group deliberation approach, and agreement between raters about the influence of each construct on implementation was consistent, likely reflecting a high level of shared mental model and leadership engagement in the implementation process. We report mainly on the results of qualitative findings, however, in the context of the study objective, qualitative analyses may provide a deeper understanding of the barriers and facilitators for implementation (7). Quantitative results of implementation are limited to documented or observed use of the innovation but does not reflect a deeper investigation into the precision of its use.

## Conclusions

We describe the factors influencing implementation of a novel comprehensive obstetric workflow for care of the COVID-19 perioperative parturient during the first surge of the pandemic using the CFIR framework. Early workflow adoption was facilitated primarily by two domains, namely thoughtful innovation design and careful implementation planning in the setting of a long-standing culture of improvement. Factors initially assessed as barriers such as communication, culture and learning climate, transitioned into facilitators once a perceived benefit was experienced by healthcare teams. These key factors provide important information for the implementation of rapid change during a time of crisis.

## List Of Abbreviations

SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus-2
COVID-19	Coronavirus disease 2019
L&D	Labor and delivery
PPE	Personal protective equipment
CFIR	Consolidated Framework for Implementation Research
ERIC	Expert Recommendations for Implementing Change
IRB	Institutional review board
ACOG	American College of Obstetrics and Gynecology
SOAP	Society for Obstetric Anesthesia and Perinatology
APSF	Anesthesia Patient Safety Foundation
CDC	Centers for Disease Control
SQUIRE	Standards for Quality Improvement Reporting Excellence
TIDieR	Template for Intervention Description and Replication

## Declarations

*Ethics approval and consent to participate:*

As stated in the methods, this study was approved by our IRB at the Beth Israel Deaconess Medical Center and did not constitute human subject research, therefore the requirement for written informed consent was waived (Protocol number: 2020D000469).

*Consent for publication:* not applicable

*Availability of data and materials:* not applicable

*Competing interests:* The authors declare that they have no competing interests.

*Funding:* not applicable

*Authors' contributions:* All authors read and approved the final manuscript. **LZ** helped with study design, data analysis and interpretation, manuscript drafting. **NL** helped with data interpretation and manuscript drafting. **YL** helped with data interpretation and manuscript drafting. **TG** helped with data interpretation and manuscript drafting. **SAS** helped with data interpretation and manuscript drafting. **PEH** helped with study design, data analysis and interpretation, manuscript drafting. **SKR** helped with study conception, study design, data analysis and interpretation, manuscript drafting

*Acknowledgements:* not applicable

## References

1. World Health Organization (WHO). Coronavirus disease (COVID-19) outbreak. 2020.
2. Li Y, Ciampa EJ, Zucco L, Levy N, Colella M, Golen T, et al. Adaptation of an obstetric anesthesia service for the SARS-CoV-2 pandemic: description of checklists, workflows, and development tools. *Anesth Analg*. 2020 Sep;
3. Sabol B, Caughey AB. Quality Improvement and Patient Safety on Labor and Delivery. *Obstet Gynecol Clin North Am* [Internet]. 2017;44(4):667–78. Available from: <https://doi.org/10.1016/j.ogc.2017.08.002>
4. Fischer F, Lange K, Klose K, Greiner W, Kraemer A. Barriers and Strategies in Guideline Implementation—A Scoping Review. *Healthcare*. 2016;4(3):36.
5. Houghton C, Meskell P, Delaney H, Smalle M, Glenton C, Booth A, et al. Barriers and facilitators to healthcare workers' adherence with infection prevention and control (IPC) guidelines for respiratory infectious diseases: a rapid qualitative evidence synthesis (Review). *Cochrane Database Syst Rev*. 2020;(4).
6. Chaillet N, Dubé E, Dugas M, Audibert F, Tourigny C, Fraser WD, et al. Evidence-based strategies for implementing guidelines in obstetrics: A systematic review. *Obstet Gynecol*. 2006;108(5):1234–45.
7. Forsner T, Hansson J, Brommels M, Wistedt AT, Forsell Y. Implementing clinical guidelines in psychiatry: A qualitative study of perceived facilitators and barriers. *BMC Psychiatry*. 2010;10.
8. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science. *Implement Sci*. 2009;4(1):1–15.
9. King DK, Shoup JA, Raebel MA, Anderson CB, Wagner NM, Ritzwoller DP, et al. Planning for Implementation Success Using RE-AIM and CFIR Frameworks: A Qualitative Study. *Front Public Heal*. 2020;8(March):1–14.
10. Kirk MA, Kelley C, Yankey N, Birken SA, Abadie B, Damschroder L. A systematic review of the use of the Consolidated Framework for Implementation Research. *Implement Sci* [Internet]. 2016;11(1).

Available from: <http://dx.doi.org/10.1186/s13012-016-0437-z>

11. Waltz TJ, Powell BJ, Chinman MJ, Smith JL, Matthieu MM, Proctor EK, et al. Expert recommendations for implementing change (ERIC): Protocol for a mixed methods study. *Implement Sci.* 2014;9(1):1–12.
12. 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):1–14.
13. Zulman DM, Damschroder LJ, Smith RG, Resnick PJ, Sen A, Krupka EL, et al. Implementation and evaluation of an incentivized Internet-mediated walking program for obese adults. *Transl Behav Med.* 2013;3(4):357–69.
14. van Oers HA, Teela L, Schepers SA, Grootenhuis MA, Haverman L. A retrospective assessment of the KLIK PROM portal implementation using the Consolidated Framework for Implementation Research (CFIR). *Qual Life Res [Internet]*. 2020; Available from: <https://doi.org/10.1007/s11136-020-02586-3>
15. Ogrinc G, Davies L, Goodman D, Batalden P, Davidoff F, Stevens D. SQUIRE 2.0 (Standards for Quality Improvement Reporting Excellence): Revised publication guidelines from a detailed consensus process. *BMJ Qual Saf.* 2016;25(12):986–92.
16. Hoffmann TC, Glasziou PP, Boutron I, Milne R, Perera R, Moher D, et al. Better reporting of interventions: Template for intervention description and replication (TIDieR) checklist and guide. *BMJ [Internet]*. 2014;348(March):1–12. Available from: <http://dx.doi.org/doi:10.1136/bmj.g1687>
17. Chen X, Liu Y, Gong Y, Guo X, Zuo M, Li J, et al. Perioperative Management of Patients Infected with the Novel Coronavirus. *Anesthesiology.* 2020;(Xxx):1.
18. Podovei M, Bernstein K, George R, Habib A, Kacmar R, Bateman B, et al. Interim Considerations for Obstetric Anesthesia Care related to COVID19 [Internet]. Society for Obstetric Anesthesia and Perinatology. 2020 [cited 2020 Apr 21]. Available from: <https://soap.org/education/provider-education/expert-summaries/interim-considerations-for-obstetric-anesthesia-care-related-to-covid19/>
19. Boelig RC, Manuck T, Oliver EA, Di Mascio D, Saccone G, Bellussi F, et al. Labor and Delivery Guidance for COVID-19. *Am J Obstet Gynecol MFM [Internet]*. 2020;100110. Available from: <https://doi.org/10.1016/j.ajogmf.2020.100110>
20. Zucco L, Levy N, Ketchandji D, Aziz M, Ramachandran SK. Perioperative Considerations for the 2019 Novel Coronavirus (COVID-19) [Internet]. Anesthesia Patient Safety Foundation. 2020 [cited 2020 Apr 22]. Available from: <https://www.apsf.org/news-updates/perioperative-considerations-for-the-2019-novel-coronavirus-covid-19/>
21. Bernstein PS, Combs CA, Shields LE, Clark SL, Eppes CS. The development and implementation of checklists in obstetrics. *Am J Obstet Gynecol [Internet]*. 2017;217(2):B2–6. Available from: <http://dx.doi.org/10.1016/j.ajog.2017.05.032>
22. Etchells E, Ho M, Shojania KG. Value of small sample sizes in rapid-cycle quality improvement projects. *BMJ Qual Saf.* 2016;25(3):202–6.

23. Etchells E, Woodcock T. Value of small sample sizes in rapid-cycle quality improvement projects 2: Assessing fidelity of implementation for improvement interventions. *BMJ Qual Saf.* 2018;27(1):61–5.
24. Taras J, Everett T. Rapid Cycle Deliberate Practice in Medical Education - a Systematic Review. *Cureus.* 2017 Apr 19;
25. Obstetric Workflows & Checklists [Internet]. COVID-19 Resources; Department of Anesthesia, Critical Care and Pain Medicine at Beth Israel Deaconess Medical Center. 2020 [cited 2020 Apr 29]. Available from: [https://anesthesia.bidmc.harvard.edu/AnesPortal/Documents/2020\\_Covid\\_19/OB/L&D Workflow for COVID\\_Combined.pdf](https://anesthesia.bidmc.harvard.edu/AnesPortal/Documents/2020_Covid_19/OB/L&D Workflow for COVID_Combined.pdf)
26. Stetler CB, Legro MW, Wallace CM, Bowman C, Guihan M, Hagedorn H, et al. The role of formative evaluation in implementation research and the QUERI experience. *J Gen Intern Med.* 2006;21(SUPPL. 2):1–8.
27. Damschroder LJ, Lowery JC. Evaluation of a large-scale weight management program using the consolidated framework for implementation research (CFIR). *Implement Sci.* 2013 May;8(152):1–17.
28. Francke AL, Smit MC, De Veer AJE, Mistiaen P. Factors influencing the implementation of clinical guidelines for health care professionals: A systematic meta-review. *BMC Med Inform Decis Mak.* 2008;8:1–11.
29. Kilsdonk E, Peute LW, Jaspers MWM. Factors influencing implementation success of guideline-based clinical decision support systems: A systematic review and gaps analysis. *Int J Med Inform [Internet].* 2017;98:56–64. Available from: <http://dx.doi.org/10.1016/j.ijmedinf.2016.12.001>
30. Grimshaw J, Freemantle N, Wallace S, Russell I, Hurwitz B, Watt I, et al. Effectiveness Bulletin Developing and implementing clinical practice guidelines. *Qual Heal Care.* 1995;4:55–64.
31. Maqbool A, Zaman N. Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID- 19 . The COVID-19 resource centre is hosted on Elsevier Connect , the company ' s public news and information . 2020;(January).
32. Wensing M, Wensing M, Sales A, Sales A, Armstrong R, Wilson P, et al. Implementation science in times of Covid-19. *Implement Sci.* 2020;15(1):1–4.
33. Bermúdez-Tamayo C, Fernández Ruiz E, Pastor Moreno G, Maroto-Navarro G, Garcia-Mochon L, Perez-Ramos FJ, et al. Barriers and enablers in the implementation of a program to reduce cesarean deliveries. *Reprod Health.* 2017;14(1):1–13.
34. English M, Nzinga J, Mbindyo P, Ayieko P, Irimu G, Mbaabu L. Explaining the effects of a multifaceted intervention to improve inpatient care in rural Kenyan hospitals - interpretation based on retrospective examination of data from participant observation, quantitative and qualitative studies. *Implement Sci [Internet].* 2011;6(1):124. Available from: <http://www.implementationscience.com/content/6/1/124>
35. Green CA, McCarty D, Mertens J, Lynch FL, Hilde A, Firemark A, et al. A qualitative study of the adoption of buprenorphine for opioid addiction treatment. *J Subst Abuse Treat.* 2014;46(3):390–401.

# Tables

Table 1: CFIR Domain - Process

<b>CFIR Constructs and Definitions</b>	<b>Ranking</b>	<b>Reason for Assigned Ranking</b>	<b>Score</b>
<b>Planning:</b> The degree to which a scheme or method of behaviour and tasks for implementing an innovation are developed in advance, and the quality of those schemes or methods.	F	The innovation was tested in real-time within the organization, assessed and modified, prior to implementation in L&D. There was a role for all stakeholders in the planning process, tracked the implementation process.	1
<b>Engaging:</b> Attracting and involving appropriate individuals in the implementation and use of the innovation through a combined strategy of social marketing, education, role modelling, training, and other similar activities.	F	Staff members were engaged with the innovation, invited to use the checklist during live cases, participated in debriefings and did not require repeated attempts to engage. This engagement encouraged feedback and enabled the rapid improvement of steps within the checklist.	1
<b>Opinion Leaders:</b> Individuals in an organization that have formal or informal influence on the attitudes and beliefs of their colleagues with respect to implementing the innovation.	F	Clinical leaders within L&D were engaged with the innovation and were actively involved in each step of implementation, assessment and improvement.	1
<b>Formally Appointed Internal Implementation Leaders:</b> Individuals from within the organization who have been formally appointed with responsibility for implementing an innovation as coordinator, project manager, team leader or another similar role	F	A formally appointed quality and safety lead (SKR) supported and enabled implementation of this innovation. Clinical leads and local stakeholder buy-in was present.	1
<b>Champions:</b> Individuals who dedicate themselves to supporting, marketing, and ‘driving through’ an [implementation]”, overcoming indifference or resistance that the innovation may provoke in an organization.	F	The innovation was informally championed by our surgical obstetric divisional lead.	1
<b>External Change Agents:</b> Individuals who are affiliated with an outside entity who formally influence or facilitate innovation decisions in a desirable direction.	NA	We did not have an outside organization assisting with implementation, this was internally driven and tested.	NA
<b>Key Stakeholders:</b> Individuals from within the organization that are directly impacted by the innovation, e.g., staff responsible for making referrals to a new program or using a new work process.	F	Key stakeholders, including a designated quality and safety team, were engaged with the innovation and assisted in the development, implementation, assessment and improvement of the innovation.	1
<b>Innovation Participants:</b> Individuals served by the organization that participate in the innovation, e.g., patients in a prevention program in a hospital.	NI	The ‘participants’ in this study were considered the patients with confirmed or under investigation for COVID-19. These participants did not impact implementation.	0
<b>Executing:</b> Carrying out or accomplishing the implementation according to plan.	F	The redesigned workflow was implemented rapidly, in a concise manner, according to plan.	1
<b>Reflecting &amp; Evaluating:</b> Quantitative and qualitative	F	The implementation team consistently assessed	1

feedback about the progress and quality of implementation accompanied with regular personal and team debriefing about progress and experience.

the progress of implementation and the quality of the innovation in order to promote continuous quality improvement.

barrier, CFIR: Consolidated Framework for Implementation Research, F: facilitator, NA: not applicable, NI: no impact.

## Table 2: CFIR Domain - Innovation Characteristics

<b>CFIR Constructs and Definitions</b>	<b>Ranking</b>	<b>Reason for Assigned Ranking</b>	<b>Score</b>
<b>Intervention source:</b> Perception of key stakeholders about whether the innovation is externally or internally developed.	F	The intervention came from within the organization, it was an internally developed workflow checklist, not from outside policy makers or regulatory bodies.	1
<b>Evidence, strength &amp; quality:</b> Stakeholders' perceptions of the quality and validity of evidence supporting the belief that the innovation will have desired outcomes.	F	The intervention came from a trusted internal source and from an expert group with awareness of local needs. Though guided by literature from previous epidemics, there was little peer-reviewed evidence of what exactly was needed to promote effectiveness.	1
<b>Relative advantage:</b> Stakeholders' perception of the advantage of implementing the innovation versus an alternative solution.	F	National guidelines and recommendations for managing obstetric COVID-19 patients were collected, synthesised, and disseminated among the stakeholders; however, there was wide variety of interpretation as to the implementation of these in practice. Implementing a sequential checklist was perceived to be faster at producing alignment.	1
<b>Adaptability:</b> The degree to which an innovation can be adapted, tailored, refined, or reinvented to meet local needs	F	The ability to adapt the innovation to the local obstetric context was clear. Input from multiple disciplines (OB, anesthesia, nursing, NICU) were involved in deciding whether changes were needed to the intervention.	1
<b>Trialability:</b> The ability to test the innovation on a small scale in the organization, and to be able to reverse course (undo implementation) if warranted.	F	Immediate testing was possible. The intervention was used during real cases with the ability to reverse the implementation if required.	1
<b>Complexity:</b> Perceived difficulty of the innovation, reflected by duration, scope, radicalness, disruptiveness, centrality, and intricacy and number of steps required to implement.	B	The workflow was felt to be very complex, involved several aspects of care that were not intuitive and required several iterations to improve performance. It required extra staff members for implementation compared to routine care, which was perceived as a further complication that may have hindered adoption, in particular if staffing levels were low..	0
<b>Design Quality &amp; Packaging:</b> Perceived excellence in how the innovation is bundled, presented, and assembled.	F	The initial reception of the innovation was positive and the quality perceived to be high.	1
<b>Cost:</b> Costs of the innovation and costs associated with implementing the innovation including investment, supply, and opportunity costs.	F	The cost of implementation was the additional manpower needed to ensure the checklist was being followed as the many steps would be impossible to memorise in a short period of time.	1

rier, CFIR: Consolidated Framework for Implementation Research, F: facilitator, NA: not applicable, NI: no impact.

### File 3: CFIR Domain - Inner Setting

CFIR Constructs & their definitions	Ranking	Reason for Assigned Ranking	Score
<b>Structural Characteristics:</b> The social architecture, age, maturity, and size of an organization.	F	The intervention took place within the L&D unit, which is a world-leading center of excellence in obstetrics and in anesthesia, and well-established division within the medical center. They have clear processes in place to facilitate quality improvement.	1
<b>Networks &amp; Communications:</b> The nature and quality of webs of social networks, and the nature and quality of formal and informal communications within an organization.	Change over time B to F	Clear lines of communication were not initially evident within the organization regarding this innovation; it was an initial source of frustration for where to locate the most up to date resource. This was rectified over the course of implementation and communicated through the hospital's COVID intranet. Further communication improvements at the local departmental levels, via intranet, email and teleconferencing permitted inter-professional collaborative work.	0
<b>Culture:</b> Norms, values, and basic assumptions of a given organization.	Change over time B to F	While the culture within the L&D unit was accustomed to the use of checklists, standard operating procedures, and iterative cycle improvement. Additional internal forces along with external pressures of fears and anxiety, were present that affected the cohesion of the unit. Pre-existing egotism and individuality initially impacted implementation negatively. In view of the urgency of COVID-19, recognition that assistance outside of the L&D unit was required, sought and later welcomed over the course of the implementation.	0
<b>Implementation Climate:</b> The absorptive capacity for change, shared receptivity of involved individuals to an innovation, and the extent to which use of that innovation will be rewarded, supported, and expected within their organization.	F	Within the organization and within the L&D unit, there was clear receptivity to implementing the innovation. It aligned with existing frameworks already in place, including the use of cognitive aids, checklists, team training and iterative process improvement. Although the checklist and processes were developed quickly, limiting stakeholder buy-in, the implementation climate supported the innovation and valued its use.	1
<b>Tension for Change:</b> The degree to which stakeholders perceive the current situation as intolerable or needing change.	F	The innovation was absolutely necessary, as the outbreak revealed gaps in our workflow for the COVID-19 parturient.	1
<b>Compatibility:</b> The degree of tangible fit between meaning and values attached to the innovation by involved individuals, how those align with individuals' own norms, values, and	F	The innovation was based upon frameworks already used within the organization (e.g.: cognitive aids, checklists) and therefore demonstrated compatibility with organizational values and work processes	1

perceived risks and needs, and how the innovation fits with existing workflows and systems.			
<b>Relative Priority:</b> Individuals' shared perception of the importance of the implementation within the organization.	F	There was clarity in the priority and urgency of this innovation. Given the anticipated surge of potential COVID-19 patients on L&D, implementing this workflow was a priority for all staff.	1
<b>Organizational Incentives &amp; Rewards:</b> Extrinsic incentives such as goal-sharing, awards, performance reviews, promotions, and raises in salary, and less tangible incentives such as increased stature or respect.	NA	This innovation was not associated with an external policy or incentive, financial or otherwise.	NA
<b>Goals and Feedback:</b> The degree to which goals are clearly communicated, acted upon, and fed back to staff, and alignment of that feedback with goals.	F	This innovation was aligned with organizational and departmental goals, and feedback was obtained to help understand if any gaps existed between the current organizational status and the perceived goal.	1
<b>Learning Climate:</b> A climate in which: 1. Leaders express their own fallibility and need for team members' assistance and input; 2. Team members feel that they are essential, valued, and knowledgeable partners in the change process; 3. Individuals feel psychologically safe to try new methods; and 4. There is sufficient time and space for reflective thinking and evaluation.	Change over time B to F	The time pressure resulted, initially, in insufficient time to for reflective thinking and evaluation.  Leaders within L&D valued the input of all inter-professional team members and, over time, staff members involved in the implementation felt like a valued partner in the change process.	0
<b>Readiness for Implementation:</b> Tangible and immediate indicators of organizational commitment to its decision to implement an intervention.	F	The L&D leadership demonstrated a readiness to change; they sought out assistance and innovation.	1
<b>Leadership Engagement:</b> Commitment, involvement, and accountability of leaders and managers with the implementation of the innovation	F	Organizational leaders demonstrated a dedicated level of engagement and invested adequate time and resource to the innovation. This included the Director of L&D, division director of maternal-fetal-medicine, division direction of OB anesthesia, Anesthesia Executive Vice Chair, and the Vice Chair for quality and safety	1
<b>Available Resources:</b> The level of resources dedicated for implementation and on-going operations including physical space and time.	F	Resources, including time, were allocated specifically to the innovation being implemented.  Resources in particular: implementation team released from clinical duties to develop and implement this innovation	1
<b>Access to Knowledge &amp; Information:</b> Ease of	B	Access to information regarding the innovation was	0

access to digestible information and knowledge about the innovation and how to incorporate it into work tasks.		difficult initially, due to version updates. All information was eventually made readily available throughout the organization through the intranet	
--	--	---	--

rier, CFIR: Consolidated Framework for Implementation Research, F: facilitator, NA: not applicable, NI: no impact.

**Table 4: CFIR Domain - Outer Setting**

CFIR Constructs & Definitions	Ranking	Reason for Assigned Ranking	Score
<b>Patient Needs &amp; Resources:</b> The extent to which the needs of those served by the organization (e.g., patients), as well as barriers and facilitators to meet those needs, are accurately known and prioritised by the organization.	Change over time B to F	Despite the purpose of the intervention being focused on managing the patient, it was designed for use amongst the healthcare force.  Initially the perceived purpose of the checklist and usefulness for care of the COVID-19 patient was not clear to some staff, creating a barrier for implementation. After the experience gained from a real case and spread of knowledge from the debriefing process after the case, the perceived benefit of the checklist then acted as a facilitator.	0
<b>Cosmopolitanism:</b> The degree to which an organization is networked with other external organizations.	NA	Networking with external organizations did not apply in this circumstance.	NA
<b>Peer Pressure:</b> Mimetic or competitive pressure to implement an innovation, typically because most or other key peer or competing organizations have already implemented or are in a bid for a competitive edge.	B	Differences in international and regional guidelines for preparedness and practice for the clinical care of patients with COVID-19 on the L&D Unit resulted in interdepartmental conflicts that impacted behaviours and impacted the readiness for alignment.	0
<b>External Policy &amp; Incentives:</b> A broad construct that includes external strategies to spread innovations including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting.	B	The leadership was in communication colleagues in China, Italy and other centers in the United States. In the early stages the practices and societal recommendations varied considerably, and this affected expectations and prevented shared mental models. This impacted the readiness for alignment.	0

: barrier, CFIR: Consolidated Framework for Implementation Research, F: facilitator, NA: not applicable, NI: no impact.

**Table 5: CFIR Domain - Characteristics of Individuals**

<b>CFIR Constructs and Definitions</b>	<b>Ranking</b>	<b>Reason for Assigned Ranking</b>	<b>Score</b>
<p><b>Knowledge &amp; Beliefs about the Intervention:</b></p> <p>Individuals' attitudes toward and value placed on the innovation, as well as familiarity with facts, truths, and principles related to the innovation.</p>	NI	<p>Individual stakeholders shared a belief that the intervention was necessary and were seeking an innovation. Obtaining the checklists and processes was challenging initially due to a lack of coordinated communication. There were disagreements with the impact of this construct with equal weighting for facilitator or barrier. It was therefore scored neutrally as having no influence on implementation outcome</p>	0
<p><b>Self-efficacy:</b> Individual belief in their own capabilities to execute courses of action to achieve implementation goals.</p>	F	<p>There was confidence in the ability to implement the intervention and that staff members would be able to use the intervention.</p>	1
<p><b>Individual Stage of Change:</b></p> <p>Characterization of the phase an individual is in, as s/he progresses toward skilled, enthusiastic, and sustained use of the innovation.</p>	NI	<p>Various roles and responsibilities within the organization of staff members affected how they readiness for adoption in the initial stages of implementation.</p>	0
<p><b>Individual Identification with Organization:</b> A broad construct related to how individuals perceive the organization, and their relationship and degree of commitment with that organization.</p>	F	<p>There was broad consensus that all staff members were working toward a common organizational goal.</p>	1
<p><b>Other Personal Attributes:</b> A broad construct to include other personal traits such as tolerance of ambiguity, intellectual ability, motivation, values, competence, capacity, and learning style.</p>	B	<p>Despite several positive traits among stakeholders in terms of willingness to implement changes, expectations toward standard operating procedures and innovation. We identified negative traits such as tribalism, egotism and individualism which affected implementation.</p>	0

*B: barrier, CFIR: Consolidated Framework for Implementation Research, F: facilitator, NA: not applicable, NI: no impact.*

# Figures

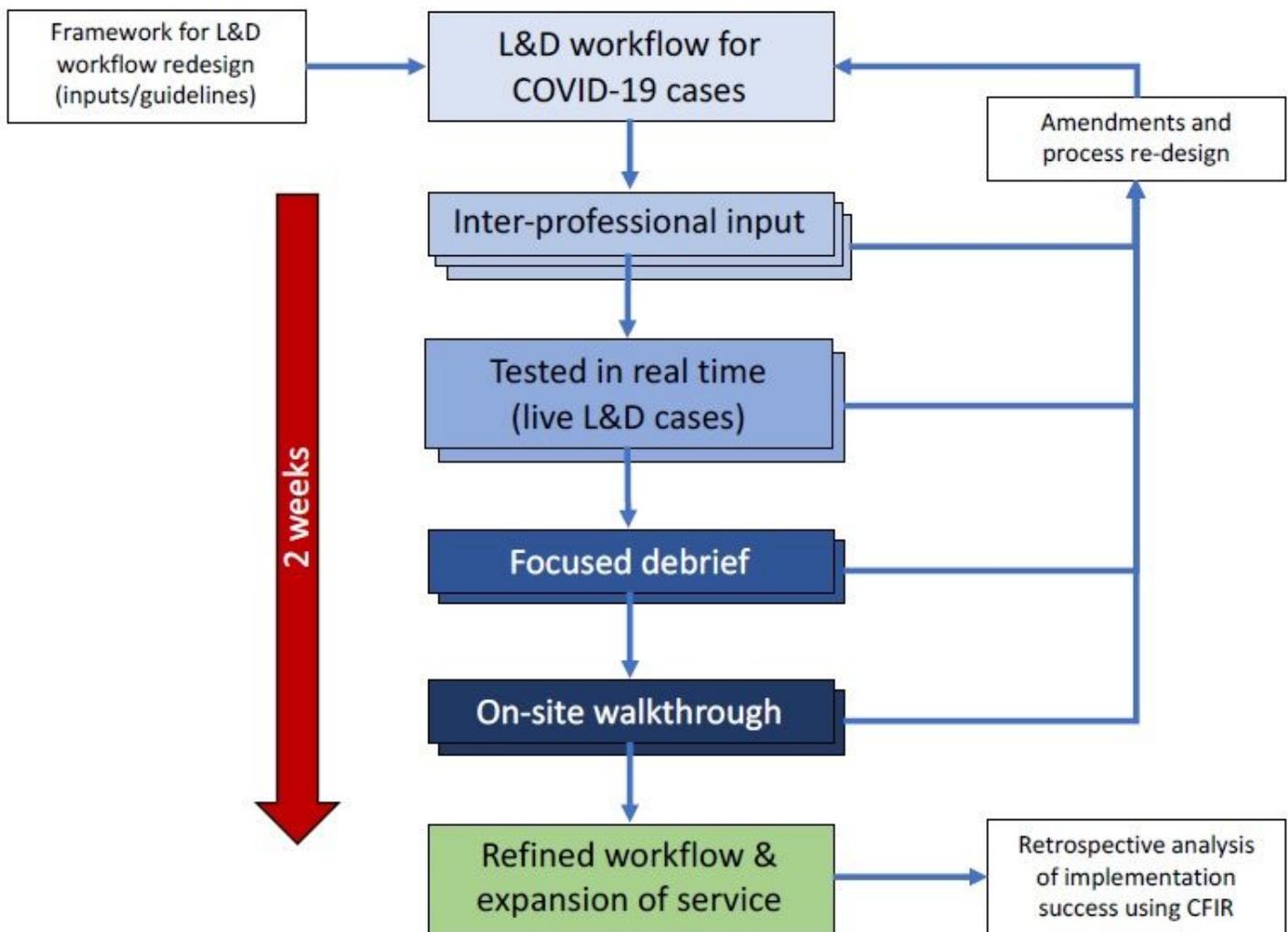


Figure 1

Rapid cycles of change. Schematic representation of rapid-cycle implementation, demonstrating how the individual processes of inter-professional input, testing in real-time, focused debriefing, on-site walkthroughs and iterative re-design contributed to our final refined product. CFIR: Consolidated framework for implementation research, L&D: labor and delivery.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [TIDieRChecklistWordOBCOVID19checklist.docx](#)
- [SupplementalMaterials.docx](#)