Outcomes of a novel mentorship approach tested in two regions of Madagascar

Data Analysis Report

Executive Summary

We present here selected results from an implementation study of a novel mentor support approach—in-situ realistic postpartum hemorrhage (PPH) simulations enhanced with a digital tool, Virtual Mentor--conducted in two regions of Madagascar between October and December 2020. 15 experienced health care workers and senior Madagascar Ministry of Public Health (MoPH) staff agreed to act as mentors for this project, in addition to their regular work. We trained these mentors to facilitate simulated PPH scenarios during 4 visits to 20 frontline health facilities so that birth care providers could practice correct clinical management within their own clinics in realistic but safe conditions. A patient actress played the part of the birthing woman and simulation materials we provided ensured the PPH simulations were realistic. We also provided a hands-free, French-language chatbot, the "Virtual Mentor," and trained the providers to talk to this chatbot while they practice the optimal management of common causes of PPH and plan of care for a woman in danger from excessive blood loss. The algorithm guiding the chatbot's conversation flow is defined by national and global (World Health Organization) standards for PPH management. We call this chatbot "Virtual Mentor."

We asked the following research questions before beginning the study.

- Primary research question:
  - ○ Does a mentorship approach using in-situ realistic simulations enhanced with interactions with Virtual Mentor lead to increases in knowledge and self-efficacy related to PPH management among providers?
- Secondary research questions:
  - ○ Is the Virtual Mentor feasible, acceptable, and usable by providers and mentors as a training tool?

We used eight data collection instruments to determine preliminary answers to these questions. These included questionnaires and open-ended interviews at different timepoints. The instrument with the highest number of total responses at a single time point included 38 providers and mentors from the 20 health centers.

Reported in detail below, our results suggest that

1. Interaction with Virtual Mentor during PPH simulations resulted in increased PPH knowledge and self-efficacy among providers.
2. Virtual Mentor is considered moderately feasible by providers, with some concern for cultural appropriateness, position of the device in the clinical space, and power source.
3. Virtual Mentor is considered highly acceptable by providers.
4. Virtual Mentor is considered moderately usable by providers, with a significant concern for accurate speech recognition.
5. Providers are tentatively enthusiastic about the potential use of Virtual Mentor in actual patient care, stating the tool decreases fear, replaces the assistance of an absent colleague, and is preferred to looking at wall charts.

Finally, we recommend further improvements to and scale of this novel mentorship approach, with the following action items:

1. Increase access to this mentorship approach
   - Scale the program piloted in this study to more health facilities
2. Improve providers' experience with Virtual Mentor
   - Change the language the chatbot "speaks" to the providers' first language, with upgrades to the voice-recognition software
   - Invest in custom-made, wearable mobile devices with high-quality microphones that will more reliably recognize the provider's voice during hands-free conversation
   - Add other clinical scenarios to the chatbot's capacity, starting with maternal hypertension/preeclampsia/eclampsia
3. Re-design Virtual Mentor to increase appropriateness and usability
   - Implement providers' feedback to improve VM's algorithm
   - Conduct interviews with providers, birthing women, and their family members at frontline facilities and collect data about increasing appropriateness for this context
4. Increase Mentors' preparation
   - Expand mentor training to provide a total of 5 in person training days for new Mentors, focused on mastering simulation skills, add to remote digital simulation educator content
   - Add training for high-priority skills and procedures, such as estimating blood loss, aortic compression, uterine balloon tamponade
5. Refine tools intended to capture PPH management knowledge and confidence
6. Design and conduct a pilot study for use of Virtual Mentor in actual patient care
   - Study safety, reliability, usability, and effectiveness

Acronyms

ATS   Atsinanana region of Madagascar

CSB   Centre de Santé de Base (Basic Health Center)

PPH   Postpartum hemorrhage

V7V   Vatovavy Fitovinany region of Madagascar

VM   Virtual Mentor/Mentor Virtuel

WHO   World Health Organization

Appendices

Introduction

Background

Nearly one-quarter of global maternal deaths are associated with postpartum hemorrhage (PPH). PPH remains the leading cause of maternal death in most low-income countries, requiring additional research on prevention and treatment options. In Madagascar, the maternal mortality ratio (MMR) in 2017 was 335/100,000, according to the World Health Organization and others.[1] PPH is the leading cause of maternal mortality and responsible for 31.48% of maternal deaths, with most PPH deaths occurring within the first 24 hours after delivery.[2]

In response to this challenge, USAID has complemented its longstanding efforts to accelerate reductions in maternal deaths with a one-time catalytic investment in Malawi and Madagascar called Advancing Postpartum Hemorrhage Care (APPHC). No single intervention will significantly decrease maternal mortality associated with PPH. Rather, approaches that strengthen health systems, such as increasing health worker capacity, are most likely to optimize population outcomes.[3,4] There is an acute shortage of skilled birth attendants in low- and middle-income countries, and their workload has increased dramatically with the rapid increase in facility births over the past 10 years. This has left many skilled birth attendants having to work alone and oftentimes having to handle rare emergencies such as PPH without support and with limited up to date skills and knowledge leading to poor outcomes. Robust support mechanisms to maintain high standards of clinical performance are vital especially where there is shortage of staff like in many frontline delivery units.

Two priorities emerged from the APPHC process. First, stakeholders prioritized a sustainable clinical mentorship intervention to strengthen the capacity of maternity care providers. Second, a qualitative research study completed in June 2019 suggested that behaviorally informed interventions, designed specifically for the providers' context of care, could improve quality and outcomes.

Mentorship intervention

The HEARD Project, with technical leadership from UCSF and collaboration from the Madagascar Ministry of Public Health and the USAID ACCESS Project, conducted a pilot study in two regions of Madagascar. Vatovavy Fitovinany ("V7V") region and Atsinanana ("ATS") region had the highest number of maternal deaths at CSBs in 2020.[5] This study tested a novel approach to strengthen provider capacity to prevent and treat PPH. The components of the approach include: i) a mentorship model using clinical simulations enhanced with a digital application and ii) a set of new provider support tools to enhance the clinical environment and optimize provider behaviors. This document reports on the effectiveness, acceptability, and sustainability of the first component, the mentorship intervention. Detailed information about the implementation process is available in a separate report, titled "An innovative approach to strengthen provider capacity for the prevention and treatment of postpartum hemorrhage at frontline facilities."

The mentorship intervention was implemented by 15 local physicians and midwives who were recruited for their clinical experience and interest in the project. The intervention was tested in ATS and V7V regions (simultaneously) from October to December 2020, and data collection continued through February 2021. Table 1 includes the names of facilities that participated in this pilot study. In the ATS region, 10 CSBs were chosen in the districts of Toamasina II, Brickaville, and Vatomandry; at these 10 CSBs, 15 providers participated in the study. 16 providers participated in the V7V region, at 10 CSBs chosen in the districts of Vohipeno and Manakara. At 70% of these CSBs, 1 provider participated; at 30% of these CSBs, 2-3 providers participated.

[1] Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva: World Health Organization; 2019, p 74.

[2] Besaina R et al. Maternal mortality related to postpartum hemorrhage: a case-control study at the Befelatanana maternity of Madagascar. Int J Reprod Contracept Obstet Gynecol 2018, 8(1):121-126.

[3] Chen L, Evans T, Anand S, Boufford JI, Brown H, Chowdhury M, Cueto M, Dare L, Dussault G, Elzinga G: Human resources for health: overcoming the crisis. The Lancet 2004, 364(9449):1984-1990.

[4] Rasch V: Maternal death and the millennium development goals. Dan Med Bull 2007, 54(2):167-169.

[5] Madagascar Ministry of Health. 2020. Digital Health Information System, version 2.

TABLE 1. LIST OF CSBS THAT BENEFITED FROM THE INTERVENTIONS

Region	District	Municipality	Facility Type	Name of the health facility	Number of providers
CSBs that received PPH simulation with Virtual Mentor plus Provider Support Tools					
VATOVAVY FITOVINANY	VOHIPENO	Agnoloka	CSB2	CSB2 Agnoloka	1
VATOVAVY FITOVINANY	VOHIPENO	Andemaka	CSB2	CSB2 Andemaka	2
VATOVAVY FITOVINANY	VOHIPENO	Ivato Savana	CSB2	CSB2 Ivato	2
VATOVAVY FITOVINANY	VOHIPENO	Mahasoabe	CSB2	CSB2 Mahasoabe	1
VATOVAVY FITOVINANY	VOHIPENO	Nato	CSB2	CSB2 Nato	1
VATOVAVY FITOVINANY	VOHIPENO	Vohindava	CSB2	CSB2 Vohindava	2
VATOVAVY FITOVINANY	VOHIPENO	Vohitrindry	CSB2	CSB2 Vohitrindry	2
VATOVAVY FITOVINANY	MANAKARA ATSIMO	Ambila	CSB2	CSB2 Ambila	1
VATOVAVY FITOVINANY	MANAKARA ATSIMO	Marofarihy	CSB2	CSB2 Marofarihy	3
VATOVAVY FITOVINANY	MANAKARA ATSIMO	Sakoana	CSB2	CSB2 Sakoana	1
CSBs that received only PPH simulation with Virtual Mentor					
ATSINANANA	BRICKAVILLE	Ambinaninony	CSB2	CSB2 Ambinaninony	1
ATSINANANA	BRICKAVILLE	Brickaville	CSB2	CSB2 Maromamy	1
ATSINANANA	BRICKAVILLE	Brickaville	CSB2	CSB2 Brickaville	2
ATSINANANA	TOAMASINA 2	Foulpointe Mahavelona	CSB2	CSB2 Foulpointe Mahavelona	2
ATSINANANA	TOAMASINA 2	Antetezambaro	CSB2	CSB2 Antetezambaro	1
ATSINANANA	TOAMASINA 2	Toamasina Suburbaine	CSB1	CSB1 Ambalamanasy Mitsimbina IV	1
ATSINANANA	TOAMASINA 2	Toamasina Suburbaine	CSB2	CSB2 Lazaret	1
ATSINANANA	VATOMANDRY	Ambodivoananto	CSB2	CSB2 Ambodivoananto	2
ATSINANANA	VATOMANDRY	Maintinandry	CSB2	CSB2 Maintinandry	2
ATSINANANA	VATOMANDRY	Tsarasambo	CSB2	CSB2 Tsarasambo	1

Virtual Mentor and PPH simulations

We created Virtual Mentor to fill a gap: frontline health workers lack effective decision support tools to implement the most up-to-date, evidence- and place-based treatment protocols, especially during emergencies. A 2018 report on maternal death published by the government of Kenya found that in 91 percent of cases, "a different management of care could have made a difference to the outcome." Additionally, frontline health workers are often alone; working at remote health centers and dispensaries. During obstetric emergencies, printed protocols, wall charts, paper checklists, and resources that require manual manipulation are of little use to a healthcare worker who is anxious, tired, or alone and needs both gloved hands to deliver proper patient care.

Virtual Mentor is a novel digital health application, originally co-designed with nurses and midwives in Kenya. For this pilot study in Madagascar, we changed the chatbot's language from English to French and revised the chatbot's PPH management algorithm to be consistent with both national and global (WHO) standards. The application, which can be used on any Android device, was downloaded to Lenovo Tab 7 devices that were easily available in Madagascar. Mentors carried the tablets during visits to CSBs.

In order that CSB providers could practice optimal PPH treatment while talking to Virtual Mentor, providers were invited to participate in PPH simulations. These PPH simulations offer birth care providers opportunities to practice correct clinical management in realistic but safe conditions, in their own work environments. We created simulation scripts for 4 PPH scenarios, from mild to severe PPH. 1 PPH scenario was simulated at each of 4 visits made to all 20 CSBs that participated in the study. In this study, simulations were conducted using materials created by a non-governmental organization called PRONTO International. A patient actress played the part of the birthing woman and these unique simulation materials, such as fake blood, made the PPH simulation seem realistic. At each CSB visit, the mentor conducted a brief review of recommended PPH treatment, and then mentors acted as simulation facilitators and coaches while a patient actress played the role of the woman experiencing PPH.

Provider support tools

A separate set of provider support tools meant to enhance the clinical care environment to optimize PPH care in the CSB was implemented in the 10 CSBs in the V7V region. The provider support tools included:

a). An activity to increase the perception of the risk of PPH and visualize the consequences of not respecting best practices, in order to motivate a commitment in favor of the prevention of PPH.

b). An oxytocin timer that assists in the timely administration of oxytocin (within 1 minute of birth) after childbirth and other clinical tasks.

c). A set of badges explaining the supportive roles that family members can play during childbirth, to facilitate task sharing with providers.

d). A simplified and visual poster of the clinical algorithm on how to manage a case of PPH, printed on phosphorescent paper, that glows in the dark. (see Appendix 1)

Mentors were asked to introduce these tools to providers during the first visit to CSBs in the V7V region by showing them a series of short orientation videos. The tools were intended to be used routinely by those providers during the remainder of the study period.

Mentor training

Fifteen experienced health care workers and senior Madagascar Ministry of Health (MoH) staff agreed to act as mentors for this project, in addition to their regular work. Eleven midwives were recruited to participate as patient actresses. The local research agency TANDEM provided data collection services and a TANDEM staff member accompanied the mentor on each CSB visit.

Mentors, patient actresses, TANDEM staff, and ACCESS and MoH representatives convened for 3 total days of training. The training included

- learning sessions facilitated by US-based trainers who joined via Zoom,
- hands-on PPH simulation skills practice of all 4 scenarios, and
- experience "talking" to Virtual Mentor via the tablet devices.

Mentors and patient actresses prepared to visit each CSB 4 times during this pilot study and conduct a different PPH simulation at each visit.

Data collection

10 research assistants and 3 regional supervisors from the TANDEM team collected data from the CSB providers and mentors throughout the study period. They administered several data collection instruments at various time points. The timing of the data collection activities reported in this document is summarized in Table 2.

TABLE 2. TIMING OF ADMINISTRATION OF VARIOUS DATA COLLECTION INSTRUMENTS

Data collection instrument	Visit 1	Visit 2	Visit 3	Visit 4	Endline
Pre and post assessment of PPH knowledge (questionnaire and case study)	P			P	
Pre and post self-efficacy questionnaire	P			P	
System Usability Scale	P			P/M	
Acceptability and feasibility questionnaire	P			P/M	
Simulation behavior checklist	P	P	P	P	
Sustainability interview (brief)				P	
Provider experience interview (long)					M

P=instrument administered to provider; M=instrument administered to or completed by mentor

We used these data collection instruments to evaluate effectiveness, acceptability, and feasibility of the intervention. These instruments are available as appendices to this document. Table 3 provides a brief description of each instrument.

TABLE 3: BRIEF DESCRIPTION OF DATA COLLECTION INSTRUMENTS USED TO EVALUATE MENTORSHIP INTERVENTION

Instrument	Description
Pre and post assessment of PPH knowledge	Two related instruments that were created for this pilot study • Questionnaire: 10 questions about PPH prevention, causes, and treatments, with multiple choice options and 1 correct answer per question • Case study or "vignette": an open-ended interview about a hypothetical woman experiencing PPH
Pre and post self-efficacy questionnaire	7-item questionnaire created for this study
System Usability Scale	10-item questionnaire validated and used widely in technology product design
Acceptability and feasibility questionnaire	A questionnaire measuring implementation outcomes
Simulation behavior checklist	A checklist of all the PPH treatment behaviors recommended by Virtual Mentor in any of the PPH simulations
Sustainability interview	A short open-ended interview administered to providers focused on assessing sustainability of this pilot program
Provider experience interview	A longer interview eliciting provider opinions about the health system's capacity to prevent and treat PPH and the role of this study's interventions in increasing that capacity

At the end of the study period, TANDEM provided tables aggregating all collected data by instrument and by region and transcripts (in Malagasy and French) of all interviews. In this report, we present results most relevant to the mentorship approach using PPH simulations with Virtual Mentor, by instrument, with simple descriptive statistics of quantitative data and thematic analysis of qualitative data.

Data collection instrument 1. PPH knowledge questionnaire

Methods

Research assistants administered a multiple-choice, 10-item PPH knowledge questionnaire (Appendix 2) before the first mentor visit (including a simulation session with use of VM) (pre-intervention) and after the last mentor visit (post-intervention, after visit 4). Questions tested knowledge of both prevention and treatment of PPH. Each question had only 1 correct answer. The research assistant asked the provider each of the 10 questions and entered the provider's answer into an electronic data capture system.

We also collected basic information about providers who responded to the PPH knowledge questionnaire. We present simple descriptions of these characteristics below. In the V7V region, all 10 providers who participated during visit 4 (post-test) had also participated during visit 1 (pre-test). In the ATS region, 9 of 11 providers who participated during visit 4 (post-test) also participated during visit 1 (pre-test). 18% of ATS region participants in the post-test had not participated in the pre-test; of these, all had participated in at least one other mentor visit.

We performed simple descriptive analysis of the frequency of correct answers to each of the 10 items and the average correct score (all 10 items). We present these results below by region and with all participants in both regions combined. We compared the average frequency of correct answers by item between the 2 time points (pre- and post-intervention) and by region.

Results

Number of provider participants

At the time of the first CSB visit, 26 providers across both regions participated in data collection ("pre-test") and intervention activities, while at the time of the fourth CSB visit 21 total providers across both regions participated in data collection ("post-test") and intervention activities. All these providers were responsible to deliver intrapartum care at their respective CSBs. Between the first and fourth visits, 8 provider participants were lost to follow-up (not available at post-test time point) and 3 providers joined the study (not present at pre-test time point). At data collection activities conducted at pre- and post-intervention time points, 14 distinct providers participated in the ATS region and 16 distinct providers participated in V7V region.

Provider characteristics

Of 21 providers who participated in the post-test, 75% self-identified as women and 25% self-identified as men. 80% reported that they were younger than 40 years old. These results were similar at the time of the pre-test.

TABLE 4. PROVIDER CHARACTERISTICS REPORTED AT VISIT 4 (POST-TEST), BY REGION

| Characteristic	N	ATSINANANA	N	VATOVAVY FITOVINANY
No. of providers	11	52%	10	48%
Gender				
Female	8	73%	8	80%
Male	3	27%	2	20%
Age				
Less than 40 years	9	82%	8	80%
40 years or more	2	18%	2	20%
Professional qualification				
General practitioner	1	9%	2	20%
Generalist midwife	6	55%	6	60%
General nurse	4	36%	2	20%
Other	0	0%	0	0%
Years of qualification				
Less than 5 years	7	64%	4	40%
5 TO 9 YEARS	2	18%	3	30%
10 YEARS OR MORE	2	18%	3	30%

At the time of the post-test, 57% of all participants identified as midwives, 29% identified as general nurses, and 14% identified as general doctors. The proportion of participants in ATS region who identified as general nurses was higher than in V7V; the proportion of physician participants in V7V was 20% and in ATS was 9%. At the time of the post-test, the number of years since participants had achieved their stated professional qualification was higher in V7V region than ATS region; 60% in V7V region stated they had 5 or more years since qualification while only 36% in ATS region stated they had 5 or more years since qualification. At the time of the post-test, none of the participants reported they had less than 2 years since qualification.

Knowledge overview

Participants showed an increase in the average number of correct answers between the pre- and post-tests. Before the intervention, the average number of correct answers (to 10 PPH management questions) was 5.5. After the intervention, the average number of correct answers was 7.5. The increase in correct answers between pre- and post-test was greater in the ATS region, which started with a lower average score.

FIGURE 1. AVERAGE % OF CORRECT ANSWERS (TO 10 PPH QUESTIONS), COMPARING PRE- AND POST-TEST, BY REGION
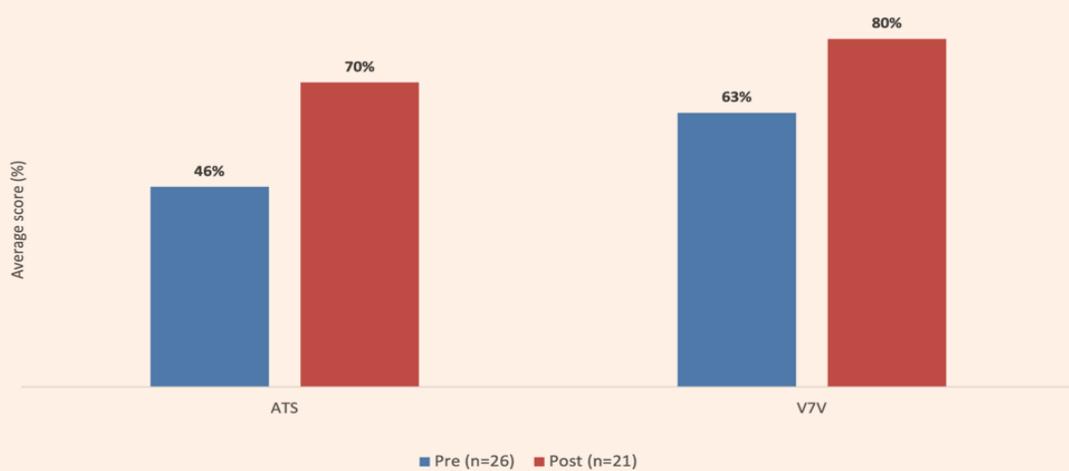
Overall, providers showed an increase in PPH management knowledge between pre- and post- in 9 out of 10 questionnaire items.

FIGURE 2. AVERAGE % OF PROVIDERS WHO ANSWERED EACH PPH QUESTIONNAIRE ITEM CORRECTLY, COMPARING PRE- AND POST-INTERVENTION SCORES
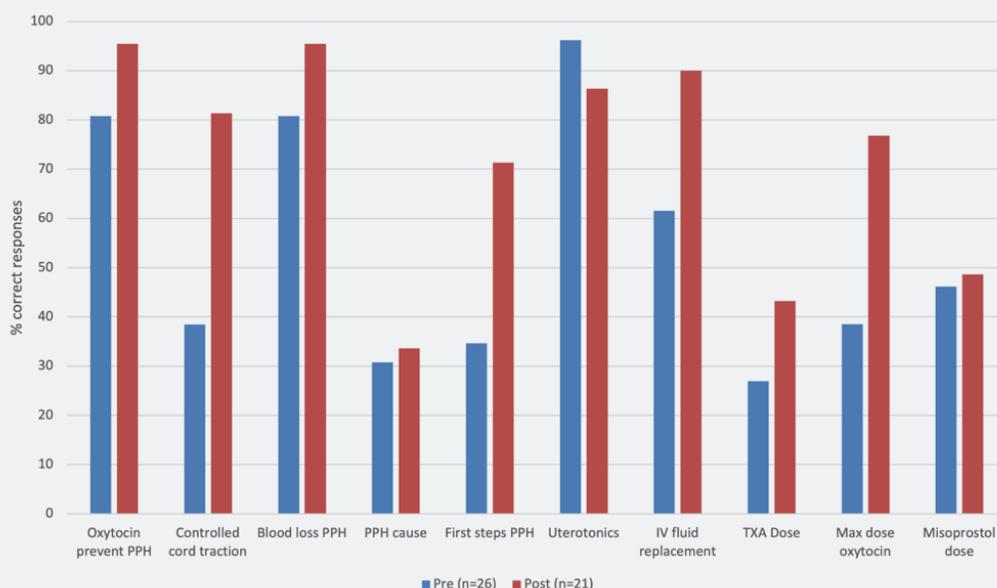
Detailed results

Providers in ATS region showed the greatest increase in scores, between the pre- and post-tests, in for these topics:

● Why controlled traction of the umbilical cord is performed during active management of the third stage of labor
● First steps of PPH management
● Maximum daily dose of oxytocin
● Correct dose of tranexamic acid (TXA) for PPH

Providers in the ATS region showed a decrease between the pre- and post-tests with respect to the correct dose of misoprostol for PPH and identification of uterotonic medications.

FIGURE 3. ATSINANANA REGION: PRE- AND POST-INTERVENTION PPH KNOWLEDGE QUESTIONNAIRE, % CORRECT ANSWERS BY ITEM
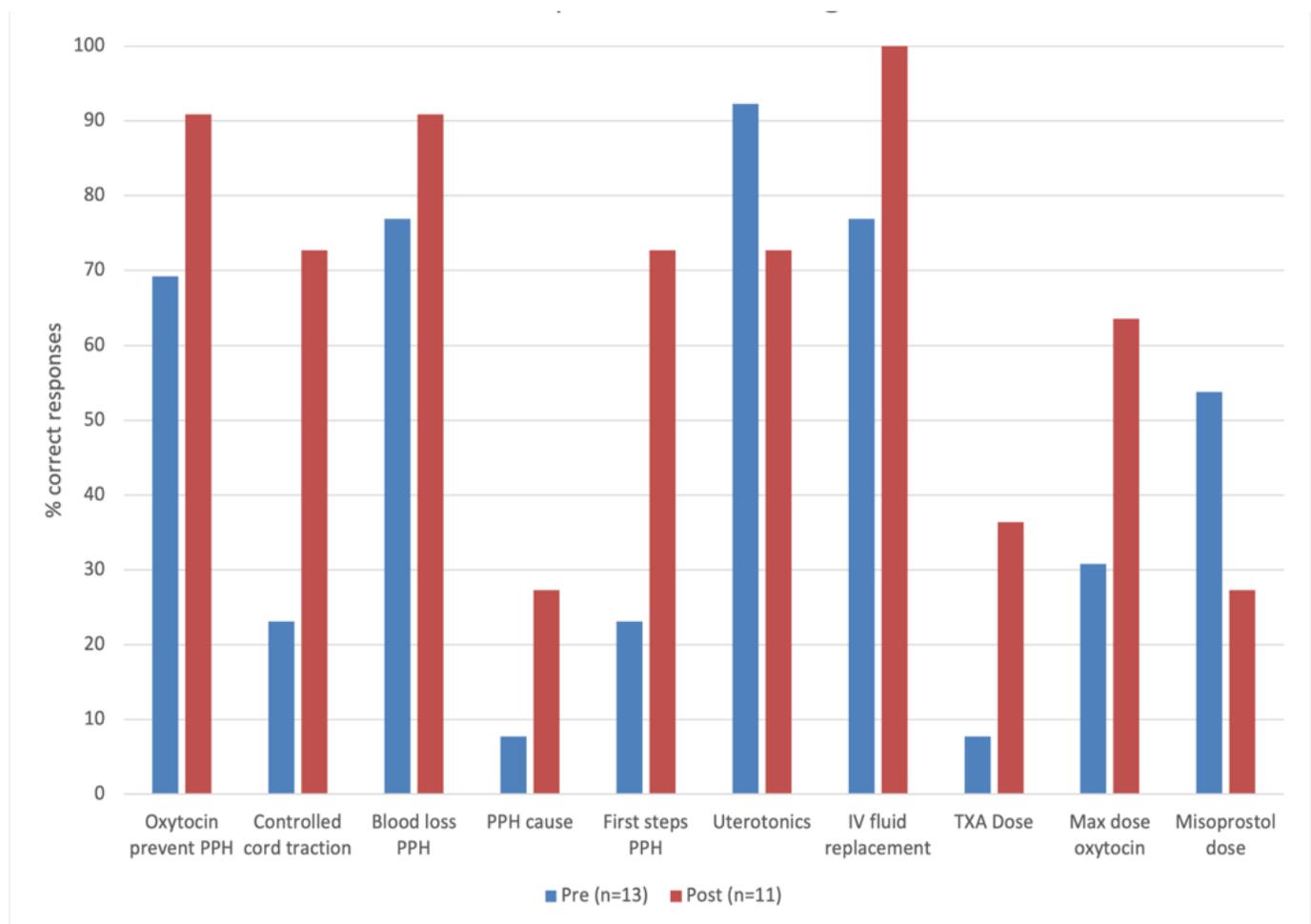
Providers in V7V region showed the greatest increase in scores, between the pre- and post-tests, in for these topics:

- Maximum daily dose of oxytocin
- Correct dose of misoprostol
- Correct ratio of IV fluid replacement in 24 hours to estimated blood loss

Providers in the V7V region showed a decrease between the pre- and post-tests with respect to the most common cause of PPH.

FIGURE 4. V7V REGION: PRE- AND POST-INTERVENTION PPH KNOWLEDGE QUESTIONNAIRE, % CORRECT ANSWERS BY ITEM
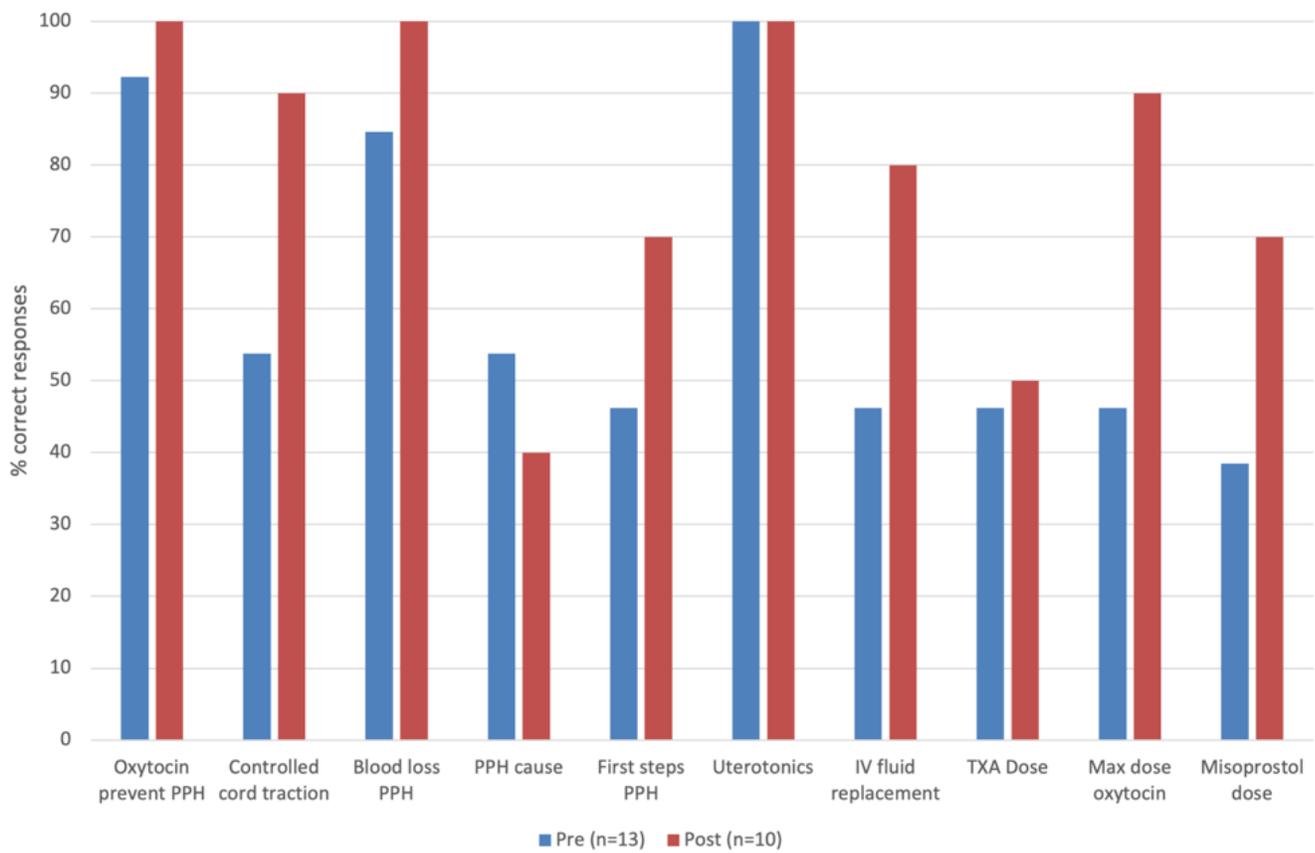
Data collection instrument 2: PPH case interview

Methods

Research assistants administered a second knowledge-test tool to each provider participant as an open-ended series of questions about a hypothetical PPH case. One identical PPH case was read to each participant each time the tool was administered. The interviewer read a script with short statements about the patient presentation and questions about the patient's diagnosis and what the provider should do next. We created a list of 26 PPH treatment actions that were indicated in the tool's hypothetical PPH case. The same 26 actions were recommended by Virtual Mentor in severe PPH cases; all 26 actions should have been practiced in the most severe PPH simulations. When the provider mentioned any of the 26 treatment actions during the interview, the research assistant checked a box next to the action.

Stating all 26 indicated PPH treatment actions during the interview equaled a 100% score. 2 (8%) of the actions were related to communication, 6 (23%) were related to correct diagnosis, and 18 (69%) of the actions were related to correct management of PPH.

Results

Overview

Overall, providers increased the number of correct treatment actions stated during a hypothetical PPH case by 19 percentage points between the pre-test (visit 1) and post-test (visit 4). This increase was greater in the V7V region (28 percentage points), which also showed a higher % possible correct answers stated in the pre-test, than in ATS region (17 percentage points).

TABLE 5. CORRECT PEC ACTIONS STATED BY RESPONDENTS DURING INTERVIEW ABOUT A PPH CASE

Region	ATS		V7V		Both	
Timepoint	Pre	Post	Pre	Post	Pre	Post
Sample size	n=13	n=11	n=13	n=10	n=26	n=21
% total possible PPH PEC actions stated by respondents during interview	37	54	42	70	43	62

FIGURE 5. COMPARISON OF 2 REGIONS: % CORRECT PPH TREATMENT ACTIONS STATED BY RESPONDENTS DURING INTERVIEW ABOUT A PPH CASE (ALL POSSIBLE CORRECT PPH TREATMENT ACTIONS = 100%)
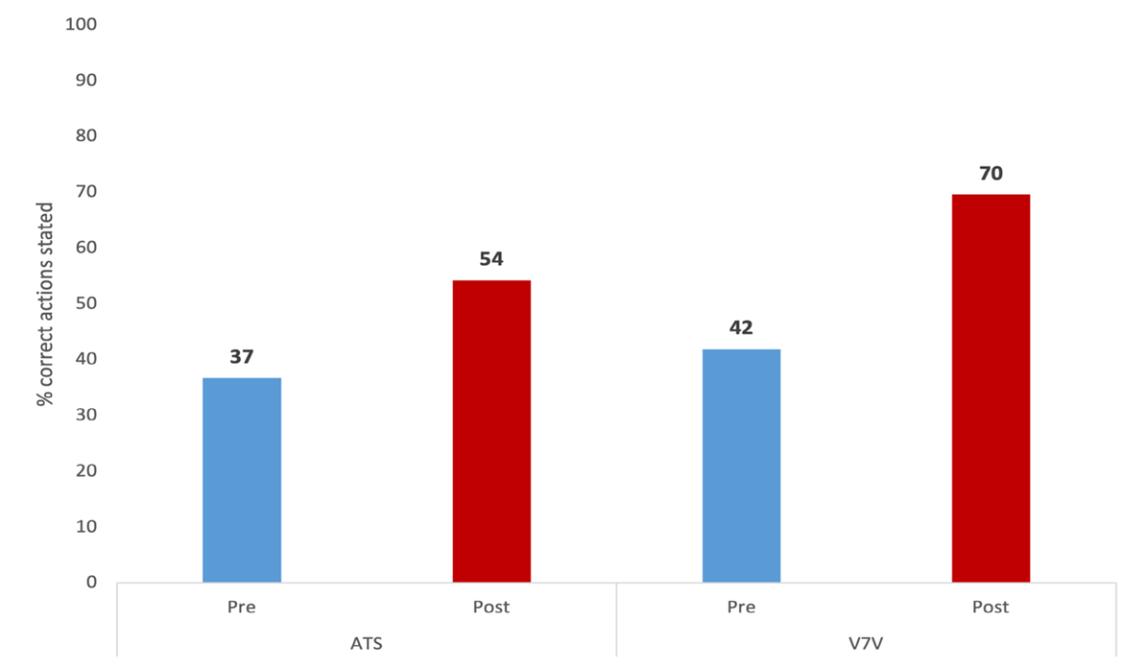
The average improvement in scores, stated as the increase in percentage points between time points, was similar for actions related to communication (23), diagnosis (19) and management (22).

Detailed results

Some PPH treatment actions showed large increases between the pre- and post-test, while others showed little change or even negative change (Figure 6). Actions that showed the greatest increase in average % report during the post-test interview compared to the pre-test interview (>30 percentage points increase) were:

- Elevate her legs (+40 percentage points)
- Manual exploration of uterus (+37 percentage points)
- Call for help (+35 percentage points)
- Empty the urinary bladder (+35 percentage points)
- Transfer to a higher-level facility (+33 percentage points)

We found that two medication-administration actions showed increases of 29 percentage points but those increases were especially interesting because the action was mentioned infrequently in the pre-test. The average % of respondents who mentioned TXA as a treatment for PPH increased from 4% to 33% (larger increase in V7V than ATS region). The administration of misoprostol as a treatment for PPH increased from 19% to 48% (again, a larger increase was seen in V7V than ATS region).

Some actions were mentioned less often in the post-test. These losses were more frequent in the ATS region. The actions that showed a negative or the lowest increase in average percentage report during the post-test interview (range -6 to +3 percentage points change), across both regions, were:

- Check for/looks for coagulopathy (-6 percentage points)
- Check for vaginal/cervical lacerations and repair them (+2 percentage points)
- Uterine balloon tamponade (+3 percentage points)

The results of the post-test showed some differences between regions. With respect to the percentage of indicated PPH treatment actions that were mentioned by respondents in the post-test, the interquartile range was smaller in V7V region (49-69%) than in ATS region (36-73%), meaning there was more variation in PPH treatment knowledge in ATS region after visit 4. In the post-test,

participants in the V7V region mentioned advanced pharmaceutical treatments for PPH significantly more often than participants in the ATS region.

- TXA was mentioned as an indicated treatment by 54% of respondents in the V7V region and 0% in ATS region.
- Ergometrine was mentioned by 31% in the V7V region and 0% in the ATS region.
- Misoprostol was mentioned by 60% in the V7V region and 36% in the ATS region.

62% of respondents in the V7V region and 91% of respondents in the ATS region correctly stated that the patient showed signs of shock according to the patient's vital signs.

FIGURE 6. COMPARISON OF THE % OF ALL RESPONDENTS AT TIME POINT 2 WHO STATED EACH INDICATED ACTION DURING SEVERE PPH AND THE % CHANGE IN FREQUENCY WITH WHICH EACH ACTION WAS STATED BETWEEN TIME POINTS 1 (VISIT 1, N=26) AND 2 (VISIT 4, N=21).
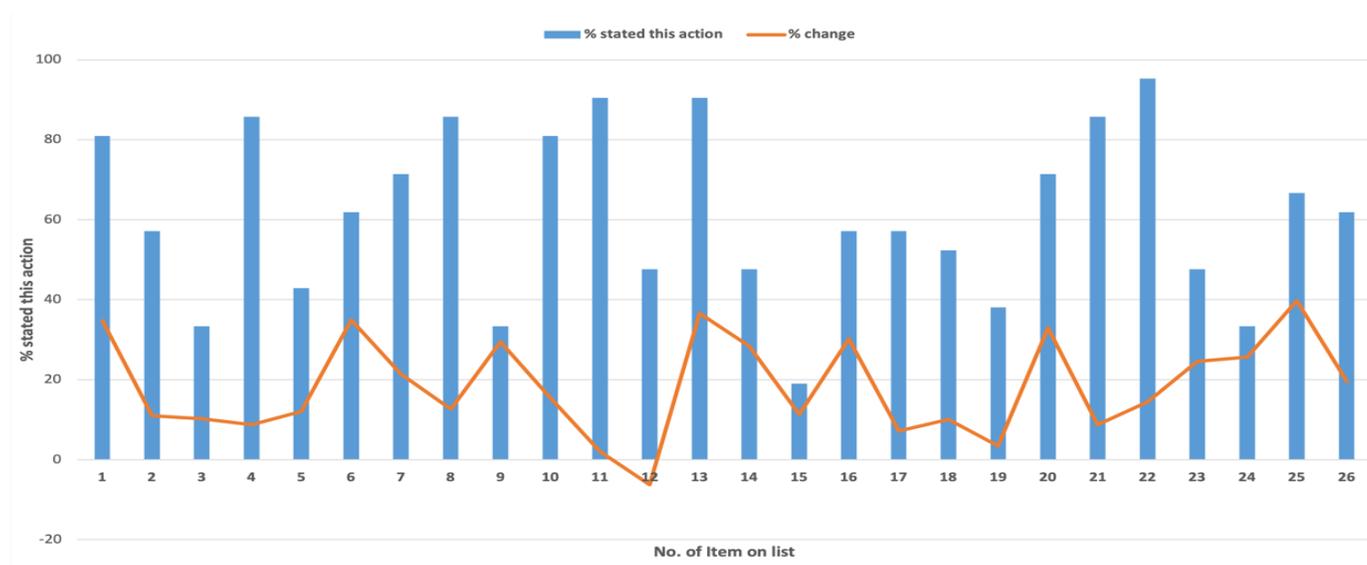
List of PPH management actions, Figure 6

1. Call for help
2. Explain procedures to mother and reassure her
3. Assess mother's level of consciousness
4. Start intravenous (IV) infusion
5. Take blood samples
6. Empty bladder with catheter
7. External uterine massage
8. Oxytocin 20 units IV
9. Tranexamic acid 1 g IV
10. Check vital signs
11. Check for and repair cervical/vaginal tears
12. Assess for coagulopathy
13. Manual exploration of uterus
14. Misoprostol 600 mcg oral
15. Ergometrine 0.2 mg intramuscular (IM)
16. Start 2nd IV
17. Bimanual uterine compression
18. Abdominal aortic compression
19. Uterine balloon tamponade
20. Refer to a higher-level facility
21. Correctly diagnoses hypovolemic shock
22. IV infusion of isotonic solution
23. Keep mother warm
24. Administer oxygen
25. Elevate mother's legs
26. Arrange transport

FIGURE 7. % OF INDICATED PPH TREATMENT ACTIONS STATED BY RESPONDENTS, POST-TEST, COMPARING ATS (N=11) AND V7V (N=10) REGIONS
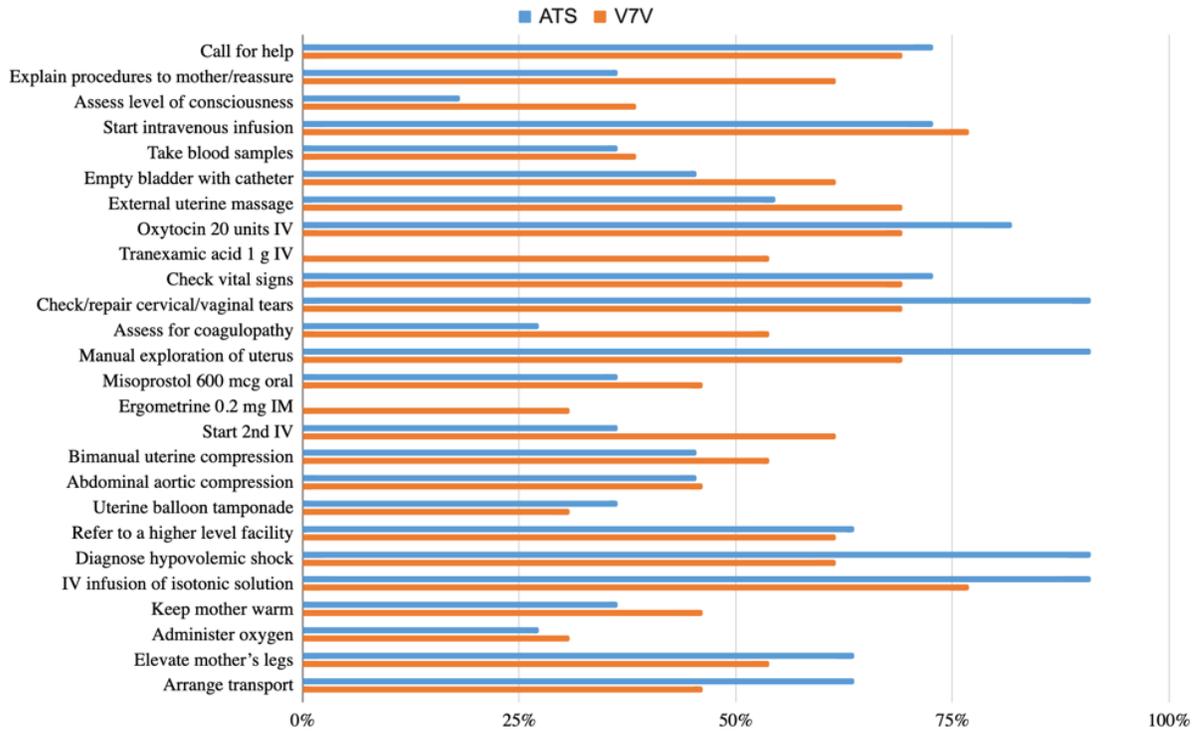

FIGURE 8. CHANGE IN % CORRECT ANSWERS BETWEEN PRE- AND POST-TEST TIME POINTS, REPORTED IN DIFFERENCE IN
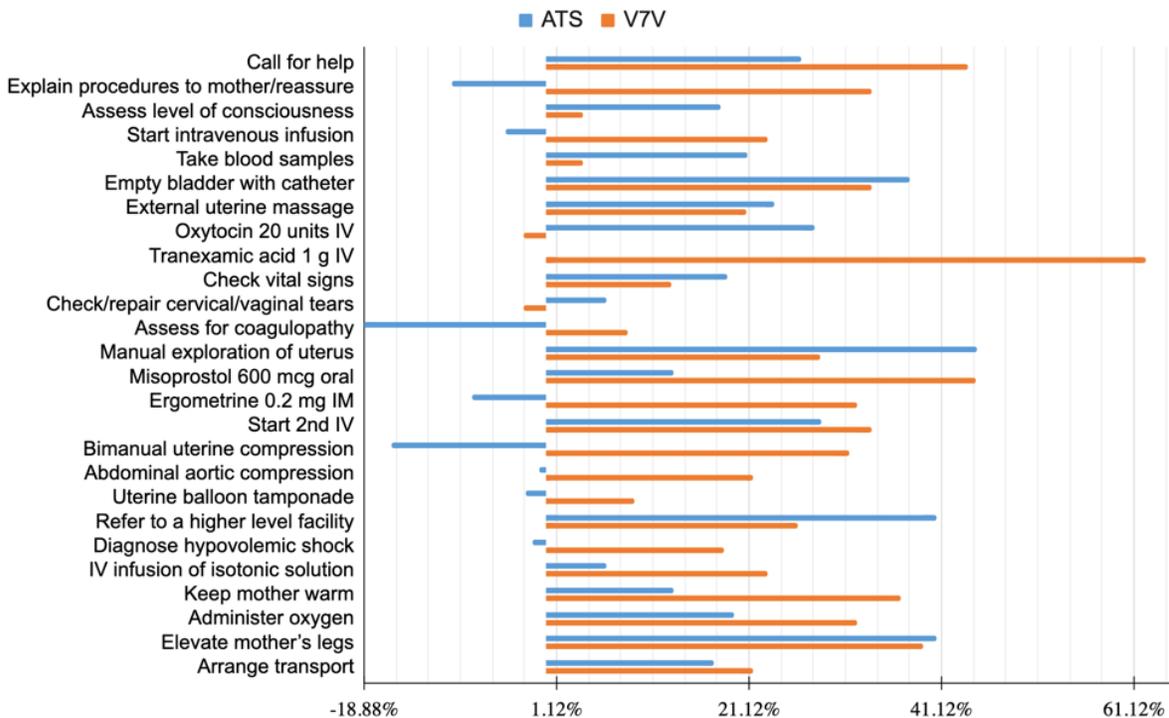
Data collection instrument 3. Self-efficacy

Methods

Research assistants administered a 7-item PPH management self-efficacy questionnaire among providers after visit 1 (pre-test) and visit 4 (post-test). Each item could be answered on a 10-point Likert scale, from 1 (lowest confidence) to 10 (highest confidence). We grouped answers into 3 categories: not very confident (1-3), moderately confident (4-6), very confident (7-10).

Results

Overview

We used the last question in this instrument, "How confident are you that you are able to effectively treat postpartum hemorrhage?" as a general measure of PPH management confidence. In response to this question, from pre- to post-test and across both regions, the frequency with which higher confidence numbers were chosen increased (Figure 9). Whereas 3 respondents had answered 1-3 (not very confident) in the pre-test, none of the respondents answered 1-3 in the post-test. Figure 10 shows that across both regions, 56% of all respondents in the pre-test and 81% in the post-test answered 7-10 (very confident).

FIGURE 9. FREQUENCY OF 10-POINT ANSWERS TO THE QUESTION "HOW CONFIDENT ARE YOU THAT YOU ARE ABLE TO EFFECTIVELY TREAT POSTPARTUM HEMORRHAGE?" RESPONDENTS FROM BOTH REGIONS, COMPARING PRE- AND POST-TEST
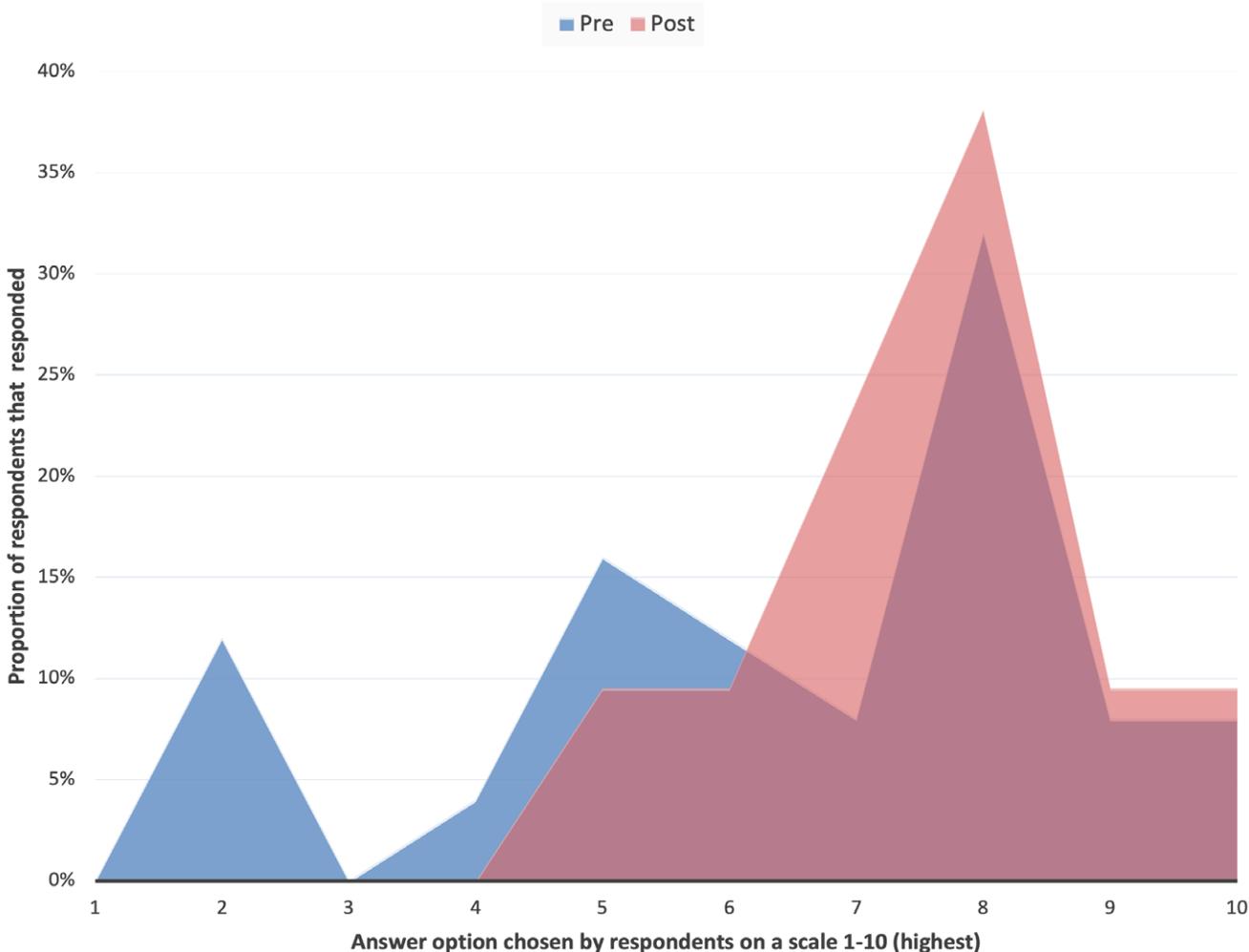
There were differences in confidence at both time points (pre- and post-) between regions. By the end of visit 4, 64% of respondents in ATS region versus 100% of respondents in V7V region answered 7-10 on the Likert scale (very confident) when asked "How confident are you that you are able to effectively treat postpartum hemorrhage?"

FIGURE 10. PRE- AND POST-TEST CONFIDENCE: % OF RESPONDENTS THAT RESPONDED TO "HOW CONFIDENT ARE YOU THAT YOU ARE ABLE TO EFFECTIVELY TREAT POSTPARTUM HEMORRHAGE?" IN THREE CONFIDENCE CATEGORIES (BY REGION)
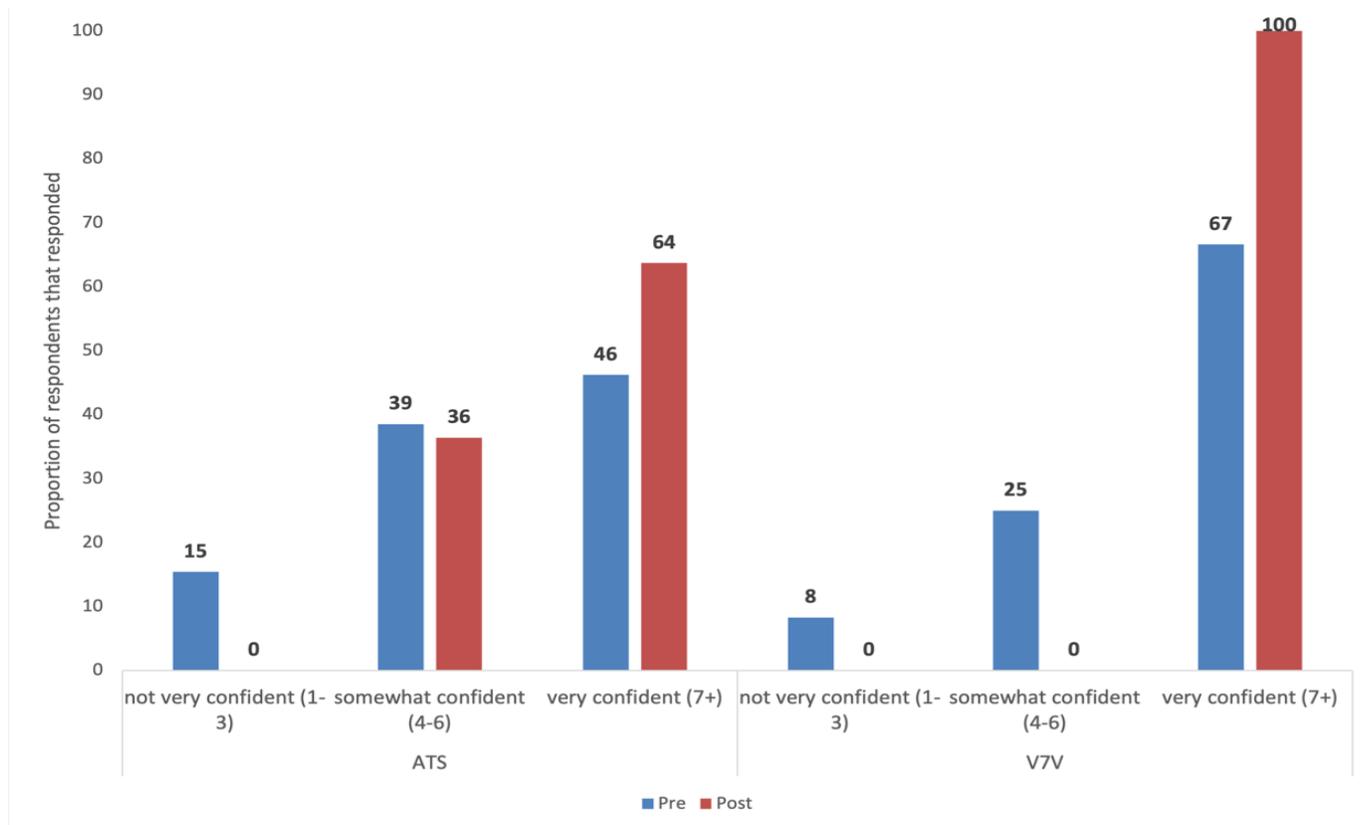
TABLE 6. AVERAGE PRE- AND POST-TEST CONFIDENCE OF PROVIDERS (ON A SCALE FROM 1 TO 10, 10 IS HIGHEST)

Item		ATS		V7V	
		Pre (n=13)	Post (n=11)	Pre (n=12)	Post (n=10)
1	How confident are you that you can correctly administer syntocinon (oxytocin) to treat postpartum hemorrhage?	6.4	7.9	7.7	9.3
2	How confident are you that you can correctly administer Cytotec (misoprostol) to treat postpartum hemorrhage?	6.7	7.5	5.6	7.6
3	How confident are you that you can correctly administer tranexamic acid (TXA) to treat postpartum hemorrhage?	3.1	3.7	4.3	5.9
	How confident are you that you can correctly administer intravenous volume replacement to a woman with postpartum hemorrhage?	6.2	7.3	7.3	6.1
	How confident are you that you can identify signs of hypovolemic shock?	7.1	7.8	8.1	9.1
	How confident are you that you can correctly complete the correct laboratory tests in the case of severe postpartum hemorrhage?	4.4	3.9	4.1	5.4
	How confident are you that you are capable to effectively treat postpartum hemorrhage?	6.2	7.1	7.0	8.1

◻ = pre- to post- **increase** in confidence

◻ = pre- to post- **decrease** in confidence

Detailed results

In this questionnaire, we asked providers how confident they were that they could complete 6 specific actions during PPH management. We compared the average pre- and post-score for all 7 (6 specific actions and 1 general) items, by region. Table 5 is a heat map showing that for almost all items and across both regions, confidence increases (green cells).

In ATS region, we saw increases in confidence for every item except

- In V7V region, we saw increases in confidence for every item except
- "How confident are you that you can correctly administer intravenous volume replacement to a woman with postpartum hemorrhage? " (Table 5, row 4)

- "How confident are you that you can correctly complete the correct laboratory tests in the case of severe postpartum hemorrhage?" (Table 5, row 6)

We examine these decreases in confidence further in the "Discussion" section, below.

There was a slight difference between regions, at both pre- and post-intervention time points, in response to the seventh and final confidence question: ""How confident are you that you are able to effectively treat postpartum hemorrhage?" Pre-intervention, provider participants in the V7V region were about 13% more confident, on average, than those in the ATS region. At the post-intervention time point, participants in V7V regions were about 15% more confident than participants in ATS region. There was a 15% increase in overall confidence to correctly treat PPH; this increase was similar across regions.

Data collection instrument 4. Acceptability and feasibility of Virtual Mentor

The instruments used in this study to measure acceptability, adoption, feasibility, appropriateness, accessibility and sustainability were adapted from the 'Dissemination and Implementation Science Measure: Organizational Questionnaire' by the Applied Mental Health Research Group (AMHR) at the Johns Hopkins Bloomberg School of Public Health. The development of these instruments was explained by Proctor et. al in 2011.

In their article, Proctor et.al., proposed a heuristic taxonomy of eight conceptually distinct implementation outcomes—acceptability, adoption, appropriateness, feasibility, fidelity, implementation cost, penetration, and sustainability—along with their nominal definitions. Find below definitions of the implementation outcomes by Proctor et. al, on which we based our data collection instruments.

Acceptability is the perception among implementation stakeholders that a given treatment, service, practice, or innovation is agreeable, palatable, or satisfactory.

Adoption is defined as the intention, initial decision, or action to try or employ an innovation or evidence-based practice. Adoption also may be referred to as uptake.

Feasibility is defined as the extent to which a new treatment, or an innovation, can be successfully used or carried out within a given agency or setting.

Appropriateness is the perceived fit, relevance, or compatibility of the innovation or evidence-based practice for a given practice setting, provider, or consumer; and/or perceived fit of the innovation to address a particular issue or problem.

Penetration (Reach/ Access) is defined as the integration of a practice within a service setting and its subsystems.

Sustainability is defined as the extent to which a newly implemented treatment is maintained or institutionalized within a service setting's ongoing, stable operations.

In this study, the 'Dissemination and Implementation Science Measure: Organizational Questionnaire' was adapted to Virtual Mentor.

Methods

We adapted the Organizational Questionnaire to be a 30-item instrument (Annexe 9) administered it to providers after the first and fourth visits. We administered the same instrument to mentors after the fourth visit. Respondents were asked if they agreed or disagreed with each statement, on a 0 ("not at all") to 3 ("a lot") scale. "Don't know" was an additional answer option.

Results

Overview

We decided to exclude the results from providers collected after the first visit, as they had little experience with Virtual Mentor at that time point and may have responded over-enthusiastically. The results from the fourth visit, including both provider and mentor responses, seem more likely to be representative of participants' experience. After the fourth visit there were 20 total respondents in the V7V region and 18 total respondents in ATS region.

More than half of participants answered "a lot" (that is, most positively) to about one-third of questions in this instrument. More items in the domains "adoption" and "acceptability" and in the suitability sub-domains "task-fit," and "self-perceived effectiveness" were scored as "a lot" than in the other domains. Figure 11 presents an overview of results for all 30 items of this questionnaire as a "heat map." Questionnaire items (rows) with darkest green shading and bold font received "a lot" or "a moderate amount" responses by 100% of respondents. Rows with only light green shading and no bold font represent more neutral responses. Rows with yellow or red shading show that a significant proportion of responses were "not at all" or "a little bit," or negative responses.

[7]Proctor, Enola et al. "Outcomes for implementation research: conceptual distinctions, measurement challenges, and research agenda." Administration and policy in mental health vol. 38,2 (2011): 65-76. doi:10.1007/s10488-010-0319-7. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3068522/

FIGURE 11. HEAT MAP OF HIGH SCORES AT VISIT 4 ON THE FEASIBILITY AND ACCEPTABILITY QUESTIONNAIRE, BY REGION, ONLY "A MODERATE AMOUNT" AND "A LOT" % ARE SHOWN

Item	Region	ATS		V7V	
	Time point and n	Visit 4 (n=18))		Visit 4 (n=20)	
		"A lot " = 3 on 0-3 scale, while "A moderate amount" = 2 on 0-3 scale			
Domain	Item	% Mod	% A lot	% Mod	% A lot
Adoption	1. Have you discussed with other providers and staff about what is needed to continue to provide VM in the future?	56%	11%	30%	35%
	2. Have you discussed with others (e.g., family, friends, coworkers, or any other people) your experiences with the VM?	44%	17%	35%	30%
	3. Would you continue to use the VM for training in the future?	33%	67%	35%	65%
	4. Would you like to use the VM for actual patient care in the future?	28%	67%	20%	80%
	5. Will using the VM be a high priority in the future?	39%	61%	30%	65%
Acceptability	1. Did you like using the VM?	28%	61%	25%	75%
	2. Do you feel good about using the VM?	67%	28%	55%	45%
	3. Did you enjoy learning with the VM?	22%	78%	10%	90%
	4. Do you feel that the skills you have learned by using VM will be useful in helping patients?	22%	78%	5%	95%
	5. Do you feel that the conversation with the VM made sense?	33%	67%	20%	80%
	6. How satisfied are you with the VM training?	67%	28%	60%	40%
	7. How satisfied are you with the VM itself?	78%	17%	60%	40%
	8. Is the virtual mentor conversation clear?	89%	11%	50%	40%
Suitability	1. How well does the VM fit with the cultural values of your patients?	72%	11%	50%	20%
Social/cultural	2. How well does the VM fit with your cultural values?	67%	22%	40%	20%
	3. Is the VM consistent with the male culture in your country?	17%	11%	45%	10%
	4. Is the VM consistent with the female culture in your country?	50%	28%	35%	25%
	5. Would patients feel comfortable with providers using VM to provide care?	67%	22%	35%	30%
Self-perceived effectiveness	6. Is the VM a good way to help you address your patient's problems?	44%	50%	45%	55%

|					
Task fit	7. Is training with the VM something you feel you should be doing as part of your job?	33%	67%	35%	65%
	8. Is using the VM for clinical care something you feel you should be doing as part of your job?	22%	78%	30%	70%
Feasibility	1. Are you sufficiently skilled at using VM in simulation training?	78%	11%	40%	60%
	2. Are you sufficiently skilled with VM to use it in actual patient care?	83%	11%	40%	40%
	3. Do you have enough time to train using VM?	56%	22%	55%	25%
	4. Are you paid enough to participate in training with the VM?	33%	0%	10%	0%
	5. Do you have the space to train with VM?	33%	33%	45%	25%
Reach Access	1. Would other providers feel comfortable using the VM in training?	44%	33%	55%	30%
	2. Would other providers feel comfortable using the VM in actual clinical practice?	50%	28%	35%	35%
	3. Would providers seek opportunities to use VM in training?	50%	44%	35%	50%
	4. Would providers seek opportunities to use VM in actual clinical practice?	44%	44%	40%	50%

Heat map legend				
Bold = 100% of respondents in the region answered either "A moderate amount" or "A lot"				
	Color Code	IF	AND	
Enthusiasm		Mod+A lot>60	<25	
		Mod+Beac>60	25-49	
		Mod+Beac>60	50-74	
		Mod+Beac>60	>74	
Caution		Mod+Beac=40-60	<25	
		Mod+Beac=40-61	25-49	
		Mod+Beac=40-62	50-74	
		Mod+Beac=40-63	>74	
Concern		Mod+Beac=<40	<25	
		Mod+Beac=<40	25-49	
		Mod+Beac=<40	50-74	
		Mod+Beac=<40	>74	

Detailed results

Acceptability scores were high in both regions and were higher in V7V.

FIGURE 12. AVERAGE ACCEPTABILITY SCORE ACROSS 8 ITEMS, BY REGION
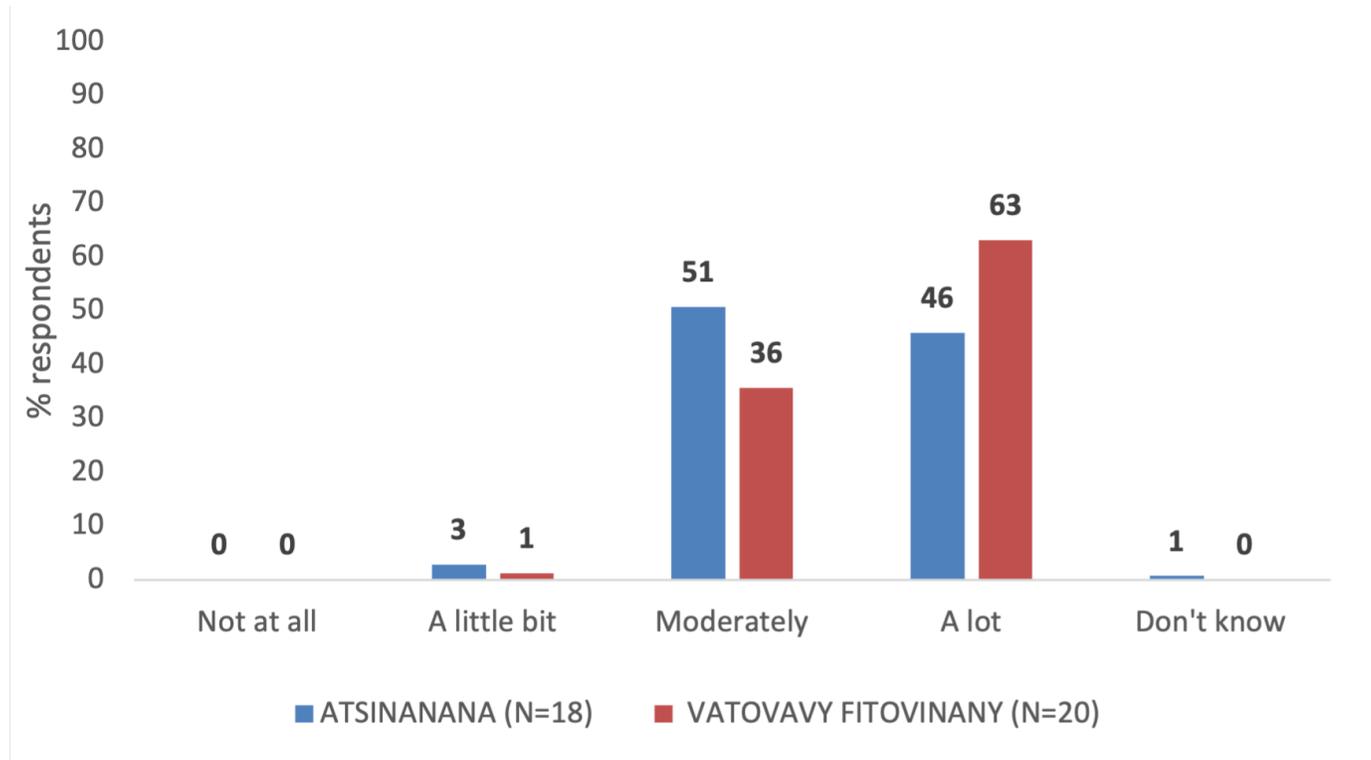
In both regions the following items were scored "a lot" by most respondents at time point 2:

- Did you enjoy learning with the VM?
  - ○ Domain: acceptability
    - 90% in V7V
    - 78% in ATS
- Do you feel that the skills you have learned by using VM will be useful in helping patients?
  - ○ Domain: acceptability
    - 95% strongly agree in V7V
    - 78% strongly agree in ATS
- Do you feel that the conversation with the VM made sense?
  - ○ Domain: acceptability
    - 80% strongly agree in V7V
    - 67% strongly agree in ATS

Adoption scores were slightly lower than acceptability scores in both regions but slightly more respondents answered "a lot" in V7V.

FIGURE 13. AVERAGE ADOPTION SCORE ACROSS 5 ITEMS, BY REGION
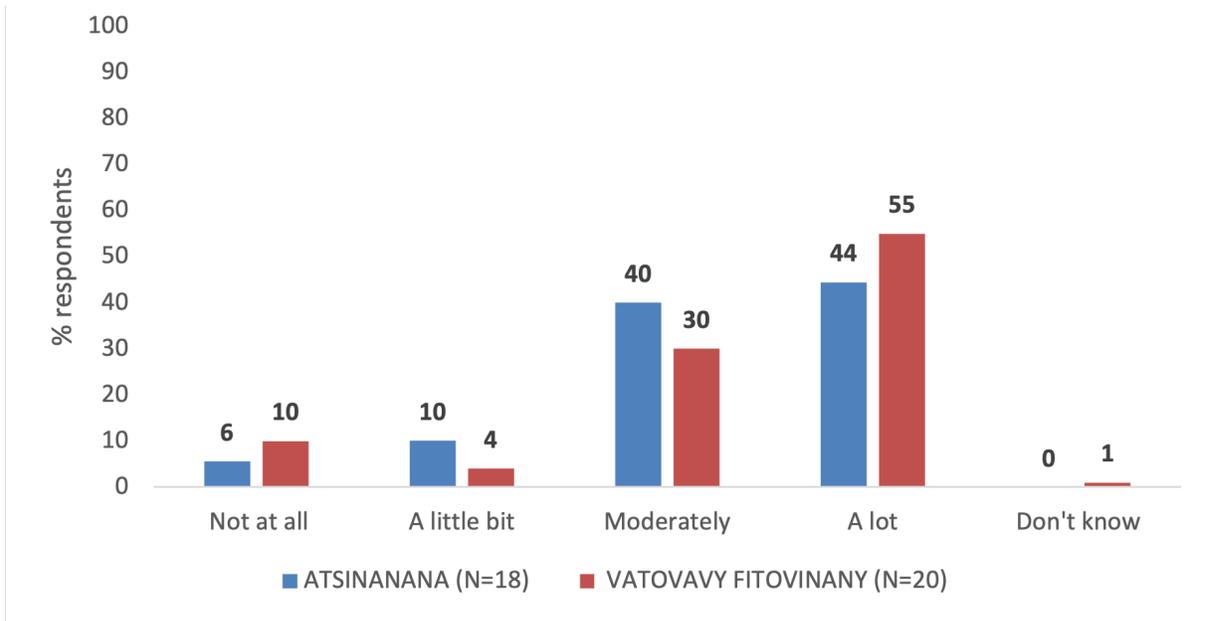
In both regions the following item was scored "a lot" by most respondents at time point 2:

● Would you like to use the VM for actual patient care in the future?

  ○ Domain: adoption

    ■ 80% in V7V

    ■ 67% in ATS

Accessibility scores were slightly lower than acceptability scores in both regions.

FIGURE 14. AVERAGE ACCESSIBILITY SCORE ACROSS 4 ITEMS, BY REGION
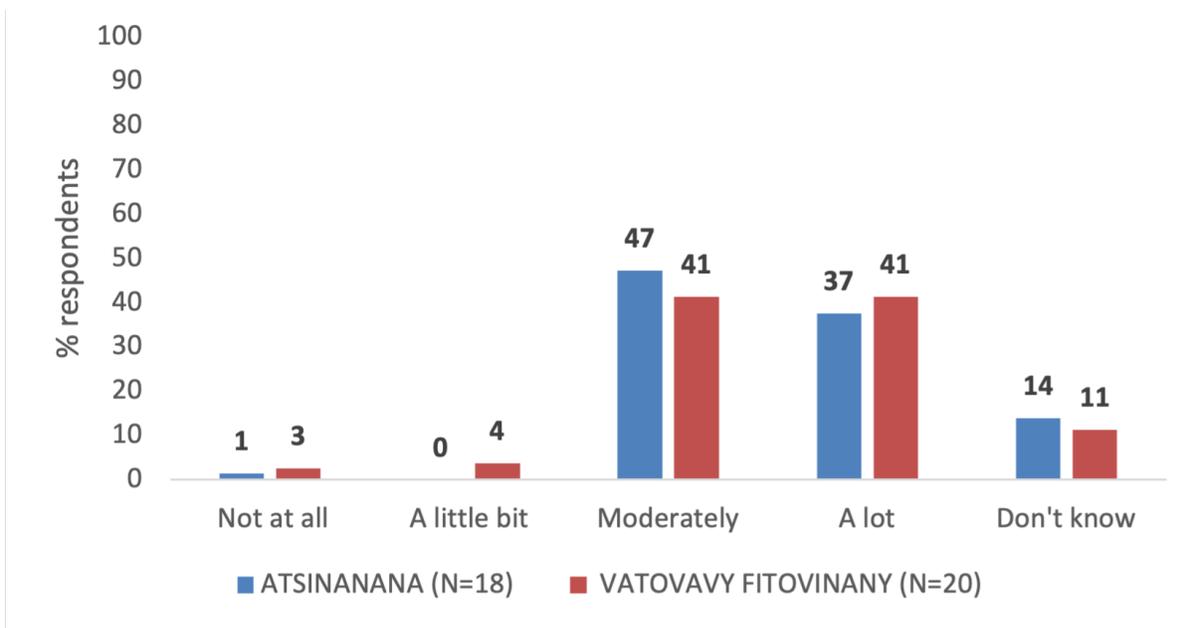
Appropriateness can be defined as the perceived fit or suitability of an innovation. Overall appropriateness scores were good but lower than acceptability scores.

FIGURE 15. AVERAGE APPROPRIATENESS SCORE ACROSS 8 ITEMS, BY REGION
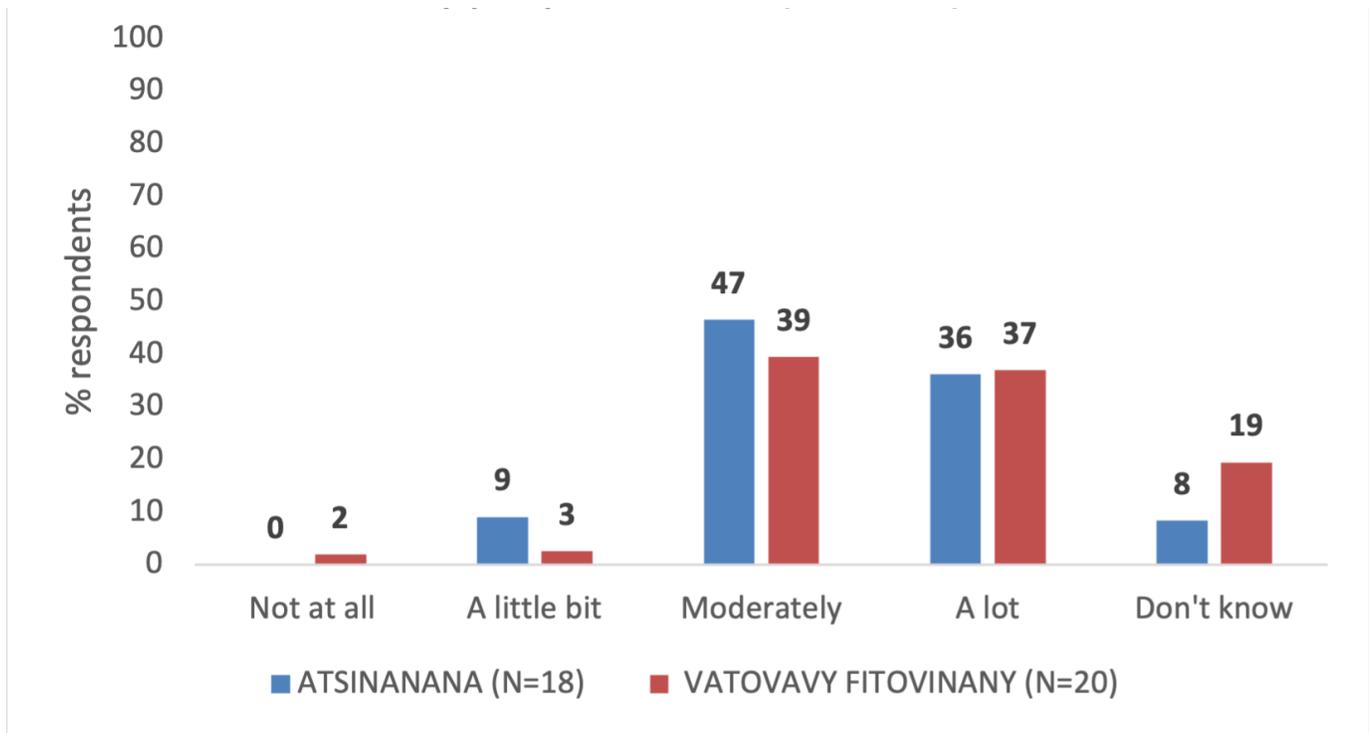
The item that received lowest scores in both regions (only 11% in ATS and 10% in V7V chose "strongly agree") was: "Is the VM consistent with the male culture in your country?" This deserves further study, because we are not sure how the question was understood by participants. Interestingly, two other questions about cultural suitability received notably low scores in V7V region:

- How well does the VM fit with your cultural values?
  - 40% chose "not at all" or "a little bit."
- Is the VM consistent with the female culture in your country?
 - 30% chose "not at all" or "a little bit."

We gained some insight into these low appropriateness scores in endline interviews with 13 providers who were asked about Virtual Mentor. In these interviews, two providers expressed concern that if they use VM during actual patient care their beneficiaries may be unnerved by the VM's computer voice (especially in French, which they may not understand) and beneficiaries' confidence in the provider may be undermined. We suspect respondents have concerns about the appropriateness of VM use in actual patient care rather than in an ongoing mentorship program:

"When the patient's or pregnant woman's companions see you using the Virtual Mentor, they may wonder what it is. They may have a little anxiety in their mind and they don't trust it." (Participant A5P41a)

"When I use [VM], people might say to each other that I'm talking on the phone because I'm not competent." (Participant A6P59)

The results of these endline interviews are presented in more detail below, on page 40.

More participants expressed concern about Virtual Mentor's feasibility than in any other domain, but the proportion of respondents who answered "a lot" to feasibility questions was slightly higher in V7V than ATS region.

FIGURE 16. AVERAGE FEASIBILITY SCORE ACROSS 5 ITEMS, BY REGION
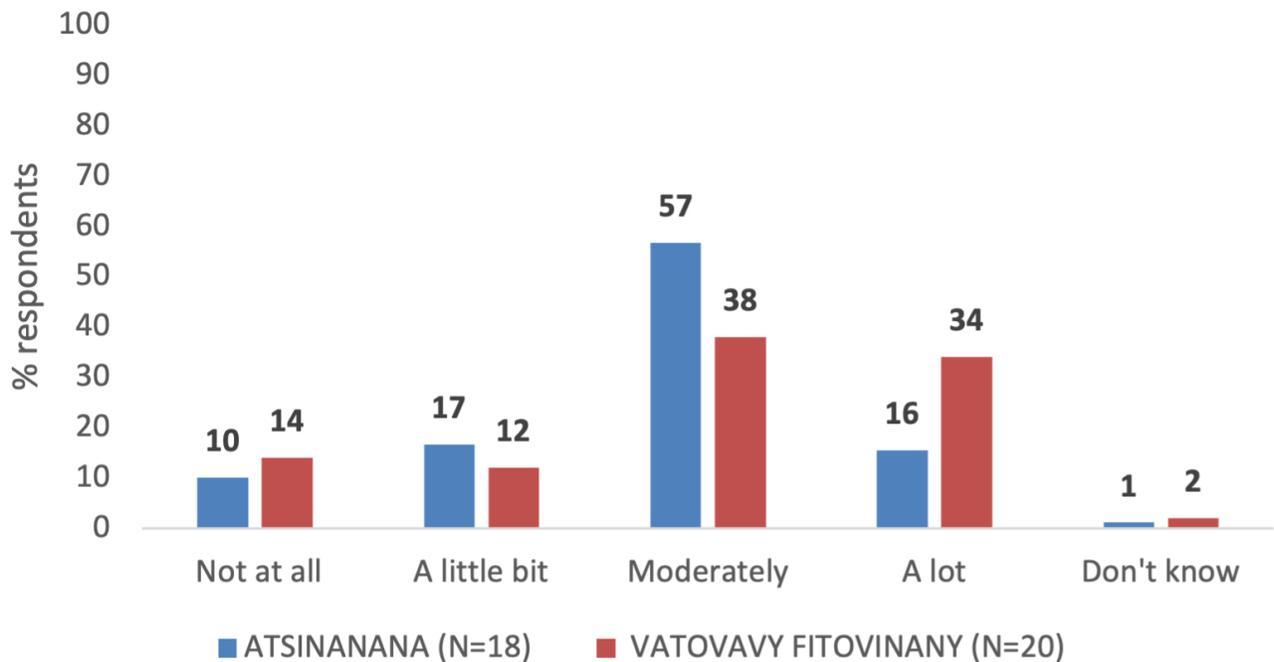
The item that scored significantly lower than all others in the feasibility domain was "Are you paid enough to participate in training with the VM?"Participants in this study were not offered a financial incentive in addition to their usual salaries, as the time they spent in study activities was within their usual working hours.

Interestingly, the only item that was scored higher in ATS region (78% answered "a lot ") than in V7V region (70% answered "a lot") was: "Is using the VM for clinical care something you feel you should be doing as part of your job?"

Data collection instrument 5. Provider behavior checklist

Methods

We hoped to understand whether or not audible recommendations from Virtual Mentor would result in provider compliance with all recommendations. After each CSB visit, the mentor was asked to record all the PPH treatment actions that had been suggested by Virtual Mentor during the PPH simulation(s) and whether the provider

1. completed the action correctly,

2. made incorrect attempts to complete the action, or

3. did not attempt to complete the action at all even though it was recommended.

In the most severe PPH case simulations, in which the mother showed signs of shock, there were a maximum of 21 actions recommended by VM.

During simulation sessions, a combination of real and fake supplies are used to achieve a realistic experience while keeping participants safe and avoiding use of valuable medical consumables. Examples of real supplies owned by the facility that may be used in simulations include a patient bed, stethoscope, and IV pole. Examples of fake supplies included in the PRONTOPack™ for use during simulations include a cloth baby doll and placenta (see Figure 17), needles that are not introduced into the skin but rather introduced into a thick pad that the patient actress wears on her leg, and ampoules filled with water that are labelled to simulate medications (e.g. oxytocin). In the case that IV oxytocin administration is indicated during a PPH simulation, the provider participant is coached to draw "fake" oxytocin from a water-filled ampoule with a needle and syringe, inject the simulated medication into a simulated bag of IV fluid, and simulate sliding the wheel of the IV tubing's wheel cassette to the "up" position to allow flow of IV fluid to the patient. This PRONTOPack™ even included a mask for administering oxygen; we assumed providers would apply this mask to the patient actress to simulate administering oxygen when indicated.

FIGURE 17. SOME CONTENTS OF THE PRONTOPACK™
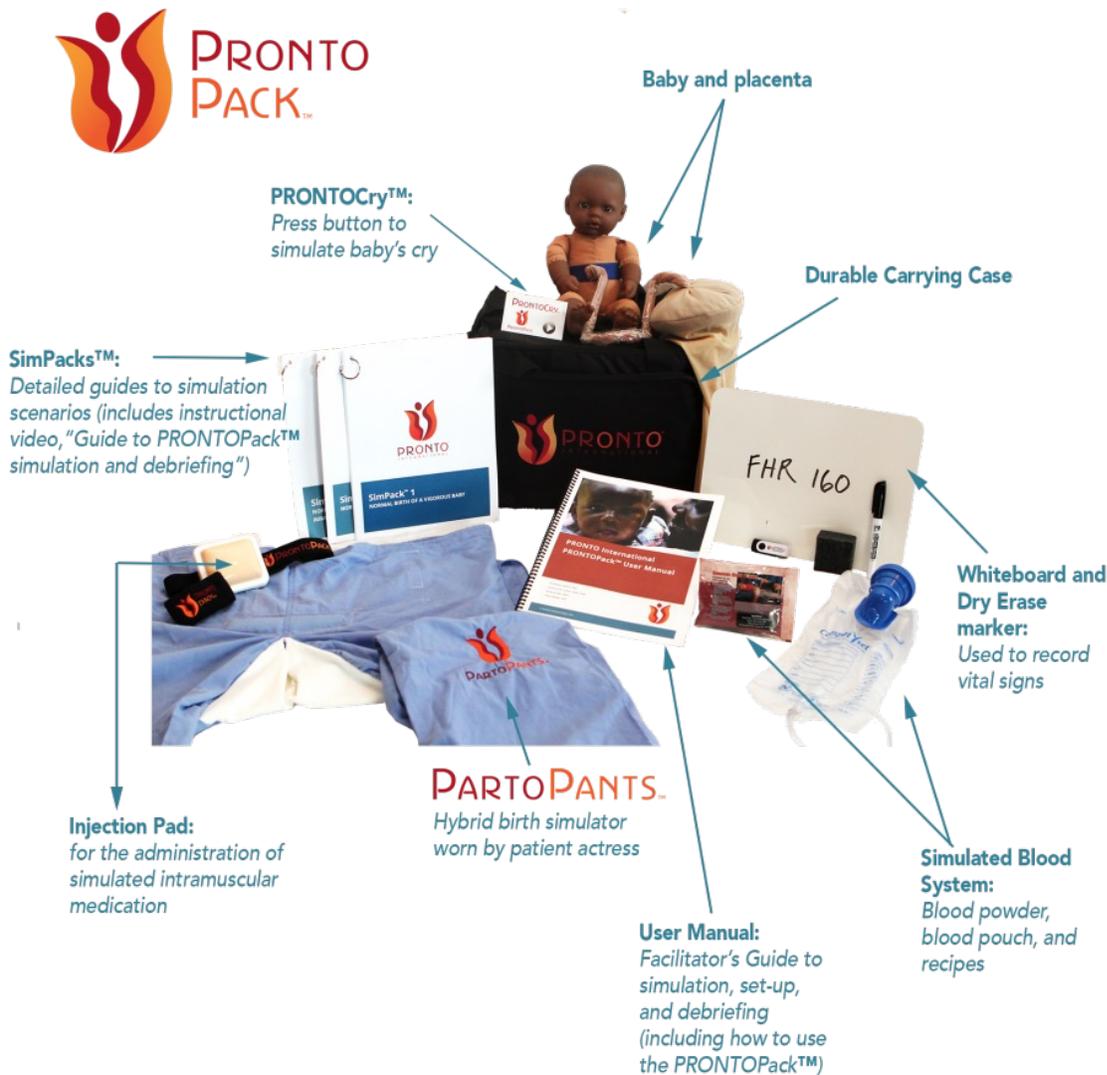
We trained mentors to prepare the simulation supplies and to orient providers to the rules of simulation sessions. Mentors asked providers to manage the simulated PPH case as they would a real patient (i.e. using the materials). We directed the mentor to record, immediately after the visit ended, which actions had or had not been correctly or incorrectly simulated by the provider, and which actions had been recommended by VM but no attempt was made by the provider to simulate them.

These data were recorded by the mentor in a checklist format. This checklist was not meant to document providers' clinical competence for each action. Rather, the mentor observed the provider during the PPH simulation and then made a judgment, while completing this checklist, as to whether the provider correctly complied with the VM's recommendation.

We combined the Provider Behavior Checklist results of all four mentor visits and only analyzed the actions that mentors recorded were indicated during the PPH simulation completed during the visit. We ignored the actions that mentors marked were not indicated during the PPH simulation completed during the visit.

Results

Overview

Results from the Provider Behavior Checklist are summarized in Figure 18. During PPH simulations, providers reacted to VM's suggestions and attempted the recommended actions most of the time. Mentors documented:

- 90% compliance for 62% of actions
- 80% or greater compliance for 86% of actions
- less than 70% compliance for 14% of actions

FIGURE 18. % OF TIMES EACH PPH TREATMENT ACTION WAS ATTEMPTED WHEN RECOMMENDED BY VIRTUAL MENTOR DURING A PPH SIMULATION. (ALL PPH SIMULATIONS IN WHICH THE ACTION WAS RECOMMENDED = 100%)
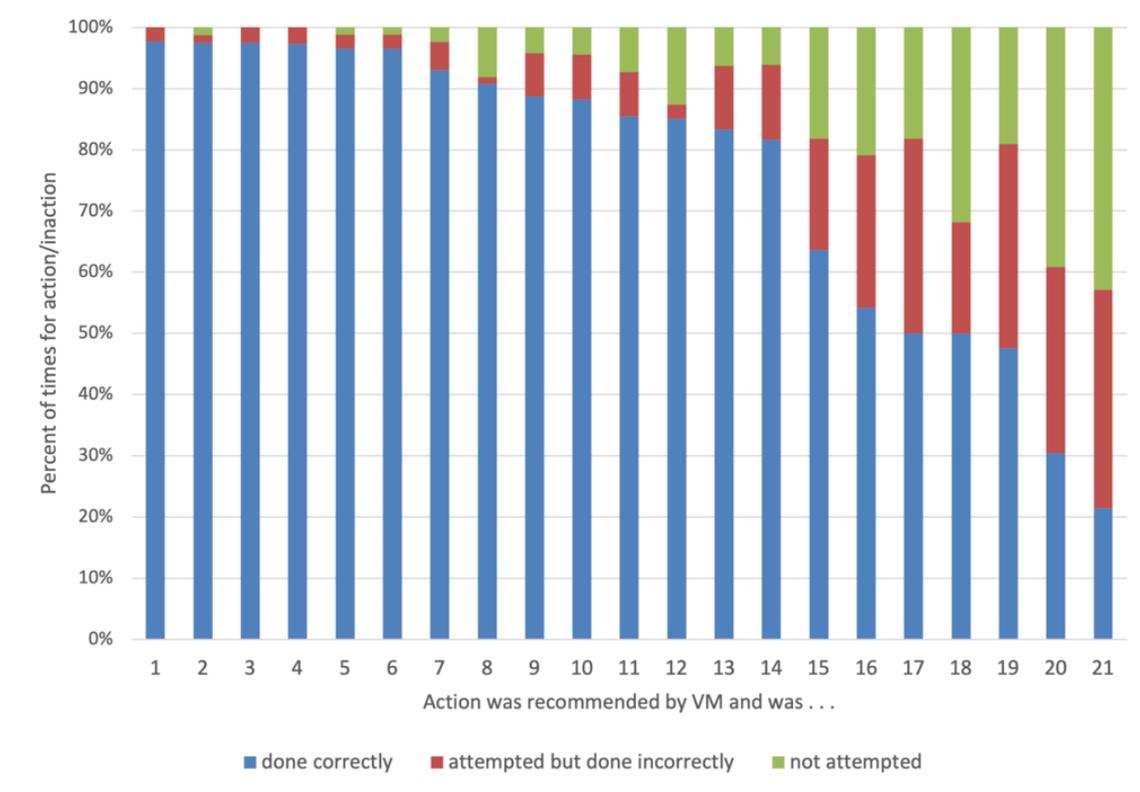
LIST OF PPH MANAGEMENT ACTIONS REFERENCED IN FIGURE 18:

1	Administer oxytocin 20 units intravenous (IV) in 1 liter fluid
2	Estimate blood loss
3	Check pulse
4	Check blood pressure
5	Start first IV line
6	Empty bladder with catheter
7	External uterine massage
8	Take blood samples
9	Check for bleeding vaginal/cervical tears
10	Administer tranexamic acid 1 gram IV over 10-15 minutes
11	Start 2nd IV line
12	Call for help
13	Manual exploration of uterus for retained products of conception, clots, or uterine rupture
14	Administer antibiotics before manual exploration of uterus
15	Repair bleeding vaginal/cervical tears
16	Elevate mother's legs
17	Give 600 mcg misoprostol oral
18	Initiate transfer of mother to a higher-level facility
19	Give 0.2 mg ergometrine intramuscular
20	Administer oxygen
21	Administer bimanual uterine compression OR aortic abdominal compression OR uterine balloon tamponade

Detailed Results

During these PPH sims, these four actions were most likely to be attempted but "incorrectly" simulated by providers, according to the mentor:

- Apply bimanual uterine compression OR aortic abdominal compression OR uterine balloon tamponade (provider was prompted to choose only one and complete it, >50% of attempts were incorrect)

- Administer oxygen to mother showing signs of shock (49% of attempts)

- Administer ergometrine 0.2 mg intramuscular (40% of attempts were incorrect)

- Administer misoprostol 600 mcg oral (40% of attempts were incorrect)

During these PPH sims, these three recommendations from VM were most likely to be ignored (provider did not attempt to complete them even though they were recommended)

- Apply bimanual uterine compression OR aortic abdominal compression OR uterine balloon tamponade (43% did not attempt)

- Administer oxygen to mother showing signs of shock (39% did not attempt)

- Prepare to transfer to higher level facility (32% did not attempt)

In a debriefing meeting of mentors, providers and project stakeholders, convened after the study period, participants explained some reasons why they ignored recommendations made by VM during the PPH simulation.

- They found it awkward or embarrassing to simulate calling out for help from a colleague, especially when there was no other provider present during the mentor's visit and because they consider this an obvious action.

- Not all CSB providers are certified to repair cervical or vaginal lacerations, so they did not attempt to simulate this.

- Since CSB providers have never used or rarely use some medications, such as oxygen, TXA for PPH, ergometrine, or misoprostol, they need more practice completing these tasks before they feel comfortable attempting them and can accomplish them correctly in the simulation.

- Since providers do not often have access to laboratory services, some did not bother to attempt simulation of taking blood samples.

Data collection instrument 6. Usability

Methods

The System Usability Scale (SUS) is a validated questionnaire to measure a product's usability perception. Ten questions are answered with a 5-point Likert scale. A standard formula is used to calculate a standardized score. The average System Usability Scale score is 68. A score that suggests the product is highly usable is 80 or higher. The adapted SUS is found as Appendix 7 to this report.

We asked providers about their perceptions of Virtual Mentor's usability. We altered a couple of the questions to ask respondents about both Virtual Mentor's usability as a training tool and a hypothetical use of Virtual Mentor in actual patient care.

Results

Overview

38 total providers and mentors responded to the SUS questionnaire after the 4th mentor visit to each CSB: 18 in ATS region and 20 in V7V region. Among these respondents from two regions, the average SUS score after visit 4 was 67 for both training use and real patient care. These results place Virtual Mentor just below or just at the average SUS score. This can be interpreted to mean that users perceived Virtual Mentor's usability to be "okay," or at the 50th percentile of product usability. We could interpret these results to mean the Virtual Mentor used in this pilot was "marginally usable" as a product.

Detailed results

This table shows the results in more detail, by region.

TABLE 7. SYSTEM USABILITY SCORES BY REGION AND IN BOTH REGIONS

Region (n)	ATS (n=18)		V7V (n=20)		All (n=38)	
Use case	Training	Patient care	Training	Patient care	Training	Patient care
SUS score	68	68	68	69	67	67

Of the 10 items in the SUS questionnaire, the question that scored "most usable" across all respondents, with an average score of 4.4 (of 5), was "I think that I would like to use this VM frequently in training." The questions that scored "least usable" across all respondents were "I needed to learn a lot of things before I could get going with VM in training" and "I think that I would need the support of a technical person to be able to use VM."

FIGURE 19: SYSTEM USABILITY SCALE SCORE BY ITEM, STANDARDIZED TO 5 AS HIGHEST SCORE
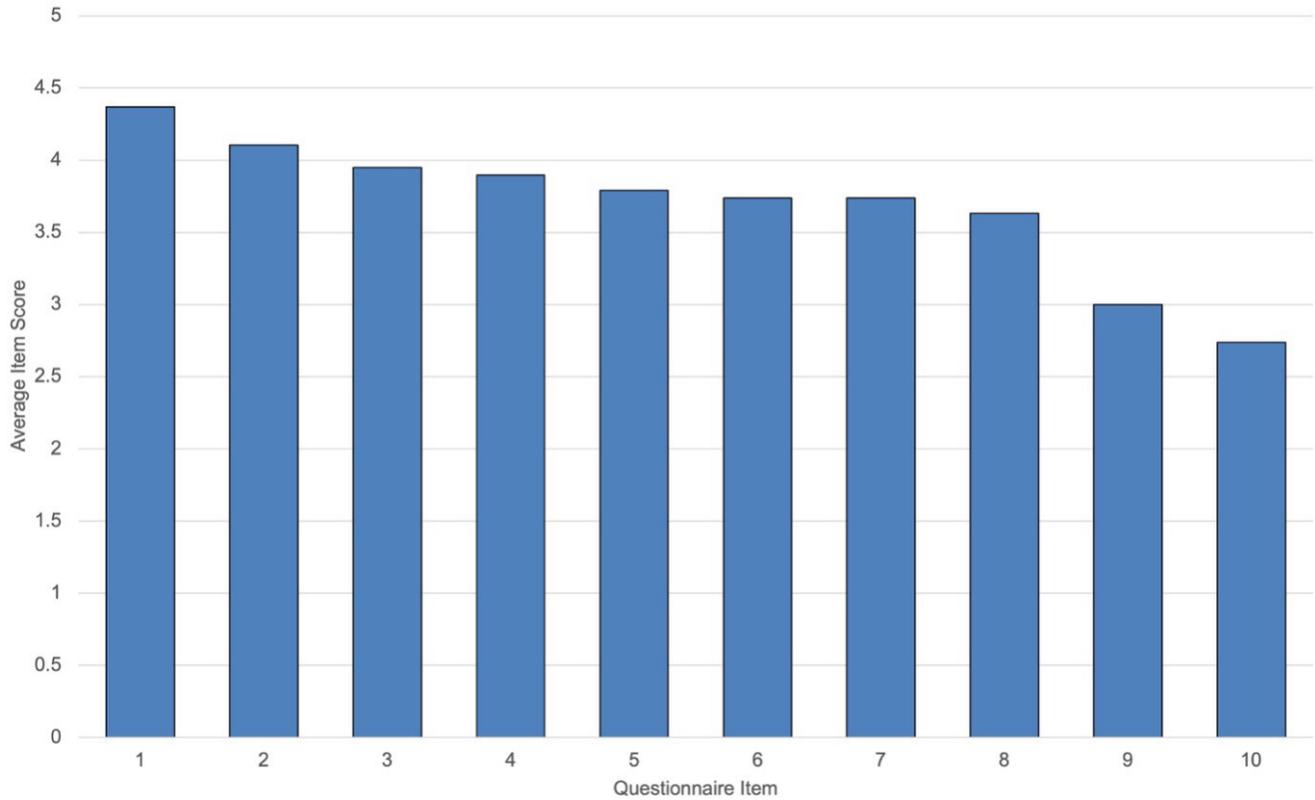
List of questionnaire items in Figure 19, from strongest agreement (far left) to lowest agreement (far right) score

1. I think that I would like to use this VM frequently in actual cases of PPH

2. I felt very confident using VM

3. I found the VM unnecessarily complex

4. I thought VM was easy to use

5. I thought there was too much inconsistency in the VM

6. I found VM very cumbersome to use

7. I would imagine that most people would learn to use VM very quickly during actual clinical care

8. I found the various functions in the VM were well integrated

9. I needed to learn a lot of things before I could get going with VM in training

10. I think that I would need the support of a technical person to be able to use VM

Data collection instrument 7. Sustainability

Methods

Research assistants conducted interviews immediately after the intervention period using a guide with open-ended prompts focused on participants' perceptions of the sustainability of the intervention and suggestions for improved sustainability. Seven providers (two from V7V regions and five from ATS region) participated in these interviews, which were each 5-10 minutes long.

Results

Overview

Three messages were mentioned most often by participants:

1). to be sustainable, Virtual Mentor's speech recognition must be improved,

2). VM will not be useful if consumables are not available, and

3). all providers and "CSB agents" (non-clinical staff) at a facility must be trained on VM use, as there will inevitably be provider turn-over.

Detailed results

Participants expressed both enthusiasm and frustration about their experiences with VM.

Enthusiasm for VM was focused on reduced provider anxiety and improved access to algorithmic recommendations. One participant emphasized that VM reduced provider "fear" and two respondents said VM provides advice when the provider is alone.

> "The Virtual Mentor is sustainable because it is indispensable, and it helps a lot. Even if you don't have human help when you work, he helps you when you have problems."
>
> *(Participant A13D04a, ATS region)*

One provider expressed a preference for the way VM delivers recommendations over the wall chart decision aid:

> "Sometimes we don't have time to read the algorithms displayed on the walls. But it is better to use the voice algorithms by the Virtual Mentor."
>
> *(Participant V5D04a, V7V region)*

While frustration with VM was focused on poor speech recognition, participants had other sustainability concerns. Three providers stated that if the consumables that VM recommends are not available for use in the CSB then

VM's utility is limited. Two providers were concerned about charging VM devices in CSBs without electricity (they suggested solar power banks be provided).

Providers offered suggestions to improve sustainability of the VM intervention package, including:

- VM should be used on a cell phone rather than a tablet device.
- Providers need training in basic clinical skills before they can perform them when prompted by VM.
- Training should be slow-paced; allow for enough days of training.
- Some providers desire additional motivation in the form of financial incentives to participate.

One provider participant had very useful feedback regarding the tool's software design:

- VM's recommendations should be spoken in shorter segments and
- Add more algorithmic decision point questions, such as asking if the patient has a penicillin allergy before recommending ampicillin.

Some unexpected insights include:

- Some providers have brand preferences for electronics.
- Some providers desire a wearable microphone/headset.
- Some providers recommend a touch-screen control rather than voice control.
- Some providers insist that VM should be fixed in place in the delivery room.

Data collection instrument 8: Endline provider interviews

Methods

Research assistants conducted endline interviews with providers about two months after the final mentor visit in this pilot study. Interviews were conducted in both intervention and control sites (the APPHC interventions were not tested in these). Using a guide with about 30 questions, these interviews solicited provider opinions about health system challenges in general and, in sites that implemented the APPHC interventions, about the tools tested in this study.

Results

Twelve providers from V7V region and 14 providers in ATS region participated in the endline interview. Among these 26 interview transcripts, there were 15 interviews in which the provider discussed the APPHC study interventions--six from V7V region and nine from ATS region. We analyzed these 15 endline interviews for themes.

Some themes that emerged from these interviews were identical to those that emerged from the sustainability-focused interviews reported above.

- VM's speech recognition must be improved.
- VM should be trialed on a phone rather than a tablet device.
- Providers want more skills instruction and practice, especially for bimanual and abdominal aortic compression, uterine tamponade, repair of cervical lacerations, and administration of medications such as misoprostol and TXA.
- A wearable headset could improve provider experience and relieve providers' concerns that patients might view VM and providers' competence negatively. The quote below represents this view and reveals that providers must always consider how to gain and maintain the trust of the beneficiaries they serve:

  "It would have to be quiet, with headphones, so that only I could hear it, so that the community could not hear anything, so that no one could hear anything. "She listens to the radio, the midwife listens to the radio… Also, the community may lose confidence in you, they say, 'the doctor is incompetent because of this talking radio, she does what this radio tells her to do.' So they lose confidence in us, they think we are incompetent … you have to put headphones on so that the others can't hear."
  (Participant A8P51, ATS region)

Other themes in these interviews gave new insights into provider experience and were repeated in other feedback sources, such as endline workshop meetings:

- Providers prefer that Virtual Mentor interact with them using the Malagasy language
- Providers want Virtual Mentor available for more emergency scenarios, including
  o Normal (uncomplicated) vaginal delivery,
  o Preeclampsia and eclampsia,
  o Neonatal resuscitation,

  o Malaria,
  o Shock (all causes),
  o Antepartum hemorrhage,
  o Sick children, and
  o COVID-19.

- Providers desire additional training in specific skills:
  o Bimanual uterine and aortic compression,
  o Uterine tamponade,
  o Repair of cervical lacerations,
  o Misoprostol and TXA administration, and
  o Managing uterine rupture.

- Providers agree that PPH simulation practice could only be accomplished on their "free days," or days when they are not on active clinical duty. However, they have widely varying preferences for the frequency of mentor visits to CSBs:
  o weekly
  o monthly, or
  o biannually.

Another theme that emerged from these interviews was that interaction with Virtual Mentor modified provider behaviors in ways that can have lasting effects in actual patient care. When asked by the interviewer how interaction with Virtual Mentor had changed the interviewee's actual management of real PPH, they reported increasing the dose of oxytocin used to treat PPH from 10 to 20 units:

"Previously, when I was dealing with a hemorrhage I would only use 10 units of oxytocin, I didn't dare to take 20, but the virtual mentor told us to take 20. This is new to me…
(Participant A8P51, ATS region)

We hypothesize that this small but significant change in the dose of oxytocin is possible for this provider to understand and implement because it is an incremental improvement in PPH management--a change that is based on previous understanding and confidence rather than a change that involved new and unfamiliar medications or techniques.

Another provider indicated that while they had learned the correct steps to take in an emergency, they may have forgotten those steps or developed alternative habits. When asked by the interviewer how interaction with Virtual Mentor had changed the interviewee's behavior during real PPH, a provider said:

"During the training, we were taught how to take care from the beginning like consolation, how to practice all the gestures. Before, we did not respect these practices but since the existence of this Virtual Mentor, we respect them." *(Participant V2P21, V7V region)*

Discussion

We begin this section of the report with further exploration of questions and hypotheses generated by some of the data collection activities and their respective results. Later in this section we discuss the larger meaning of the results presented in this report.

PPH knowledge (data collection instruments 1 & 2)

There was a notable difference in baseline knowledge scores and knowledge changes between regions; on average, participants in V7V region scored 17 percentage points higher at baseline than those in ATS region and the post-test score among V7V participants was 28 percentage points higher than in ATS regions. One example of this difference is how frequently TXA, not yet in use in Madagascar but recommended by WHO, was mentioned as a treatment for PPH in the post-test case review (instrument 2): no providers mentioned it in ATS region while 54% of providers in V7V region mentioned TXA. This same trend was seen for mention of ergometrine, a medication not generally available in CSBs but recommended in global and national PPH treatment algorithms, in the post-test case review.

We gained some insight into this difference from the endline data collected by TANDEM from January 26th - February 15th 2021. In that data collection activity, provider participants from intervention CSBs and control CSBs were sampled in both V7V and ATS regions. Those results show that among the 17 provider participants questioned at intervention CSBs in V7V region, 77% had received BEmONC training, while only 25% of the 20 providers questioned in ATS region had received BEmONC training. We believe this difference in previous training experience best explains the knowledge assessment differences seen in our results. Further, the following differences between provider participants in the two regions should be considered:

- Participants in the V7V region had more years of experience, on average.

- Fewer providers in the ATS region were consistent participants in both the pre-test and the post-test.
- Fewer provider participants in ATS region (1 general doctor) were physicians compared to V7V region (2 general doctors).
- Implementation of Breakthrough Research provider support tools implemented only in the V7V region may have contributed to differences in post-test scores between regions.

  ○ There is a plausible relationship between the provider support tools implemented in V7V region and 2 topics for which we saw higher post-test scores in V7V region: evaluation for coagulopathy and application of uterine balloon tamponade.

  ○ There is no plausible relationship between the provider support tools and 2 other topics for which we saw higher post-test scores in V7V region: misoprostol administration and maximum daily dose of oxytocin.

We suspect that our instruments for measuring knowledge require re-design, as we noted two unexpected results:

- The topics of greatest knowledge gains and losses between regions were quite different, with little overlap.
- Knowledge performance was sometimes inconsistent between the two knowledge-measuring instruments we used; for example, in V7V region participants showed little knowledge gain with respect to the correct dose of IV TXA administration (noted in the PPH questionnaire), but there was a large increase in proportion of providers who mentioned TXA as a PPH treatment in the post-test PPH case interview.

PPH management confidence/self-efficacy (data collection instrument 3)

While overall confidence to correctly manage PPH increased from pre-to post test, we noted losses in self-efficacy from pre- to post- with respect to 2 specific PPH management tasks:

- Correctly administer misoprostol to treat PPH and complete the correct lab tests in the case of PPH, in ATS region
- Correctly administer IV volume replacement in the case of PPH, in V7V region

Comments made by mentors and providers at follow-up meetings convened after the program period help explain these losses. Participants in these meetings noted that if

the consumables are not available at their facilities, they lose confidence that they can apply the correct treatments for PPH--especially after they better understand what the standard of care should be.

For example, while drawing blood for indicated lab tests is recommended by Virtual Mentor, laboratory evaluation is not possible at the CSB. Providers' confidence they could correctly manage PPH likely decreased with respect to lab assessments because they were reminded during simulations that they do not actually have the supplies needed at their facilities to fully evaluate the woman's condition.

Participants at end line meetings also stated that their confidence to correctly replace lost blood volume with IV fluid decreased from pre- to post- because during these program activities they learned that they must use the estimated blood loss in this calculation, and they must have access to sufficient IV fluid to correctly replace lost volume. Participants told us they did not feel capable of accurately estimating blood loss. This is a skill set that deserves further capacity-building. They also told us they do not have sufficient access to IV fluids to correctly replace lost blood volume.

In an endline data collection activity, providers from both intervention and control sites were asked about their confidence with respect to completing 13 PPH-related actions. Compared to providers in control sites, twice as many providers from CSBs that received the intervention answered with the highest level of confidence ("I can do it without supervision"). The largest difference in confidence responses was for the item "administer uterotonic medications correctly," in which three times as many intervention-site providers answered with the highest confidence level compared to control-site providers. These differences in confidence levels between intervention and control sites, at 2-3 months after the study period, deserve further study. We hypothesize that intervention providers applied the skills they practiced during PPH simulation to actual patient care after the study period, and by the time of the endline data collection they had gained confidence in their knowledge and skills.

We cannot yet explain why, in both regions, the confidence score for identifying hypovolemic shock decreased. This deserves further study.

Acceptability and Feasibility (data collection instrument 4)

We found that participants in V7V regions were more likely to score Virtual Mentor higher on this questionnaire, suggesting greater enthusiasm for this digital tool in that region. We are not sure why there was a regional difference.

We do not yet understand how to interpret the low scores in response to the question "Is the VM consistent with the male culture in your country?" We plan to ask follow-up questions at the next opportunity. Insights into providers' opinions about Virtual Mentor's appropriateness may be found in comments they shared at a post-program meeting. Providers who participated in this meeting stated that if Virtual Mentor were used by a provider during a real PPH, patients may be confused by the interaction between provider and Virtual Mentor. Specifically, they feared that patients would:

- Feel apprehensive if a provider was listening to a computer voice before completing clinical actions
- Perceive that the provider is not competent to perform correct clinical actions without step-by-step instructions

Provider participants suggested that patients would need to be oriented to the supportive purpose of Virtual Mentor. This insight deserves attention in future implementation.

Provider behavior checklist (data collection instrument 5)

We noted that not all providers attempted recommended actions during PPH simulations, even when prompted by Virtual Mentor. As the results in Figure 19 show, there was highly reliable completion of basic PPH management actions (e.g., first 7 actions listed in Figure 19), but other actions were less reliably completed. Despite this drop-off in action completion rates, we may assume that more providers completed these actions in simulation under the direction of Virtual Mentor than they would have done without reminders from Virtual Mentor. A controlled trial comparing provider behaviors during simulation WITH and WITHOUT Virtual Mentor is required to understand if providers are more likely to complete recommended PPH management actions when in "conversation" with Virtual Mentor.

Participants reported that they felt some frustration when they were prompted by Virtual Mentor to perform an action that is not possible in the CSB, and this is likely

represented in the Provider Behavior Checklist results. Indeed, reminders that one does not have access to resources needed to provide the standard of care can be discouraging rather than inspiring. We need to do further work to understand whether best outcomes are achieved by implementing a Virtual Mentor algorithm that is more aspirational or more pragmatic.

Usability (data collection instrument 6)

These results suggest the Virtual Mentor, as used in Madagascar during this pilot study, needs further design improvements to increase users' perception of usability, in all usability domains. We suspect the Virtual Mentor's low usability scores were related to participants' complaints that Virtual Mentor could not always "hear" their answers and a preference for Malagasy over French in this context.

Additional results available from a workshop convened after study period

Approximately one month after the study ended, a selection of mentor and provider participants convened in a 1-day workshop; one of these was convened in each region. The objectives of these meetings were:

1. To understand how the APPHC approach could be scaled sustainably in Madagascar, and;

2. To define an ideal mentoring model for Madagascar.

These workshops provided invaluable feedback. Participants provided a list of personal and professional characteristics the ideal mentor must possess. They asserted that in order for this training approach to be sustainable, the following must be accomplished:

- Technology
  - Mobile devices available at CSBs, and with better audio capability
  - Reliable power source to charge mobile device

- Providers
  - Staff retention at CSBs
  - Motivation/incentives, such as certificates

- Mentors
  - Remote and in-person coaching
  - Allowances
  - Data credits to access streaming videos

Provider participants recommended that all providers should have access to this training and that mentors should provide follow-up and supervision (in-person or remote) to reinforce the training content. They also requested that providers have access to Virtual Mentor at the CSB even when clinical mentors are not present. Mentor participants desired:

- Further training in order to master simulation and mentorship skills and certification, in order to advance their opportunities for professional promotion.

- The average preferred frequency of future mentor visits to each CSB was between 2-4 times in a year with each visit one-half day to 2 days in length.

- Providers and mentors were asked if matrones (community-based, unlicensed midwives) should be invited to participate in simulation sessions; their opinions were divided on this subject.

Providers in V7V responded positively about continued use of the provider support tools (timer, badges, and poster) in facilities. Providers in ATS region who watched the provider support tools videos during the post-study workshop asked to learn more about them.

One of the most interesting results in this study comes from the Organizational Questionnaire, in which 70% of providers in V7V region and 78% of providers in ATS regions answered, "a lot" to the question "Is using the VM for clinical care something you feel you should be doing as part of your job?"

While providers were generally enthusiastic about the potential use of Virtual Mentor in actual patient care as a decision support tool, they feared that patients would:

- Feel apprehensive if a provider was listening to a computer voice before completing clinical actions

- Perceive that the provider is not competent to perform correct clinical actions without step-by-step instructions

Provider participants suggested that patients would need to be oriented to the supportive purpose of Virtual Mentor. The issue of orienting patients to PPH care in general and to the roles of providers, patients, and support people during such an emergency deserves further study. Specifically, we believe there are ways to help patients orient to Virtual Mentor use during PPH, such as changing the language to Malagasy and adding narration that explains its purpose in ways the patient is more likely to understand.

Summary and next steps

Mentors and providers were enthusiastic about the mentorship model. The average preferred frequency of future mentor visits to each CSB was between 2-4 times in a year with each visit one-half day to 2 days in length.

Provider participants appreciate the realistic simulations and are tentatively enthusiastic about the Virtual Mentor concept, with important recommendations for improved usability and feasibility. Through these data collection instruments, participants provided clear feedback to inform improvement and scale of this novel mentorship approach.

Our objectives in the next phase are listed below.

1. Increase access to this mentorship approach

- Scale the program piloted in this study to more health facilities

2. Improve providers' experience with Virtual Mentor

- Change the language the chatbot "speaks" to the providers' first language, with upgrades to the voice-recognition software
- Invest in custom-made, wearable mobile devices with high-quality microphones that will more reliably recognize the provider's voice during hands-free conversation
- Add other clinical scenarios to the chatbot's capacity, starting with maternal hypertension/preeclampsia/eclampsia

3. Re-design Virtual Mentor to increase appropriateness and usability

- Implement providers' feedback to improve VM's algorithm
- Conduct interviews with providers, birthing women, and their family members at frontline facilities and collect data about increasing appropriateness for this context

4. Increase Mentors' preparation

- Expand mentor training to provide a total of 5 in person training days for new Mentors, focused on mastering simulation skills, add to remote digital simulation educator content

- Add training for high-priority skills and procedures, such as estimating blood loss, aortic compression, uterine balloon tamponade

5. Refine tools intended to capture PPH management knowledge and confidence

6. Design and conduct a pilot study for use of Virtual Mentor in actual patient care

- Study safety, reliability, usability, and effectiveness

APPENDICES

APPENDIX 1: GLOW-IN-THE-DARK PPH MANAGEMENT POSTER CREATED BY BREAKTHROUGH RESEARCH AND IDEAS42

Recommended interventions are (left to right):

- In case of uterine atony: massage uterus, administer oxytocin, perform bimanual compression, perform abdominal aortic compression, apply uterine balloon tamponade, refer to higher-level facility

- In case of retained placenta or placental fragments: manual exploration of uterus, refer

- In case of cervical or vaginal lacerations: repair lacerations, refer

- In case of coagulopathy: refer
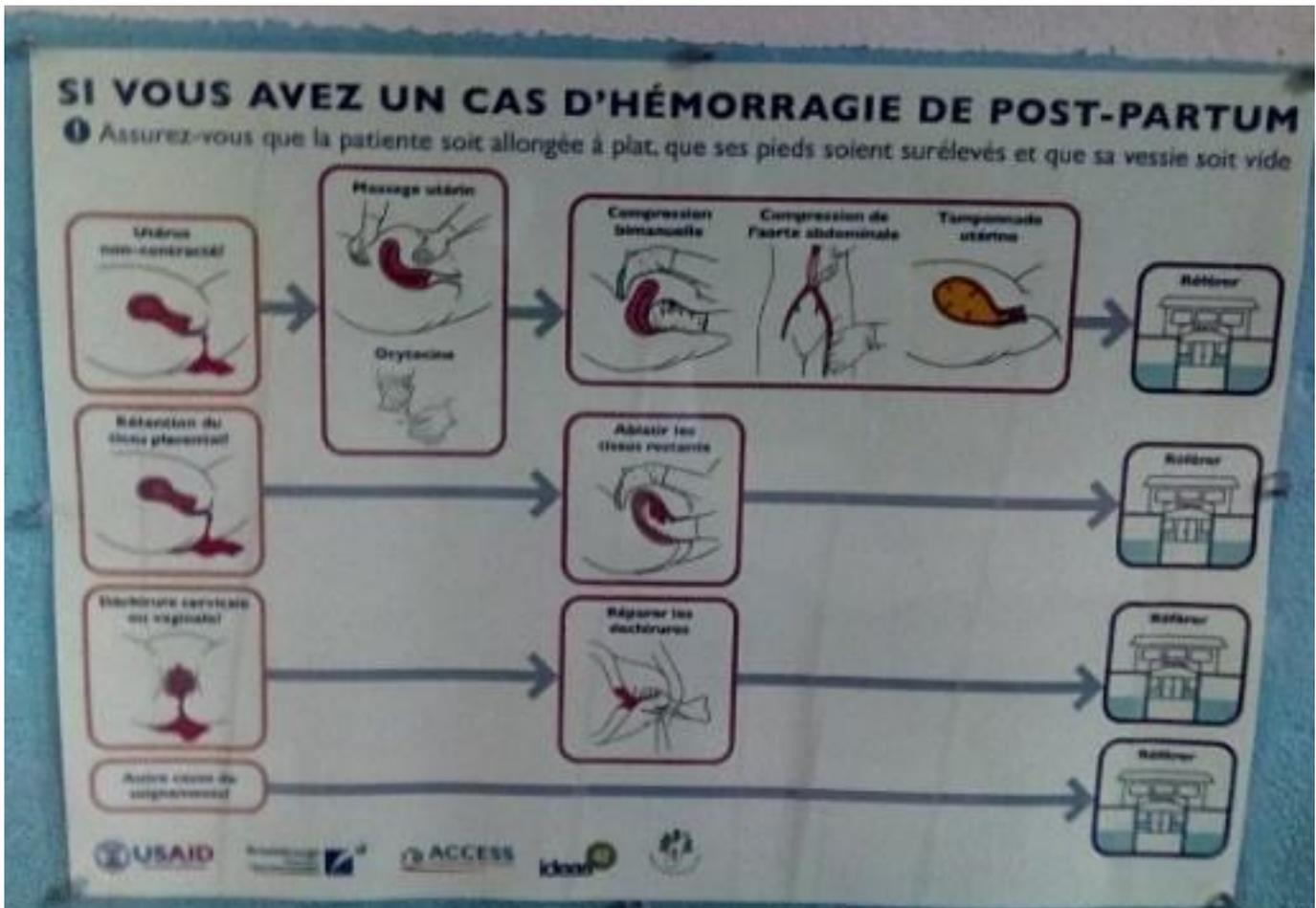
APPENDIX 2. PROVIDER CHARACTERISTICS AND PPH KNOWLEDGE QUESTIONNAIRE

FACILITY IDENTIFICATION			
District:	1- [___|___]	Zone /Region	1- [___|___]
1- Rural 2- Urban	[___|___]		
Facility name: _____Code [___|___]			
Facility type	01-District Hospital 02-Community Hospital 03 Other Hospital 04 Health Centre 05 Maternity 88-Other (Specify)_____		[___|___]
INTERVIEW DATE (DAY, MONTH, YEAR E.G. 02/08/19			[___|___/___|___/___|___]
Language(s) Used to Conduct Interview	01=French 02=Malagassy 03= Local Language 88 =Specify_____		[___|___] [___|___] [___|___]
INTERVIEWER'S NAME			[___|___]
	SUPERVISOR	EDITED BY	ENTERED BY
Name DATE	_____ _____	_____ _____	_____

TIME INTERVIEW STARTED: (RECORD TIME IN 24-HOUR)   [___|___:___|___]

SECTION I				
Section I: provider characteristics				
NO	QUESTION	RESPONSE OPTIONS	CODES	SKIP
1.	Provider is…	Female	1	
		Male	2	
2.	How old are you?	Age (years)	_____	
		Don't know	98	
3.	Provider is currently working in…	Maternity Admission room	1	
		Antenatal room/ward	2	
		Postnatal ward	3	
		Labour and delivery ward	4	
		Nursery	5	
		Special Care Baby /KMC unit	6	
		Other (specify) _____	88	
4.	What is your current professional qualification? [DO NOT READ OPTIONS]	Specialist Medical Doctor	1	
		Medical Officer	2	
		Clinical Technician (Diploma)	3	
		Clinical officer (Degree level)	4	
		Medical Assistant	5	
		Registered nurse BSN	6	
		Registered nurse/midwife BSN	7	
		Registered psychiatric nurse	8	
		Registered nurse with diploma	9	
		Community Health Nurse	10	
		Nurse/midwife Technician	11	
		Enrolled nurse/midwife	12	
		Enrolled midwife	13	
		Student nurse/ midwife	14	
		Nutrition Officer	15	
		Other (specify) _____	88	

SECTION I			
5.	How many years has it been since you received your professional qualification? PLEASE LIST THE TIME IN MONTHS IF IT IS LESS THAN 12 MONTHS. OTHERWISE, RECORD THE NUMBER OF YEARS	[___|___:___|___]	
6.	For how many years have you worked in...? ..21[READ OUT OPTIONS. RECORD '00' IF LESS THAN ONE YEAR]		Years
		a) Health care system	_____
		b) This facility	
		c) This unit	_____

Now I am going to ask you to fill this part of the questionnaire yourself:

1. Which activity helps to decrease the risk of postpartum haemorrhage (PPH)?
   a. Inj. Oxytocin 10 IU IM soon after the birth of the baby
   b. Packing the vagina after birth of placenta
   c. Checking for placental bits in uterus by manually sweeping the uterus
   d. None of the above

2. During controlled cord traction (CCT) for placenta delivery, the health care provider puts one hand above the mother's pubic bone. Why?
   a. To prevent the urinary bladder from prolapsing into the vagina
   b. To support the uterus so that it does not turn inside out with placenta delivery
   c. To encourage the placenta to release from the uterus and make placental delivery easier
   d. None of the above

3. Diagnosis of postpartum haemorrhage (PPH) after a normal birth is blood loss of more than:
   a. 100 ml
   b. 250 ml
   c. 350 ml
   d. 500 ml

4. The most common cause of postpartum haemorrhage (PPH) is:
   a. Coagulation disorder (blood will not clot)
   b. Retained placenta or placental tissue (bits of placenta)
   c. Trauma to the uterus, cervix, or vagina (bleeding laceration or tear)
   d. Uterine atony (non-contracting uterus)

5. Aarti just delivered her 4th baby. After the placenta delivered, Aarti started to bleed heavily. The FIRST three actions the health care provider should perform are:

   a. Uterine massage; insert a balloon tamponade; perform the steps of AMTSL

   b. Check for cervical lacerations; aortic compression; insert a balloon tamponade

   c. Call for help; uterine massage; start IV to administer medications to help the uterus contract

   d. Start an intravenous (IV) drip; take a blood sample for blood type; and transfuse blood

6. Treatment of PPH due to uterine atony might include the use of which "uterotonic"

medications?

   a. Oxytocin, misoprostol, Methergine

   b. Oxytocin, magnesium sulphate, Methergine

   c. Misoprostol, methyldopa, hydralazine

   d. Oxytocin, nifedipine, salbutamol

7. Treatment of hypovolemic shock during and after a PPH includes:

   a. Raising the head of the delivery coach when the woman complains of feeling dizzy

   b. Ferrous and folate (Fe/FA) tablets orally or per rectum

   c. Blood transfusion when the woman's heartbeat is 100

   d. Replacement of intravenous (IV) fluids 3 times the amount of estimated blood loss (EBL)

8. What is the correct dose of tranexamic acid for a woman with PPH?

   a. 1 mg

   b. 1 g

   c. 10 g

   d. Tranexamic acid should not be used to treat PPH

9. What is the maximum daily dose of oxytocin (within 24 hours)?

   a. 20 unité

   b. 60 units

   c. 100 units

   d. There is no maximum daily dose of oxytocin

10. What is the correct dose of misoprostol to give to a woman with PPH? HPP?

    a. 200 mcg

    b. 400 mcg

    c. 600 mcg

    d. None of the above

APPENDIX 3: VIGNETTE FOR MANAGEMENT OF PPH

Participant ID number	
Date of interview	
Time at start	
Time at finish	

> **Now I am going to read you a scenario about a patient. I am going to tell you what is happening. Then I will ask you to describe to me what you would do as the provider caring for this patient. Please share as much detail as you can about the different actions you would take to help this patient. Do you have any questions?"**

[To data collector: after you read the scenario and ask what the respondent will do. Go to the checklist and mark down 1 point for every answer that they mention. They do not have to use the exact wording. But their answer has to represent the desired action such as "call for a car to transport patient" is the same as "arrange transportation."]. After each question you will ask them one more time if they would do anything else.

A. Madame Vola is 21 years old and has just given birth to a healthy baby boy after 12 hours of labour. It was her first baby and she delivered in the clinic. Active management of the third stage was performed, and the placenta and membranes were delivered 20 minutes after birth and were complete. The midwife who attended the birth left the hospital at the end of her shift. Approximately 30 minutes later, a relative rushed in to tell you that Mrs X is bleeding profusely.

   a. What will you do?

   Follow-up question: "Would you do anything else?"

B. On examination, you find that Mme.Vola's pulse is 120 beats per minute and weak and her blood pressure is 86/60mm Hg.

   b1. What is Mme Vola's presenting complication?

   b2. What will you do now?

   Follow-up question: "Would you do anything else?"

C. You find that Mme Vola's uterus is soft and not contracted.

   c. What will you do now?

   Follow-up question: "Would you do anything else?"

D. After five minutes, Mme Vola's uterus is well contracted, but she continues to bleed heavily.

   d. What will you do now?

   Follow-up question: "Would you do anything else?"

SCORING. POSTPARTUM HEMORRHAGE

Criteria	Score	Mark result
PART A		
Calls for help from colleagues	1	
Explain to M. Vola what will be done, responds to her concerns (Note: any answers related to communicating with patient get 1 point)	1	
Rapid evaluation of M. Vola's general condition and vital signs		
Level of consciousness	1	
temperature	1	
Blood pressure	1	
Respiration rate	1	
Assess quantity of blood		
Other (specify): _____		
PART B		
B1. States that M. Vola is in shock from PPH (Note: if respondent says patient has hemorrhage, ask "Anything else?" We want to mark if they mention SHOCK. Examples of responses include: "shock", "shock from hemorrhage", "shock from PPH", "too much bleeding causing shock", "severe PPH").	1	
B2. Palpate uterus for firmness, (check for uterine tone)	1	
Check for perineal tears (check for vaginal or cervical tears)	1	
Start IV infusion using normal saline or Ringer's lactate at a rate of 1L in 15–20 minutes (give credit for action to start an IV and infuse fluid)	1	
Administer oxytocin IV or IM (give uterotonic medication- oxytocin or misoprostol) (Note: If respondent answers either "put an IV" or "give oxytocin" then give 1 point. Then follow-up with question: "How many units?") _____ units	1	
PART C		
Massages the uterus to expel blood and blood clots and stimulate a contraction	1	
Covers M. Vola to keep her warm	1	
Elevates M. Vola's legs	1	
Continues to monitor (or has assistant monitor) blood loss, pulse and blood pressure. (Note: any of these answers "take blood pressure", "monitor blood loss", "monitor pulse" gets 1 point).	1	
Begin bi-manual compression (Note: any of these answers "use hands to provide pressure to stop bleeding", "squeeze uterus", "pressure on uterus" gets 1 point.)	1	
Check for missing placenta parts / retained placenta (Note: any of these answers "examine placenta", "see if missing pieces of placenta" gets 1 point.)	1	

Criteria	Score	Mark result
Consider other methods to control hemorrhage (0.5 pts each) 1. Misoprostol 2. Additional oxytocin 3. TXA 4. Uterine balloon 5. Methergine 6. NASG	0.5 each	1. ____ 2. ____ 3. ____ 4. ____ 5. ____
Arrange for transport (Note: any of these answers "referral", "refer patient", "arrange transport", "get a car" etc. will get 1 point.)	1	
Other (please specify):_____ (Note: please write any other actions that respondent says they would take that have not been included in previous answers.)		
PART D		
Massages the uterus to expel blood and blood clots and stimulate a contraction	1	
Covers M. Vola to keep her warm	1	
Elevates M. Vola's legs	1	
Continues to monitor (or has assistant monitor) blood loss, pulse and blood pressure. (Note: any of these answers "take blood pressure", "monitor blood loss", "monitor pulse" gets 1 point).	1	
Begin bi-manual compression (Note: any of these answers "use hands to provide pressure to stop bleeding", "squeeze uterus", "pressure on uterus" gets 1 point.)	1	
Check for missing placenta parts / retained placenta (Note: any of these answers "examine placenta", "see if missing pieces of placenta" gets 1 point.)		
Consider other methods to control hemorrhage (0.5 pts each) 1. Misoprostol 2. Additional oxytocin 3. TXA 4. Uterine balloon 5. Methergine 6. NASG	0.5 each	1. ____ 2. ____ 3. ____ 4. ____ 5. ____
Arrange for transport (Note: any of these answers "referral", "refer patient", "arrange transport", "get a car" etc. will get 1 point.)	1	
Other (please specify):_____ (Note: please write any other actions that the respondent says they would take that have not been included in previous answers.)		

APPENDIX 4: SELF EFFICACY ASSESSMENT

On a scale from 1 to 10, how confident are you in each of these clinical scenarios? Please circle the number that best represents your confidence level.

1 is lowest confidence   10 is greatest confidence

1. How confident are you that you can correctly administer syntocinon (oxytocin) to treat postpartum hemorrhage?

1	2	3	4	5	6	7	8	9	10

LOW CONFIDENCE   **HIGH CONFIDENCE**

2. How confident are you that you can correctly administer Cytotec (misoprostol) to treat postpartum hemorrhage?

1	2	3	4	5	6	7	8	9	10

LOW CONFIDENCE   **HIGH CONFIDENCE**

3. How confident are you that you can correctly administer tranexamic acid (TXA) to treat postpartum hemorrhage?

1	2	3	4	5	6	7	8	9	10

LOW CONFIDENCE   **HIGH CONFIDENCE**

4. How confident are you that you can correctly administer intravenous volume replacement to a woman with postpartum hemorrhage?

1	2	3	4	5	6	7	8	9	10

LOW CONFIDENCE   **HIGH CONFIDENCE**

5. How confident are you that you can identify signs of hypovolemic shock?

1	2	3	4	5	6	7	8	9	10

LOW CONFIDENCE   **HIGH CONFIDENCE**

6. How confident are you that you can correctly complete the correct laboratory tests in the case of severe postpartum hemorrhage?

1	2	3	4	5	6	7	8	9	10

LOW CONFIDENCE   **HIGH CONFIDENCE**

7. How confident are you that you are capable to effectively treat postpartum hemorrhage?

1	2	3	4	5	6	7	8	9	10

LOW CONFIDENCE   **HIGH CONFIDENCE**

APPENDIX 5: ACCEPTABILITY AND FEASIBILITY SURVEY

Question	Not at all	A little bit	A moderate amount	A lot	Don't know
Acceptability	1	2	3	4	8
Adoption					
1. Have you discussed with other providers and staff about what is needed to continue to provide VM in the future?					
2. Have you discussed with others (e.g. family, friends, coworkers, or any other people) your experiences with the VM?					
3. Would you continue to use the VM for training in the future?					
4. Would you like to use the VM for actual patient care in the future?					
5. Will using the VM be a high priority in the future?					
Acceptability					
1. Did you like using the VM?					
2. Do you feel good about using the VM?					
3. Did you enjoy learning with the VM?					
4. Do you feel that the skills you have learned by using VM will be useful in helping patients?					
5. Do you feel that the conversation with the VM makes sense?					
6. How satisfied are you with the VM training?					
7. How satisfied are you with the VM itself?					
8. Is the virtual mentor conversation clear?					
Appropriateness					
Social/cultural					
1. How well does the VM fit with the cultural values of your patients?					
2. How well does the VM fit with your cultural values?					
3. Is the VM consistent with the male culture in your country?					
4. Is the VM consistent with the female culture in your country?					
5. Would patients feel comfortable with providers using VM to provide care?					
Self-perception of effectiveness					
6. Is the VM a good way to help you address your patient's problems?					
Task fit					
7. Is training with the VM something you feel you should be doing as part of your job?					
8. Is using the VM for clinical care something you feel you should be doing as part of your job?					
Feasibility					

1. Are you sufficiently skilled at using VM in simulation training					
2. Are you sufficiently skilled with VM to use it in actual patient care					
3. Do you have enough time to train using VM?					
4. Are you paid enough to participate in training with the VM?					
5. Do you have the space to train with VM?					
Reach Access					
1. Would other providers feel comfortable using the VM in training?					
2. Would other providers feel comfortable using the VM in actual clinical practice?					
3. Would providers seek opportunities to use VM in training?					
4. Would providers seek opportunities to use VM in actual clinical practice?					

APPENDIX 6: PROVIDER BEHAVIOR CHECKLIST

Choose one answer for each row, for each simulation completed.

Behavior	Completed this behavior correctly? (mark if yes)	Attempted but did not demonstrate correct behavior (mark if yes)	Did not complete because was not recommended by VM in this scenario (mark if yes)
Call for assistance from another person			
Start 1st IV line			
Oxytocin 20 units IV in 1 liter fluid			
Massage uterus			
Empty bladder			
Check for bleeding cervical / vaginal tears			
Repair bleeding cervical / vaginal tears if found			
1 gram TXA IV over 10-15 minutes			
600 mcg misoprostol oral route OR Methergine 0.2 mg intramuscular route			
Take blood samples and send to lab			
Explore uterus for retained products and clots			
1 gram ampicillin or ceftriaxone IV			
Start 2nd IV line			
Bimanual compression OR abdominal aortic compression OR UBT applied			
Check blood pressure			
Check heart rate			
Diagnose signs of shock			
Elevate legs			
Apply oxygen			
State estimated blood loss			
Order correct volume replacement for blood lost			
Begin transfer of patient to theatre or higher-level facility			

If the providers did not perform all of the recommended actions as directed by VM, please explain below why? (supplies, resources, forgot, decided not to)

APPENDIX 7: SYSTEM USABILITY SCALE

Strongly disagree=1   **Strongly agree=5**

Item	Item	1	2	3	4	5
1a	I think that I would like to use this VM frequently in training					
1b	I think that I would like to use this VM frequently in actual cases of PPH					
2	I found the VM unnecessarily complex					
3	I thought VM was easy to use					
4	I think that I would need the support of a technical person to be able to use VM,					
5	I found the various functions in the VM were well integrated					
6	I thought there was too much inconsistency in the VM					
7a	I would imagine that most people would learn to use VM very quickly during training					
7b	I would imagine that most people would learn to use VM very quickly during actual clinical care					
8	I found VM very cumbersome to use					
9	I felt very confident using VM					
10	I needed to learn a lot of things before I could get going with VM in training					

APPENDIX 8: SUSTAINABILITY INTERVIEW

Interviewer says: "A sustainable program is one that continues after external support ends

How much do you think the Virtual Mentor meets this definition of sustainable?"

Not at all 1	A little bit 2	A moderate amount 3	A lot

"Please explain your answer… What is missing from this definition of sustainable?"

Probes:

1. Are there aspects of the Virtual Mentor that should be changed to make it more sustainable, if so, what are they? (voice, color, size)

2. What else would we need to know about the virtual mentor to help with understanding how sustainable it is?

APPENDIX 9: IN-DEPTH INTERVIEW GUIDE FOR MATERNITY CARE PROVIDERS

Title (qualification and position) of the participant	
Name of the organization or institution	
Name of the participant	
Date of interview	
Start time	
Time of realization	

Overview of factors that influence the use of health services during childbirth and providers' general perceptions of health services at childbirth

1. In your opinion, what is the biggest problem in the area of maternal health in your community? (Probe on: maternal complications, ANC, nutrition, delivery care, health system limitations?)

2. What are the biggest problems or challenges that service providers face when providing services to women during childbirth in this community? Why do you say this?

3. What factors do you think influence the decision of where pregnant women seek delivery services during childbirth (either at the facility or by traditional birth attendants)? What makes you think this?

Explore possible stressors for maternity service providers

4. From your perspective, what factors affect your ability to do your job?

Relaunch:

- Give examples of what helps you provide services
- Give examples of what may hinder your ability to provide services
- How does your work environment affect your performance? Give positive/negative examples.

5. Can you think of a time when you felt stressed about your work? Please describe.

Relaunch:

- What do you think led to this feeling? Anything else?
- Is there anything that could have helped you relieve the stress you felt?
- How could your supervisor have helped you in this situation?

Understand the factors related to the prevention, detection and management of PPH

6. What do you know about PPH? How do you determine if a woman has PPH? What do you think about how it could be prevented and treated?

7. Are you aware of any medications that can prevent and treat this disease? If so, how would you describe the availability, accessibility and affordability of these services?

8. How do you manage women with PPH in your work? What does the referral process look like?

9. Please describe the main responsibilities in your role and the challenges you face in your role in terms of treating and supporting pregnant women?

10. Are there any guidelines that you refer to when doing your work? How useful are they?

11. What do you usually advise women about PPH?

12. What community factors do you think influence women's decision to go to a health care facility?

13. What do you think should be done to provide the necessary care for these women?

14. Do you know of any strategies to help women in the community who have PPH and cannot get to a facility? (Relaunch on: misoprostol)

Understand providers' experiences in using and thinking about the usefulness of provider support tools

1. What do you know about the provider support tools in place in this health facility? (Ask again about what they are?)

2. How would you describe the main purpose of the stopwatch to another midwife?

   a. Does the stopwatch do a good job of that? Why or why not?

   b. What do you like most about the stopwatch?

   c. What don't you like about the timer? [Probe: Do you have any difficulties using it, what were they? How would you change it?]

3. How did you use the stopwatch during a delivery? When did you use it?

   a. [If the person did not use it during a delivery: Why didn't you use the stopwatch during a delivery?]

4. Describe how the timer changed the delivery process here?

5. How would you describe the primary purpose of the family member task badges to another midwife?

   a. Did the badges do a good job of that? Why or why not?

   b. What do you like most about the family member stain badges?

   c. What don't you like about badges? [Probe: Do you have any difficulties using them, what were they? How would you change it?]

6. How did you use the badges during a delivery?

   a. What badges do you use most often? Why do you use them?

   b. Are there any badges you never use? Why not?

   c. Are there any missing tasks for which you would like a badge?

   d. [If the person did not use them during a delivery: Why didn't you use the badges during a delivery?]

7. How do you explain the badges to family members?

   a. How do family members react? [Probe: do some family members react differently than others].

   b. What tasks are family members most responsive to? Why or why not?

   c. Are there tasks that family members do not want? Why or why not?

   d. What do family members do with the badges when you hand them out?

   e. What do family members do with the badges when they leave?

8. Describe how badges have changed the delivery process here?

9. Is the illuminated sign installed in this health facility?

a. Where? Why in this place?

b. How often do you see her there?

c. What do you think when you see the poster?

d. Have you seen the poster in the dark? What does it look like?

10. How would you describe the purpose of the poster?

11. What effect, if any, has this poster had on your work?

12. During a training session in the last 6 months, did you participate in an exercise using dice?

13. How would you describe the purpose of this exercise? (prompt: what was the link between the exercise and PPH)

14. Describe what you got out of this exercise (prompt: What impact did the exercise have on your perception of PPH?)

Virtual Mentor

15. Do you think the Virtual Mentor is helpful in improving and maintaining your clinical skills? Why or why not? What are its strengths? What are its weaknesses? How would you change it to improve?

16. Do you think simulation is a valuable tool for training providers in a clinical setting? What are its strengths? What are its weaknesses? How could it be integrated into your setting? How often?

17. How has participating in the simulation while talking to the Virtual Mentor changed the way you care for patients with true PPH? [Please provide examples].

18. Would the virtual mentor be a valuable tool for the provider in the actual care of patients? Why or why not? How could you improve it for use in clinical care? What is the setting in which it would be most useful? Why or why not?

19. For which PPH management actions/procedures would you like additional training?

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Breakthrough RESEARCH Population Council

4301 Connecticut Ave., NW
Suite 280
Washington, DC 20008
+1 202 237 9400
breakthroughactionandresearch.org
BreakthroughResearch@popcouncil.org

USAID's Health Evaluation and Applied Research Development URC

5404 Wisconsin Ave
Suite 800
Chevy Chase, MD 20815
www.iscollab.org

heard@urc-chs.com

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