

Evaluation of SIMESON, A Training Program to Improve Access to Quality Health Care for Pregnant Women and Newborn in Different Health Care Facilities of Northern Bangladesh

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Research article

Keywords: Evaluation, Perinatal health, PPH, SIMESON, Helping baby breathe, Bag and mask ventilation

Posted Date: August 25th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-58898/v1>

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Version of Record: A version of this preprint was published at Nursing Open on November 16th, 2021. See the published version at <https://doi.org/10.1002/nop2.1131>.

Abstract

Background: Access to perinatal health care is improving in Bangladesh, but maternal and neonatal mortality is still a public health concern. SIMESON (simulation for essential skills for obstetrical and neonatal care) training was focused on expanding maternal-newborn health services for safe delivery by improving infrastructure, perinatal knowledge, and skills of health care providers working in health care facilities in northern Bangladesh. Our objective was to explore the current knowledge and skills of health care providers already trained by SIMESON, in reviewing perinatal health situation including the current status of health care facilities, cost estimation and most importantly delivering perinatal health services.

Methods: It was an observational study involving 88 health care providers working in 20 health care facilities. Cost estimation following both quantitative and qualitative approaches was also attempted.

Result: Knowledge and skills of health care providers regarding the provision of normal delivery and immediate postpartum care, management of postpartum hemorrhage (PPH), and retained placenta; and use of the bag and mask ventilation to help a baby breathe were found to be considerably strengthened following SIMESON training. During the 6 months after training, there were 477 PPH cases managed successfully with only 1 death; neonatal deaths observed were 6.6 per 1000 live births; twice the number of facility deliveries; and 80% use rate of Ambu bag for helping baby breathe. The estimated cost per trainee was 395.68 USD, and 5.85 USD per beneficiary.

Conclusion: SIMESON training improved maternal and child health by facilitating the health care professionals' improved knowledge and skills, enhancing access to health care facilities, and increasing facility delivery. Such a training program should be promoted within health system in hard-to-reach areas of the country that are burdened with other commitments.

Background

Access to maternal health care is improving in Bangladesh, maternal deaths have declined significantly, but the maternal mortality rate is still a public health concern (196 per 100,000 live births in 2016) [1]. Nearly half of these deaths are due to postpartum hemorrhage (PPH) and eclampsia. These two causes are still playing a significant role in maternal deaths (rates remained unchanged between 2010 and 2016 in Bangladesh) [2]. Newborn deaths are alarming and half of these deaths occur during the very first day of life, while 86% of newborn deaths occur within their first week of life [3]. Many of these deaths can be prevented by providing training to the health workers and developing their skills on some key issues related to perinatal care [4]. The percentage of births attended by trained health professionals has increased from 27% in 2010 to 50% in 2016 [5]. Moreover, pregnant women seeking institutional care for delivery have increased from 23% in 2010 to 47% in 2016 [6]. Treatment seeking for pregnancy-related complications has increased from 29% in 2010 to 46% in 2016 [7]. Despite all these advancements, maternal and neonatal deaths are still enormously high.

SIMESON (SIM for Simulation, ESON for Essential Skills for Obstetrical and Neonatal care) has been developed to address the needs of delivery service providers, particularly working in remote areas with limited access to facilities. SIMESON relies on low-dose high-frequency approach (facility-based learning modules have been developed to improve competency and confidence of the health care team, thus, to save more lives during pregnancy and at birth). It demonstrated impressive improvements in the identification and management of PPH, newborn asphyxia, and care of low birth weight baby [8]. Terre des hommes foundation (Tdh) implemented SIMESON in Mali to reduce stillbirths as well as neonatal and maternal mortality [9]. This training protocol has been successfully piloted in Mali and is currently aiming at scaling up of these encouraging achievements to other settings with unacceptably high rates of maternal and neonatal mortality. Through a total of 186 training sessions, overall skills improved by 45%, health facilities improved their competencies by 45%, and knowledge expanded by 90%. Impressive improvements were noted in the identification and management of PPH, newborn asphyxia, and low birth weight baby care. Kurigram District is situated in North-East Bangladesh. It is a highly disaster-prone area and is known to be affected annually by heavy rains, waterlogging, flash flood, river erosion, etc. Data obtained from Kurigram Civil Surgeon office which is under Ministry of Health and Family Welfare (MOHFW) showed that in 2015 maternal mortality rate was 140 per 100,000 live births, half of them were due to PPH, the neonatal mortality rate was 28.2 per 1,000 live births, and death due to birth asphyxia was 28.4%. As a part of government and non-government efforts to tackle this situation, in 2019 Tdh implemented SIMESON in Kurigram aiming to increase the number of facility-based births conducted by qualified health personnel for expanding services to a larger number of women and newborn babies.

Here we aimed to measure the current knowledge and skills of SIMESON trained health care providers in delivering perinatal health services, assess the perinatal health situation and readiness of health care facilities for the management of maternal and neonatal emergencies, and estimate the cost of SIMESON in Kurigram.

Methods

Study design

It was an observational investigation. The study followed both quantitative and qualitative approaches among health care providers who received SIMESON training.

Study sites and study population

The study was carried out in January 2020 in a total of 20 health care facilities (Kurigram 250 bedded Sadar Hospital, 8 Upazila Health Complexes, 8 Health and Family Welfare Centres, 1 Mother and Child Welfare Centre, and 2 Community Clinics) in Kurigram, a northern district of Bangladesh. The health care facilities were selected based on accessibility to delivery facilities, availability of staff trained in SIMESON, and provision of perinatal health services in a running infrastructure. Eighty-eight government health care providers (57 senior staff nurses, 14 midwives, 12 family welfare visitors, 3 family welfare

assistants, and 2 community health care providers) who received SIMESON training and currently working in those facilities were assessed.

Data collection

Health care staff members, working at different government health facilities were the study participants who were selected through purposive sampling for observation of their perinatal care deliveries. A cross-sectional design was followed to collect quantitative data. Data were collected using paper-based standardized questionnaires that have been validated by the Tdh team. The questionnaires were based on an internationally accepted protocol on Helping Mothers Survive (HMS) and Helping Babies Survive (HBS). Guidelines, checklists, and questionnaires were developed based on Tdh's baseline report and our evaluation proposal as well as the literature review. Informed consent was taken from each participant in a written format. Data collection process included (i) review of hospital logs, observation of the place of care for delivery and surroundings, (ii) administration of self-administered multiple-choice questionnaire (MCQ) to the trained health care providers, (iii) observation of their birthing practices, management of PPH and retained placenta and helping baby breathe, (iv) in-depth interviews of the participants, pregnant mothers, and their caregivers, who recently received perinatal care, key personnel of the facility, community leaders, local qualified health care providers, and nurses, and (v) financial record review to collect information on project implementation and monitoring related costs.

Intervention

SIMESON training program

The SIMESON project uses a mobile unit with two health workers specifically trained in medical simulation who make regular visits to each peripheral health facility to provide practical training in essential procedures. The overall aims of the project are to save the lives of mothers and their babies at birth in four domains: knowledge about routine care of post-partum for the mother, helping baby breathe [10], essential care for every baby [11, 12], and management of bleeding after birth [13, 14]. Additionally, the program involved specialized technologies (e.g. mannequins and video recordings) that allowed trainees to imagine a scenario that imitates the real-life setting without affecting patient safety [15].

An initial assessment of knowledge and skills was conducted in February 2019 to identify the training needs of staff members of these facilities. For knowledge 151 and for skills 148 government health care providers in 53 health care facilities of Kurigram were assessed.

Tdh used a collaborative approach to adapt the SIMESON and team-training program to make it culturally and contextually applicable to local settings of Kurigram. The training started in April 2019 with 148 health care providers from 32 intervention facilities. Among them, 128 participants completed the 6 months training. The training was led by eight trainers who conducted exercises, awareness assessments, and team-training events during the training. Over the intervention period, trainers provided

monthly refresher training and monitored the performance, lasting about two to three hours, at each facility.

Evaluation

i) Knowledge and skill assessment

To examine the current knowledge status, quality of service delivery, scopes for improvements, and any likely scale-up, we measured the impact of training on providers' knowledge through a self-administered questionnaire, which providers filled out immediately before the commencement of the skill assessment during final evaluation. Health care providers who participated voluntarily were asked to answer a set of questions or statements. The knowledge assessment contained 33 questions of multiple choice on core topics that were responded by the participants. The skill assessment had 65 statements in which participants were required to demonstrate the SIMESON step by step in a mannequin. We were, however, able to collect this data from 88 (68.75%) for knowledge assessment and 86 (67.2%) for skill assessment out of the 128 providers during the evaluation (others could not be reached at the time of evaluation).

ii) Facility assessment

Of the 32 health care facilities, having the SIMESON training program we visited 20 facilities during the evaluation. We included perinatal health information, antenatal care (ANC) and postnatal care (PNC) information, number of deliveries, newborn health information, essential resources required: communication services, health registers/logs, and basic protocols, delivery room essential requirements/medical equipment and supplies, essential drugs required, and information on access to health care facilities.

iii) Qualitative research

We interviewed health care providers and pregnant women at the intervention facilities. For this, we conducted in-depth interviews (IDIs), key informant interviews (KIIs), and informal interviews for assessing challenges and barriers to the delivery of high-quality care and their familiarity with SIMESON training. The qualitative research was conducted with a purposive sample through 14 IDIs, 6 KIIs, and 3 informal interviews who participated voluntarily after giving written informed consent. IDIs were conducted among senior staff nurses, midwives, family welfare visitors, family welfare assistants, sub assistant community medical officers, and community health care providers. Guidelines were used to reveal information of interest and to allow interviewees to express their opinions and ideas in their own words. Interviews were undertaken until the saturation point was reached, i.e. no new information generated with further interviewing. Six KIIs were conducted, and the key informants were elected representatives of the people of the locality, nursing supervisor, and monitoring officer of Tdh. Interviews for both IDIs and KIIs lasted for approximately 30 minutes. Three informal interviews of hospitalized pregnant women after childbirth were conducted for assessing satisfaction levels for the services and

obstetric care provided by health care facilities. Each of these interviews lasted for approximately 10 to 15 minutes. The verbatim was recorded on tape recorders and transcribed concurrently.

iv) Cost estimation:

Through the SIMESON training program perspective, economic costs were calculated for the analytical period between February and December 2019. Program expenditures data were collected from SIMESON's financial statements, expenses were divided into capital expenditure and operating expenditure. Interviews were conducted with Tdh's main program staff to understand the specific plan in phases and to identify the categories of costs by each of the activities. These costs associated with the SIMESON program were listed and estimated accordingly. Expenditures for staff included expenses for project team members. Materials and equipment included costs of the services needed for the project whereas the costs for facilities covered the cost of using some non-organization-owned workspaces. Other costs included recurrent cost items such as rent, utilities, printing, IT (information technology) installation, IT bills, cell phone, phone bills, stationery, janitorial, housekeeping supplies, leaflet, brochure, announcement materials, facilities for food, lodging, transportation, the recreation of participants, and remuneration for the faculties. All costs are expressed in CHF (Swiss Franc) with an exchange rate of 1 CHF=1.03 USD (US Dollar) for January 2020.

Data quality and survey supervision

Data collectors were properly oriented and trained on the tools before data collection. Overall data quality and survey were supervised by the investigators of icddr,b. Local-level coordination was facilitated by additional staff members of the Kurigram Tdh team. Data quality was checked randomly by the investigators through on -the -spot monitoring.

Data analysis

Data entry was done by the data management team of icddr,b who was not involved in data collection. Data cleaning, updating, range check, duplication check, consistency check, frequency check, and cross-tabulation were performed by two separate data management assistants who were also involved in crosschecks. Raw data were rechecked if there were any discrepancies. Data were entered into SPSS, and descriptive statistics such as frequency distribution, percentage, and tabulations were performed as part of data analysis. We focused on descriptive statistics with quantitative data and, utilized a framework approach (widely known as thematic analysis or qualitative content analysis) with both the combined strategies of deductive and inductive types of analysis to deal with the qualitative data [16].

Results

Knowledge assessment: comparison between baseline and evaluation

After a comparison between baseline and evaluation findings, we found that (i) knowledge about normal vaginal delivery and routine postpartum care increased regarding- washing hands before normal delivery

even before wearing the gloves (10% to 98.9%), provision of family planning advice according to the need of the couple (10% to 88.6%), and current recommendation on performing episiotomy (37% to 72.7%); (ii) newborn care: knowledge about helping babies to survive increased in consequence of suctioning unnecessarily or frequently (9% to 64.4%) and in which area to be observed to diagnose severe jaundice in newborn (47% to 67.8%); (iii) maternal complications: knowledge about bleeding after completion of birth increased especially for the cervical tear (19% to 62.1%) and manual removal of placenta (26% to 62.1) (Table 1).

Table 1. Knowledge assessment: comparison between baseline and evaluation

Knowledge assessment	Baseline (%) (n=151)	Evaluation (%) (n=88)
(i) Normal delivery and routine care in post-partum for the mother and helping babies survive		
Washing hand for the delivery even if wearing gloves	15 (10)	87 (98.9)
Current recommendation on performing an episiotomy	56 (37)	64 (72.7)
Correct chronology of AMTSL	49 (33)	54 (61.4)
Provision of family planning: advice according to the needs of the couple	15 (10)	78 (88.6)
Time of measuring the newborn's heart rate	16 (24)	82 (94.3)
Consequences of suctioning a baby unnecessarily	13 (9)	56 (64.4)
(ii) Essential care for Every Baby		
Initiation of breastfeeding within the first hour after birth	99 (66)	72 (82.8)
Normal temperature range	96 (64)	72 (82.8)
Which area to be observed to diagnose severe jaundice in newborn	71 (47)	59 (67.8)
(iii) Bleeding after Birth Complete		
Postpartum care after bimanual compression	92 (61)	63 (72.4)
Management of PPH due to atony	54 (36)	57 (65.5)
Management of PPH if uterotonics failed	23 (15)	36 (41.4)
Initiation of manual removal of placenta	13 (9)	43 (49.4)
Circumstances for manual removal of the placenta	39 (26)	54 (62.1)
Medications are given before manual removal of placenta	34 (23)	53 (60.9)
Check cervical lacerations	29 (19)	54 (62.1)

Skill assessment: comparison between baseline and evaluation

a) *Skills regarding normal delivery and routine care in immediate post-partum for the baby:* Skills regarding normal delivery and routine care in immediate post-partum for the mother increased to 100% in case of almost all components and 86.3% in case of proper perineal wash. During the care of the newborn, the percentage of the newborn who had temperature measured soon after birth got reduced (42% to 34.9%), counting the respiratory rate for one full minute was slightly increased (36% to 38.4%), skills increased in observed level of alertness and muscle tone (26% to 77.9%), and weight measurement (56% to 88.4%). Practice to initiate breastfeeding within the first hour of birth and keeping the baby in mothers' arm, not with other relatives were both raised to 100% from 55% and 43% respectively (Table 2).

Table 2. Skills regarding routine care in immediate post-partum for the baby: comparison between baseline and evaluation

Skill assessment	Baseline (%) (n=148)	Evaluation (%) (n=86)
Routine care in immediate post-partum for the baby		
Alertness and muscle tone	39 (26)	67(77.9)
Measure the temperature	62 (42)	30 (34.9)
Count respiratory rate for a full minute	53 (36)	33 (38.4)
Weight measurement of the newborn	83 (56)	76 (88.4)
Examine the baby in the mother's arm	64 (43)	86 (100)
Breastfeeding and bonding	82 (55)	86 (100)

b) *Skills regarding– atony and post-partum hemorrhage:* increased in looking for bleeding (66% to 100%), checking bladder and catheterizing the woman (31% to 70%), measuring pulse and blood pressure, and initiating IV infusion along with oxytocin administration (47% to 74.4%), bimanual compression technique (9% to 76.7%), rechecking of the uterus (37% to 95.5%), massaging of the uterus, and the practice of respectful maternity care (39% to 100%) (Fig 1).

Fig 1. Skills regarding– atony and post-partum hemorrhage: comparison between baseline and evaluation

c) *Skills regarding– retained placenta and manual removal of the placenta:* Increased in repeating 10 IU IM oxytocin, encouraging emptying of the bladder, giving diazepam 10 mg IM, and starting IV line with

normal saline to prevent shock. Administering IV antibiotics, giving oxytocin 20 IU in 1L saline if the placenta is not removed, an examination of the placenta, checking uterine tone and its massaging, removal of the placenta, and controlled cord traction for each contraction (Fig 2).

Fig 2. Skills regarding– retained placenta and manual removal of the placenta: comparison between baseline and Evaluation

d) Skills regarding – bag and mask ventilation: All the participants correctly demonstrated the steps related to bag and mask ventilation during the evaluation, except the step of ventilating at 40 breaths per minute (range is 30-50/minute) was reported from 37% to 83.7%.

e) Skills regarding helping baby breathe: Increased in evaluating newborns' chest movement, effective ventilation, ventilation with bag and mask within the golden minute, close observation of the baby, recognition of the breathing in baby and normal heart rate, continuous ventilation, squeezing of the bag harder, and removal of secretions from the mouth and nose raised. Skills related to the removal of wet clothes reduced from 87% to 67.4%. (Fig 3).

Fig 3. Skills regarding helping baby breathe: comparison between baseline and evaluation

Facility assessment

During the baseline assessment, the number of deliveries in 59 health care facilities was 2973 in 6 months which almost doubled during the evaluation, where a quarter of the deliveries were performed by the caesarian section. About 478 mothers experienced PPH. There were 2 maternal deaths, among them one was due to PPH and another one was as a result of eclampsia. About 43.9% PPH was due to cervical or vaginal tear, 26% from prolonged labor, and 20% as a result of retained placenta. Other causes included uterine atony, retention of products of conception, placenta previa, maternal infection, and maternal comorbidities (e.g. maternal high blood pressure, diabetes mellitus, etc.). Neonatal death was 6.6 per 1000 live births, among them, eight newborn died due to low birth weight and birth asphyxia.

All the facilities had soap/alcohol hand rub for hand hygiene, 95% facilities had a functional delivery table, 55% facilities had 3 colored waste bin, 70% facilities reported presence of baby scale, and 80% facilities had Ambu bag, only 45% facilities mentioned having baby length board. Eighty-five percent of facilities had oral antibiotics and 40% indicated availability of the IV antibiotics for mothers, 75% of facilities were maintaining oxytocin supply, and 65% of facilities had IV fluid supply.

All facilities visited during evaluation indicated that no fees were required for normal delivery and newborn care, 70% facilities had clear referral criteria, 40% indicated the presence of complaints box or register/log and those facilities had accountability mechanisms for addressing the mistreatments or violations, and 85% facilities had informed consent procedure.

Findings from qualitative research

The qualitative data highlighted the expectations of providers about the training and its effect on their knowledge and skill. Representative quotations from IDIs, KIIs, and informal interviews are thematically shown here.

Theme 1. The overall perception of SIMESON training

Participants appreciated the experience immensely and were thankful for getting the opportunity to be included in the training. Some of them stated that the training had refreshed their knowledge of essential skills while others suggested including some new topics in the training curriculum. Participants expected an improvement in their skills due to this training and desired more training opportunities like this. They also acknowledged improvements in their competence and confidence during the management of obstetric and neonatal emergencies, as well as coordination and collaboration between patient-providers. *"... I learned a lot from Tdh (SIMESON training) ...and now if I face such kinds of emergencies, I can manage that... I believe SIMESON training helped me a lot."*

Theme 2. The objective of SIMESON training

The respondents understood that the main objective of the SIMESON training was to reduce maternal and neonatal mortality. Few more information were obtained from interviews, for example, the number of institutional deliveries increased, ideal labor rooms being set-up, quality of maternal and newborn care increased, hygiene during normal vaginal delivery better maintained as of late, application of PPH management techniques (e.g. bimanual compression) and helping baby breathe skill acquired. *"..... the objective was to increase the practice of normal delivery in Health Care Facility.... sometimes, home delivery causes complications..... that's why they (Tdh) targeted to increase the number of facility delivery..... and eventually reduce maternal and neonatal mortality"*

Theme 3. Effectiveness of SIMESON training

The participants mentioned that the SIMESON training helped them to improve their skills regarding normal vaginal delivery, which were reflected through their comments –

"There are certain instructions like what we should do during normal delivery, who would be the in-charge of what etc. in detail. This (the SIMESON training) has significantly improved my skills..." and *"This training helped us in remembering the things that we need to apply during the management of normal vaginal delivery of a pregnant woman."*

Theme 4. Benefits of the training

It was refreshers training for most of the participants.

"Tdh (SIMESON) served as a supplementary training, which helped me to overcome my shortcomings in conducting normal delivery....."

Regarding the benefits of the pregnant women, the participants quoted, *“Women died previously due to lack of skill in managing PPH.....”* and *“The women are happy now, they said that they would recommend others to go for normal delivery in the health facility”*

Regarding the benefits of the newborn, participants mentioned, *“We used to be very nervous during baby resuscitation, now we can handle it quite well”* and *“Now we use the penguin sucker; we have learned how to help a baby breathe.....”*

Theme 5. Experience of the participants after the training

Tdh team successfully improved the skills of healthcare personnel in normal vaginal delivery, the participants have become more aware of hygiene, the whole process is more organized and systematic now, the confidence of participants has increased significantly, they have learned new techniques like bimanual compression, wearing gloves, etc., PPH management is currently done more efficiently.

“If we see excessive bleeding in PPH, right away we apply bi-manual compression to manage the case.”

Theme 6. Challenges faced

Due to the shifting duty hours, there was limited availability of the participants during the training period. It was difficult to organize all the participants in a prefixed time due to their heavy workload. The participants found it difficult to engage themselves in the training with full concentration when it was arranged during their duty hours. Lack of understanding of the patients' attendants about the use of the bag and mask for the resuscitation of the neonate and reluctance of others to disclose their pregnancy status and to attend the ANC in due time were other challenges encountered.

Theme 7. The satisfaction of the participants

Participants were doing their tasks more efficiently in recent days. This was a hands-on training that helped the participants to retain their skills aptly. The duration of any maneuver related to normal vaginal delivery, baby resuscitation, and management of PPH has significantly reduced, and the processes themselves have become much easier to perform. Regarding respectful maternity care, one participant said, *“..... from the training we also learned to express empathy towards the mother and the baby.....”*

Theme 8. Suggestions for improvement

Participants were asked about what they might recommend for enhancing the quality of training. Most of them recommended extending the training period, including more sessions, and regular conduction of such training.

“The training had a short duration, ended rather quickly, if more time were allocated for the training, we would have learned better”.

Some participants proposed to shorten the training hours but increase the training period. There was a strong consensus among attendees that more health professionals should be included to participate in the training to support facility-wide progress.

“The number of participants should be increased (a diverse group of staff); all the staff members (of a facility) need to know about these things”

Participants suggested to include more clinical topics like; management of eclampsia, how to repair a perineal tear, and Kangaroo mother care. Participants who are currently serving at the peripheral government health centers stated that they could not apply some of the skills acquired through the simulation training due to a lack of medical and obstetrical instruments.

“If the equipment can be arranged, it would be good to perform the procedures we have learned in the training..... we do not have sufficient instruments in the facility, some of the equipment has become old and rusty”.

Cost estimation

The cost estimation of the SIMSON training program revealed costs of CHF 384.16 (395.68 USD) per trainee (health care provider) and CHF 5.68 (5.85 USD) per indirect beneficiary (mother and newborn) who sought care from facilities (Table 3).

Table 3: Cost estimation of SIMESON training program

Cost components	Inputs	CHF*	USD	% of the total cost
Capital expenditures	National Coordinator Health	867	893.01	1.76
	Project Officer	1,350	1390.5	2.74
	Basic training	9,491	9,775.73	17.4
	Capital (i.e. laptop)	261	268.83	0.5
	BCC (i.e., poster, leaflet)	6,967	7,176.01	12.8
	Staff/personnel (i.e., staff nurses)	30,278	31,186.34	55.4
Total Capital expenditures		49,214	50,690.42	86.0
Operating expenditures	Regular training	5,030	5,180.9	8.8
	Stationeries	165	169.95	0.3
	Meeting	345	355.35	0.6
	Social mobilization (i.e. Communications)	753	775.59	1.3
	Conveyance for service provider (i.e. local transport, rent car)	1,348	1,388.44	2.4
Total Operating expenditures		7,641	7,870.23	13.4
Total cost		56,855	58,560.65	100.0
Cost per direct beneficiary (n=148)		384.16	395.68	
Cost per indirect beneficiary (n=10000)		5.68	5.85	

Discussion

This is one of the few studies that specifically combined both knowledge and skills for quality of care to minimize maternal and neonatal mortality in a single intervention and, to our knowledge, the first to use SIMESON as the training tool in Bangladesh. Here, we found that SIMESON training has expanded the knowledge and skills of health care providers in treating obstetric and neonatal emergencies. Moreover, the perceptions of the health care providers suggest that this type of training is very much helpful in their capacity building and they are eagerly looking forward to the continuation of the training for a longer period in the larger population. By visualizing the facility assessment results, we can comprehend that the training resulted in improvements as regards the number of facility delivery and decreased maternal and neonatal mortality.

Health care providers who took part in a simulation-based training course on obstetric emergencies of a tertiary care university hospital of the United Kingdom also reported a noticeable improvement in both of

their knowledge and skills when dealing with real-life emergencies observed in prospective follow-up research [17]. The incorporation of training with the "learning by doing" approach meant that professionals understood and practiced all the skills of emergency obstetric and neonatal emergency care (EmONC) and minimized the limited learning opportunities identified in prior EmONC training sessions [18].

After a comparison between baseline and evaluation, knowledge increased in washing hands before normal delivery, even before wearing the gloves, provision of family planning advice according to the need of the couple, current recommendation on performing an episiotomy, and where to look for cervical tear and the skill of manual removal of placenta. Regarding neonatal care knowledge also increased in understanding the adverse consequence of suctioning a newborn when performed unnecessarily, and which part of the baby to be observed to diagnose severe jaundice in case of a newborn. Similarly, a mixed-method study on integrated simulation training on emergency obstetric and neonatal care and respectful maternity care in Ghana observed that providers' knowledge increased from an average of 61.6% at pre-test to 74.5% at post-test [19].

During skill assessment, we found that participants were very prompt in conducting normal delivery. Researchers have reported that an intensive training session for vaginal deliveries on an obstetric mannequin or birth pelvis model at the beginning of the obstetrics clerkship automatically and substantially improved the self-assurance of medical students to engage in an uncomplicated, supervised attempt for vaginal deliveries in a teaching hospital of Canada [20]. A quasi-experimental study conducted in Pakistan reported significantly better post-training results after a simulation-based normal delivery skill learning [21]. Participants usually did not miss any steps. Data from several other simulation studies found that the application of deliberate practice to simulation training narrowed differences in performance in pediatric residents of USA and obstetric and neonatal emergencies of Northern Guatemala [22, 23].

Properly following the steps of PPH management procedure were also increased from baseline to evaluation. In Northern Tanzania, skills expanded from 19% before, to 43% immediately after, to 48% at nine months after training on bimanual uterine compression [14]. Similar work has shown that multidisciplinary *in situ* simulation activities enhance the management of obstetric emergencies such as PPH and is a safe and effective way to develop skills and improve health care processes [24]. The skills of the trainees on the management of retained placenta and manual removal of the placenta were highly improved in all the steps of the procedure from baseline. Studies have observed that trainees exhibited positive changes in attitude; as well as the perception of overall team performance in a simulated environment of obstetric emergency care [25]. Similar research studies have reported active training methods, such as simulations, case-based learning, hands-on skills training, and direct feedback reviews are components of successful in-service training to enhance health care providers' knowledge and skills in Cuernavaca, Mexico [26, 27].

All the participants correctly performed the steps regarding the bag and mask ventilation. Similar program assessments that took place in India and Kenya which were strongly acceptable, demonstrated increased confidence, enhanced knowledge, and acquired skills [11]. Performance regarding helping baby breathe also increased from baseline to evaluation. Skills related to the evaluation of chest movement, effective ventilation, and ventilation with bag and mask within the golden minute raised significantly. Participants in a program on helping babies breathe for neonatal resuscitation in resource-limited settings (Pakistan and Kenya) demonstrated high satisfaction, high self-efficacy, and advancement in knowledge and skills [28]. During the management of newborn babies immediately after birth, skills regarding the measurement of the newborns' temperature and removal of wet clothes were decreased from baseline, it was probably due to giving more emphasis on other steps like the bag and mask ventilation, eye medication, convulsion assessment, etc. while avoiding others by the participants.

According to Bangladesh Maternal Mortality and Health Care Survey 2016, the most common causes of maternal mortality were hemorrhage (31%), followed by eclampsia, and abortion-related complications [1]. Hemorrhage and eclampsia accounted for 55% of all maternal deaths in 2016 [1]. In our evaluation, we found two maternal deaths due to PPH and eclampsia which were lower than that of the national data. We found cervical and vaginal tears (45%) were the main causes of PPH. However, the causes of PPH varied in different studies. Studies on associated factors of PPH in Pakistan reported that PPH is caused by cervical, vaginal and perineal tears occurring in 24% cases [29] and a similar study in Nigeria revealed cervical and vaginal tears occurring in 14% cases [30]. In Zimbabwe, a case-control study reported that cases were much more likely than controls to have a traumatic delivery involving vagina or cervix and causing tears, which accounted for more than one-third of the hemorrhage [31].

Bangladesh Demographic and Health Survey (BDHS) 2017-18 indicated a neonatal mortality rate of 30 per 1000 live births in 2015 in Bangladesh [32]. In our evaluation, we found neonatal deaths at 6.6 per 1000 live births. This observation represented the neonatal death among facility-based deliveries and did not include the number of neonatal deaths in the community, this might explain the reasonable lower number of neonatal deaths in the 20 health care facilities. Worldwide the major causes of neonatal mortality are low birth weight and birth asphyxia [33, 34] and we observed similar results during our evaluation. The number of institutional deliveries almost doubled from baseline to evaluation and according to BDHS 2017-2018, facility delivery has increased from 15% to 50% in Bangladesh in the last 10 years [32].

The results of the performance evaluation showed that providers appreciated the quality of the training which included both the information context and the skill content. The respondents understood that the main objective of the SIMESON training was to reduce maternal and neonatal mortality. Several studies showed that their intervention incorporated contents of deliberate training such as engaged learners, well-defined objectives, resident level complexity, and concentrated repeated training with direct input from professional trainers [15, 35].

Participants were experiencing several issues during and after successful completion of the training such as improving the skills in managing normal delivery. They also had positive opinions about the training. They acknowledged changes in their expertise and trust in treating obstetric and neonatal crises, as well as coordination and collaboration between patient-provider. In a similar study in Ghana, more than 95% of the participants reported that the training was beneficial for them and that they should use the skills acquired in their real-life [19]. Some of the participants mentioned that the exchange of greetings and respect as well as the provision of continued support to the pregnant women who are in labor should be an essential part of respectful maternity care that they learned from the training. Different research results indicate that comprehensive training that provides healthcare providers with the ability to understand, practice, and comment on their delivery of supportive maternity care in the sense of intense emergency obstetric simulations has the potential to increase the childbirth experience of women in low-resource settings [36].

After experiencing several challenges and difficulties, participants still have satisfaction regarding the SIMESON training; this was a hands-on training that helped the participants to retain skill aptly. Similar changes have been identified in the skills of pediatric and internal medicine residents after several deliberate practice sessions over longer periods in Tripler Army Medical Center, Honolulu, and the internal medicine residency program at Northwestern University, Chicago respectively [37, 38]. The duration of any maneuver regarding normal delivery, baby resuscitation, and management of PPH has reduced, and the process has become much easier.

Increasing the knowledge and skill of health care providers by implementing the SIMESON training program is the most effective and single intervention with reasonable costs for reducing maternal and neonatal mortality. SIMESON training program is a low-cost program in a rural area of Bangladesh. Although we have done the cost estimation of SIMESON, we were not able to compare our results with other programs due to a lack of similar studies with identical technicality, timeline, and geography. The cost per indirect beneficiary was considerably low, the estimated cost per direct beneficiary (trainee health care providers) was reasonable.

Both qualitative and quantitative approaches, relatively large sample for quantitative study design, diversity in participants to capture maximum variability by the qualitative research design, site visits to facilitate real-life observations were the strengths of the evaluation. The evaluation had some limitations. Shorter time available for evaluation during clinical rotations of the participants limited enough opportunities for knowledge and skill assessment. We were unable to assess actual (real-life) improvements in the skill of obstetric and neonatal emergencies and knowledge retention as the practices were mainly observed in the mannequin except for a few normal deliveries with essential care of newborn babies in a real-life situation at facilities. Advanced analyses were not done due to a lack of access to baseline data by the evaluation team. Finally, convenience sampling was used for qualitative research. So, findings from the qualitative data may not be generalizable outside the resource-poor settings. Our results indicate that this SIMESON training is practical, appropriate, and efficient in resource-limited environments in improving maternal and child health in Bangladesh.

Conclusion

Post-training skills of health care providers strengthened in all four components of maternal and newborn care. Through this training, there were improvements in the quality of care for maternal and neonatal health services at the government health care facilities of Kurigram. Taking up such training may guide efforts to provide healthy, sensitive, respectful, high quality obstetric and neonatal care even in remote rural settings of a larger population in Bangladesh. As most of the skills and knowledge increased from baseline, we recommend the SIMESON training to continue with regular monitoring and periodic evaluation. To improve the quality of subsequent training, the causes of knowledge and skill reduction in some components should be explored. Incorporating the management of eclampsia, and suturing skill component in the training to manage perineal tear will further reduce maternal morbidity and mortality. Kangaroo mother care component should be introduced to reduce neonatal mortality. However, sustainability is depending on implementing the training with similar materials and methodologies by the Bangladesh Government as one of the components of regular refresher training in expanded areas.

Abbreviations

AMTSL	Active Management of the Third Stage of Labor
ANC	Antenatal care
EmONC	Emergency Obstetric and Neonatal Care
HBB	Helping Baby Breathe
HCFs	Health care Facilities
icddr,b	International Centre for Diarrhoeal Disease Research, Bangladesh
IDI	In-depth interview
KII	Key informant interview
PNC	Postnatal care
PPH	Post-partum hemorrhage
SIMESON	Simulation for Essential Skills in Obstetrical and Neonatal care
Tdh	Terre des hommes foundation

Declarations

Ethics approval and consent to participate

Tdh has a memorandum of understanding (MoU) with the Ministry of Health and Family Welfare (MoHFW) in Bangladesh. Under this MoU, Tdh is responsible for conducting the formal assessment and evaluation in collaboration with the family planning authorities. The study was initiated after getting

approval from the Institutional Review Board of icddr,b which is comprised of the Research Review Committee and Ethical Review Committee. Signed written informed consent was obtained from the participants. The respondents had the freedom to withdraw themselves from participation at any point in the study. The consent form was read out to the participant if he/she was unable to read (particularly the women of the locality). The confidentiality of the participants was maintained strictly.

Consent for publication

Not applicable.

Availability of data and materials

Due to concerns about participants' confidentiality, data is available on request. The full dataset has not been stored in a public repository as it contains participants' names, contact numbers, institution names and a few identifiers that may lead to the identification of individual participants. However, the identification of participants is not possible from the data presented in the article as it contains summarized results only. The full dataset is freely available upon written request to the corresponding author. Request for the study dataset may be sent to Dr. Mohammad Jobayer Chisti, Senior Scientist, icddr,b. Email: chisti@icddr.org.

Competing interests

The authors declare no conflict of interest regarding the publication of this paper.

Funding

This study was financially supported by Tdh. The funding body had no role in the design of the study, data collection, analysis, interpretation of the findings.

Authors' contributions

Tdh conceived and developed the SIMESON training program. Tdh and icddr,b evaluation team developed the data collection tools. RD managed the data set and analyzed the data, developed the tables/graphs, and wrote the initial draft of the manuscript. RD and FDF developed the qualitative research guideline and FDF wrote the result for the qualitative part. MS and NA analyzed the cost estimation part. SAS, MJC, TA, and ASGF critically reviewed the manuscript and gave intellectual inputs. All authors contributed to the final version of the paper.

Acknowledgments

We acknowledge with gratitude the commitment of the SIMESON program as supported by Tdh. The authors are grateful to Tdh Kurigram staff, trained government health care providers of Kurigram, mothers, and children from Kurigram for their invaluable contributions. We acknowledge the contribution of icddr,b's core donors including Government of the People's Republic of Bangladesh, Global Affairs

Canada, Canada; Swedish International Development Cooperation Agency and the Department for International Development, UK Aid for their continuous support and commitment to the icddr,b's research efforts.

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Figures

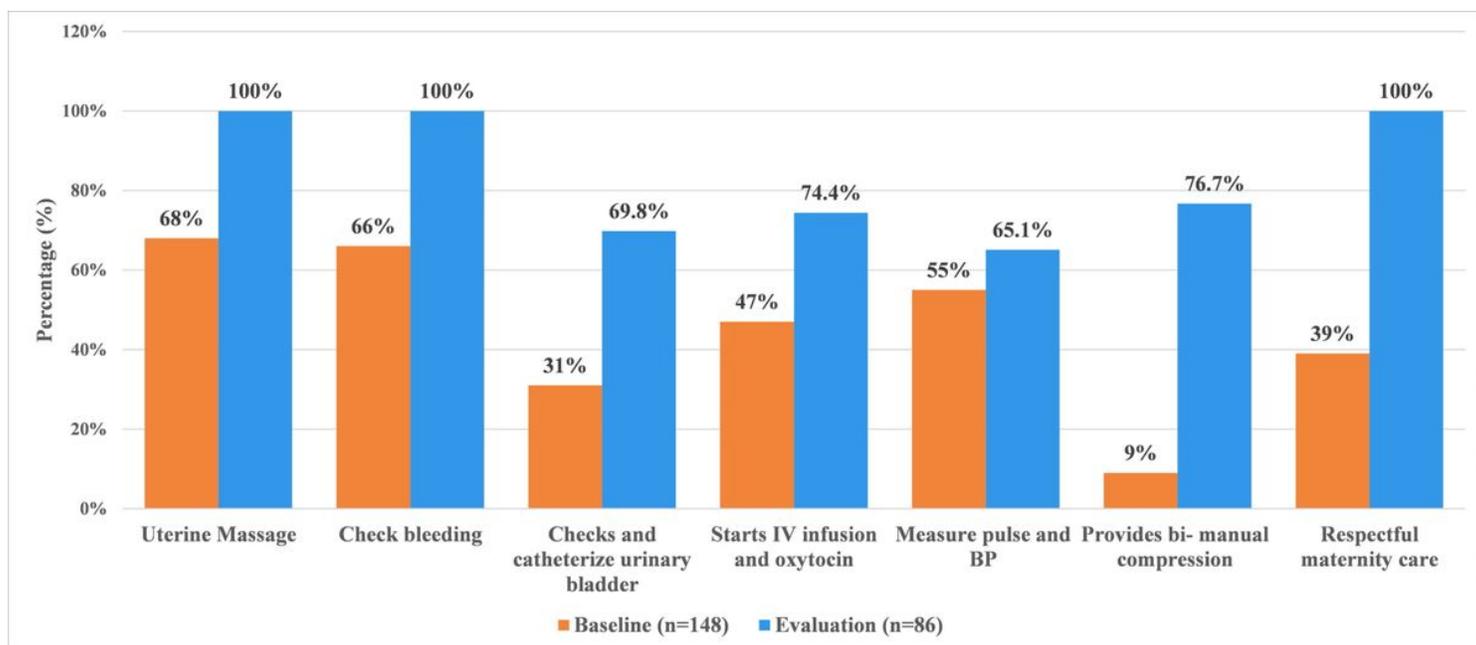


Figure 1

Skills regarding– atony and post-partum hemorrhage: comparison between baseline and evaluation

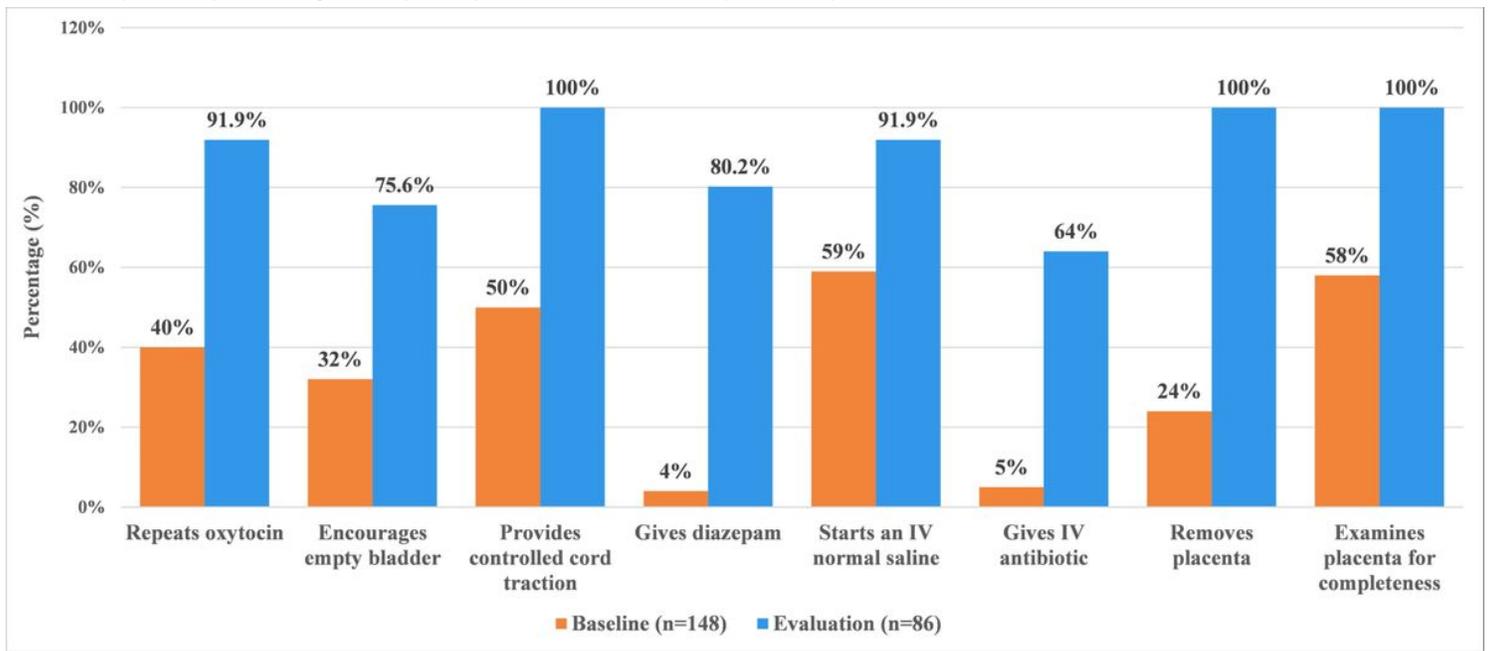


Figure 2

Skills regarding– retained placenta and manual removal of the placenta: comparison between baseline and Evaluation

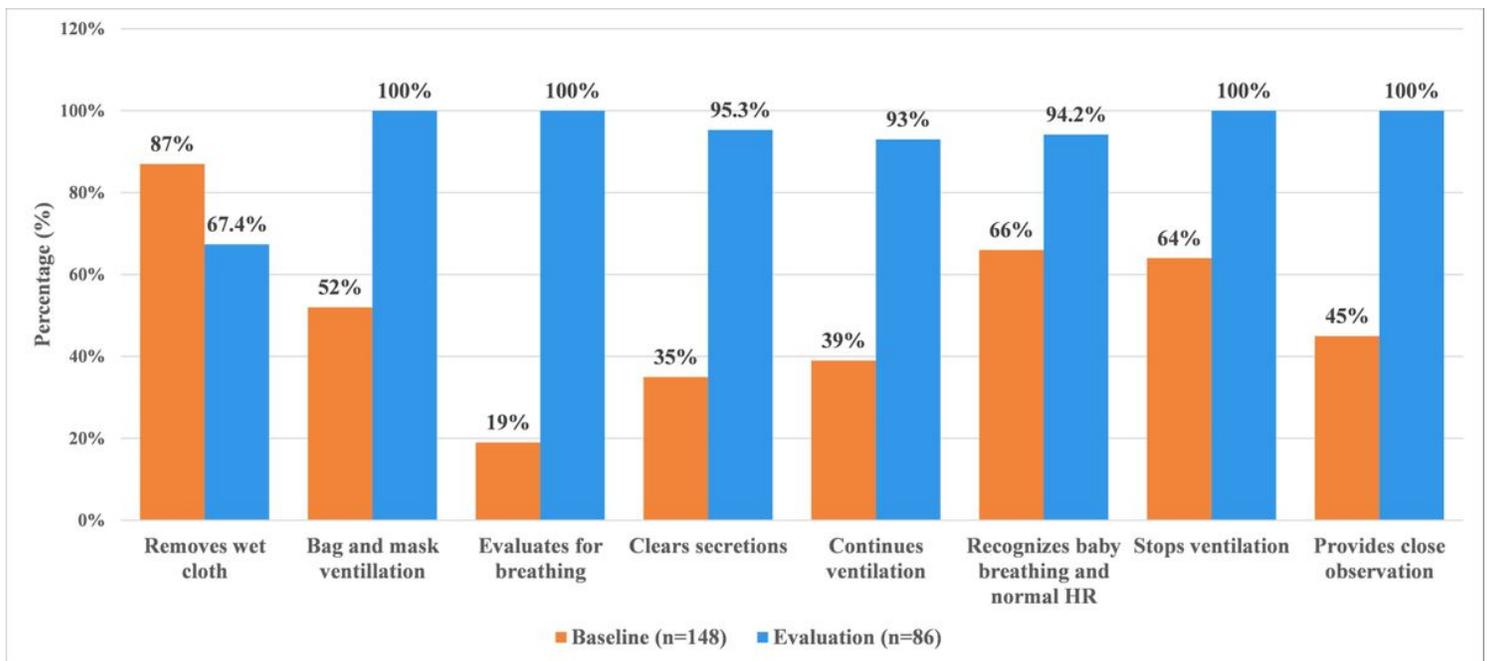


Figure 3

Skills regarding helping baby breathe: comparison between baseline and evaluation

Supplementary Files

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