Training interventions on Helping Babies Breathe among health workers in tertiary hospital of the Republic of South Sudan: A non-randomized quasi-experimental study

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Abstract

This study aimed to examine the effects of the Helping Babies Breathe (HBB) training interventions program on the knowledge, psychomotor skills, and competency of health workers in managing birth asphyxia and reducing mortality of newborns experiencing asphyxia within 24 hours. This study used pre- and post-test design (quasi experimental study). Purposive sampling was employed, and a computer-generated number was used to select the participants. Health workers from Juba Teaching Hospital comprised the intervention group. They were evaluated before and after the training from February to June 2017. A post training skill and competency evaluation was performed using a NeoNatalie newborn simulator and was repeated after three months of implementation for intervention and control group. Seventy health workers were enrolled; 40 were in the intervention group and 30 in the control group. Early newborn mortality due to asphyxia within 24 hours in intervention and control measure at pre and post implementation showed a significant reduction within the intervention than the control. Knowledge, psychomotor and competency of health care workers improved immediately after training and early newborn mortality reduced by half at the end of three months. It is recommended that training of health workers on HBB should be scaled up in most of the health facilities in South Sudan.

Introduction

South Sudan has a high number newborn mortality. The neonatal mortality was estimated at 35 per 1,000 live births with infant mortality of 67 per 1,000 live births.1

In 2015, 4.5 million (75%) of all under-five deaths occurred within the first year of life. The risk of a child dying before completing the first year of age was highest in the African region (55 per 1000 live births) and over five times higher than that in the developed region (10 per 1000 live births). Although, there is reported decreased in the number of infant mortality birth worldwide, more newborn deaths are reported in low and poor developing countries where access to health care for the vulnerable (women and newborn) was difficult and sometimes nonexistent.2

According to the World Health Organization3 an estimated 136 million infants are born each year, and this figure is expected to rise globally to nearly 137 million births yearly by 2016. In the entire human life cycle, the riskiest period is the day of birth.4 Previous studies reported that 136 of the one million of newborn births each year will not survive their first day of life. Based on the global total of one million deaths each year, efforts must be aimed at reducing the high number of newborn deaths.

The main causes of newborn deaths have remained unchanged for the last decade and are usually infection-related complications (26%), intrapartum complications (24%) including birth asphyxia, preterm delivery (34%) with breathing problems contributing to mortality and morbidity, and congenital abnormalities (9%).6 The real cause of newborn deaths is difficult and most challenging to determine for the health professionals. Nurses, midwives, clinical officers, medical officers, maternal health workers, and community health workers attending births must have the essential knowledge and skills to assess the neonates’ breathing status and effectively respond as needed. Majority of the health workers/staff often failed to recognize breathing difficulties early and, most of the times, could not assess and take immediate action to resuscitate non-breathing babies at the time of delivery. Priority has often been given to the mother’s needs. The neonates often remained unattended for several minutes with little attention. This problem could be partly attributed to not having a staff member present dedicated to the newborns. Despite the burden of newborn death being high in the low and poor countries, the coverage of skilled birth attendance is very scarce in these countries.7 Similarly, more than one million preterm neonates die from complications of preterm delivery, including respiratory distress syndrome, as majority of the preterm newborns require assistance to initiate breathing at birth.4

Having known that prematurity and intrapartum hypoxic are the main causes of early neonate mortality in majority of the neonates, global, regional, and local training of health workers in basic neonatal resuscitation will help improve the newborn survival and will save hundreds of thousands of newborn infants yearly.4

Despite the benefits of the health workers’ training on neonatal resuscitation in averting newborn deaths, the coverage of neonatal resuscitation remains very low in settings with a high burden of neonatal deaths. Currently, various neonatal resuscitation training courses are being promoted and implemented in many countries in order to build the capacity and competence of the health workers to become better qualified in managing sick newborns or children in the emergency setting.
A number of guidelines and algorithms exist, and most of these can be found online. However, most of the guidelines and algorithms are reported to have been based on the consensus of the pediatricians’ expertise rather than the evidence-based training module.8

Newborn life support, neonatal resuscitation program, the WHO’s essential newborn care, and pediatric life support are the courses used in teaching neonatal resuscitation. A review conducted by Opiyo and English9 found inadequate evidence to prove that in-service training in neonatal resuscitation had improved the skill and performance of the health workers in caring for critically ill newborn baby. However, there is still some evidence to show the benefits of training of health workers in newborn resuscitation.

Among the most effective strategies available for low-resource setting is the Helping Babies Breathe (HBB) program, a neonatal resuscitation training program aimed to increase the knowledge and skills of skilled birth attendants (SBA).10 The HBB is a life support program developed by the American Academy of Pediatrics in collaboration with other organizations.11 With the objective of achieving a sustainable development goal of ending preventable neonatal and under-five child deaths through increasing the coverage of SBA and improving the quality of maternal and newborn care, the training intervention on Helping Babies Breathe in hospitals and health centers is essential. The “HBB-plus” training intervention is believed to increase the knowledge, skill, and competency of the health workers on newborn resuscitation that will contribute to reducing asphyxia-related newborn mortalities in South Sudan.

Neonatal resuscitation is not new in the South; however, the simplified version of resuscitation packaged as Helping Babies Breathe is a new idea that has not been explored and implemented in the public health facilities in South Sudan on large scale. The training was adapted from the Helping Babies Breathe program developed by the American Academy of Pediatricians for low-resource countries. This study aims to evaluate the immediate and long-term effects of the HBB training on the knowledge and skills of health professionals about neonatal resuscitation and the reduction of neonatal mortality due to asphyxia.

Materials and Methods

The protocol for this non-randomized clinical trial and supporting Trend statement checklist are available as supporting information respectively and the registration was registered retrospectively. Reason for late registration: the study was initially measuring the increase in the knowledge, skill, and competency, and the distal portion of the impact on newborn resuscitation and survival was added later.

The study population and design

The pre and post study was conducted two tertiary hospital of Juba and Wau in South Sudan. After obtaining ethical clearance from the South Sudan Ethical review board, Ministry of Health, and Administrator of both Juba and Wau Teaching Hospital, a total of 70 health workers (40 from the intervention group and 30 from the control group) comprising midwives, clinical officers, nurses, community maternal health workers, and intern doctors were selected. The 40 health workers from Juba Teaching Hospital were trained on simplified Helping Babies Breathe for two days. Purposive sampling was used in selecting the participants of the study. The implementation period lasted for three months from March to June 2017, and the three months evaluation took place in June. Blinding of the participants was unachievable based on the nature of the intervention. Health workers in the control group never received any HBB training and continued to provide routine care to the newborn, whereas those in the intervention group received two days, 6 hours training based on the HBB protocol.

Participant’s recruitment

Health workers who consented to participate in the study were randomly selected. Forty participants were selected from Juba teaching hospital (Intervention) and thirty from Wau teaching hospital (Control). All health worker selected to participate in the study had no received any training on helping babies breath protocol for the past one year. Training for the health workers in the intervention lasted for two day six hours each.

Procedures and intervention

HBB facilitators and participants

Training of HBB was conducted by experienced facilitator who were trained midwives and received training as research assistants. Training session of the health workers were divided into two phases to allow a ratio of one trainer to 6 participant’s trainee and adequate time for supervision. Training covered main area of preparation for birth, newborn routine care, the golden minute and ventilation of the newborn. The participant were introduced to each section of the HBB protocol followed by demonstration and return demonstration by the participants. The trainers and the trainees reviewed the training and practical sessions related to newborn asphyxia, routine care, ventilation. The health workers practiced on Neonatalie new born simulator. Health workers trained were provided with the basic equipment’s for the practice of HBB neonatal resuscitation during and after the training. Participants were asked to evaluate the training session using Likert scale of one to five and majority agreed that the training enhanced their psychomotor skills and competency in newborn resuscitation.

HBB knowledge and psychomotor skills and competency evaluation

Health workers were tested using multiple choice questionnaire pre and post intervention for both groups lasting for twenty minutes. Psychomotor skill and competency for the intervention and control group were conducted in simulated environment using Bag and Mask checklist for psychomotor skill and OSCE A&B for competency. Health workers in the intervention group were assessed at pre, post and 3 months period while those in the control group were assessed at posttest and 3 months follow up. Health were scored for each of the steps and action in the checklist. The correctly performed action was awarded a score of one whole incorrect steps or answer was given zero marks. To qualify to have adequate knowledge psychomotor skill and competency for newborn resuscitation, health workers must score 80% or above and this was also considered successful completion of the course.

Study outcomes

The primary objective was that HBB training will improve the knowledge and practical skill of the participants. This was determined tests conducted to evaluate changes before training, post training and 3 months follow up. The secondary was reduction in early neonatal deaths within 24 hours and the observed outcome was tested by Pearson Chi square for newborn deaths due to asphyxia within 24 hours.

Data management and analysis

Data from the answer sheets and evaluation checklist were entered into SPSS version 20 software, where the results of the pre- and post-test as well as the three-month follow up was analyzed and presented. To get the result desired, all the files containing the different measurements were merged at one point in time before conducting the complete analysis. The mean scores in knowledge, psychomotor skills, and compe-
tendency from the pre- and post-test within the intervention and within control groups was tested using repeated measure ANOVA for within intervention and control group. The unpaired sample t-test was used to test the mean difference in knowledge, psychomotor skills, and competency between the intervention and control group. The result analyzed and obtained was presented and reported as mean of the correctly passing scores ± standard deviation. The study was considered significant at p value < 0.05.

**Ethical Clearance**

The study was approved by Chulalongkorn University College of Public Health, Bangkok, Thailand in December 2016. The ethical clearance for study was approved by the Ethical Review Board, Ministry of Health, and South Sudan in February 2017, and the ethics review committees of Juba and Wau Hospital. Informed consent both written and verbal was obtained from the participants before the training intervention. Verbal approval was sought from the mothers with newborn with asphyxia by the health worker.

**Results**

A total of 70 health care workers enrolled in this study of which 40 received simplified HBB training and completed (100%) the pre- and post-test course assessment. Approximately 30 participants in the control group took the post-test simultaneously with those of the intervention group. Because the health workers at the control group were unable to receive the training due to insecurity, their pre-training assessment (baseline) for the practical skill was conducted at the time of the post-test administered among the intervention group; it was then considered as the immediate post intervention assessment to evaluate the knowledge, skills, and competency of these health workers. At three months, two of the participants in the intervention group and one from control group were lost to follow up. Therefore, only (67) 96% of the health workers completed the assessment at three-month follow up (Figure 1).

**Socio demographic and professional characteristics**

Majority of the health workers were aged between 25 years to 35 years. Nurses and midwives were the majority in intervention and control group and were predominantly female (82.5%) in intervention and 80% providing newborn care (Table 1). Most of the health workers were working in maternity labor room) 23 (57.5%) and 19(63.3%), children ward 16 (40%) and 7(23.3%) and operating theater 1(2.5%) and 4(13.3%) respectively. Majority of the health workers self-reported to be registered nurses and midwives with tertiary and college education (77.5% of the intervention versus 73.3% in control).

The level of income in the middle income bracket of 1001- 2,000 SSP varies between intervention and control group with control group slightly receiving higher income compared to intervention. The difference however is not significant.

The duration of practice among the health workers ranged from less than one year to over five years with most having practiced over five years (32.5%) intervention and versus (36.7%) in control group and there was insignificant difference between intervention and control group (Table 1).

**Health workers HBB knowledge**

Examining the test mean score of the participants within the intervention and within the control at pretest, posttest intervention and three months of study period tested by repeated measures ANOVA, in intervention, there was significant increase in terms of knowledge between the pretest and immediate post intervention (mean difference increase of 55.2 (50.9-59.6) p<0.05) and this decreased slightly between the immediate post intervention and three months follow up with mean difference of 13.3(-17.7-8.87), p=0.05). This mean decrease between the immediate post intervention and 3 months follow was insignificant.

In the control group, there was slight increase in knowledge between pretest and immediate post (mean difference of 3.1(-3.0-9.4) p> 0.05) and this increased further at 3 months follow up (mean difference of 0.3(-0.1-6.0) p>0.05) which was insignificant.

In terms of outcome between the intervention and control group, there was no significant difference in knowledge at baseline (p>0.05). However, this significantly increased in intervention at posttest and 3 months (p<0.05) (Table 2).

**Health workers HBB psychomotor skills**

Repeated measures ANOVA was used to test for the psychomotor skill for the intervention and control group at baseline,
immediate post intervention and 3 months follow up (Table 2). When compared from baseline to 3 months follow up, the intervention had significant increase between base line and immediate post intervention with mean difference of 69.2(62.8-75.7) p<0.05 and this increased at 3 months follow up (mean difference 0.1(-0.3-0.8), p<0.05). In the control group, the baseline was not tested and only the immediate post intervention and 3 months follow up was tested. From the outcome, there was no significant increase in psychomotor skill in the control (mean difference -3.4 (-11.0-4.10, p>0.05)). Between the intervention and control group at immediate post intervention and 3 months follow up, there was significant increase in psychomotor skill in the intervention compared with the control group (p<0.05).

Health worker competency for simple resuscitation measured through OSCE A

In Table 2 below, health workers competency for simple resuscitation in the intervention and control group tested by repeated measures ANOVA at baseline, immediate post intervention and 3 months follow up showed that within the intervention group, there was significant increase of competency from baseline to immediate post intervention (mean difference of 61.2(57.0-66.5 p<0.05) and deceased slightly at 3 months follow up (mean difference 0.3(1(-4.6-5.32). However, the mean difference between the immediate post intervention and 3 months was not statically significant (p>0.05). Health workers in control group were not tested at baseline for simple resuscitation but tested at immediate post intervention and 3 months follow up (p>0.05).

Health worker competency complex neonatal resuscitation measured through OSCE B

When compared from baseline to 3 months of follow up, the intervention group had significant increase between baseline and immediate post intervention (p<0.05) and this decreased at 3 months follow up (mean difference 2.74(-6.71-1.22) but the changes remained insignificant (p>0.05)

In the control group, the health worker were tested at immediate post intervention and 3 months follow up and there was no sig-

Table 1. Sociodemographic and professional characteristics (age, gender, and educational level).

| Demographic Characteristics     | Intervention (Freq. (N=40)) | Control (Freq. (N=30)) | p-value | Statistical test |
|--------------------------------|----------------------------|------------------------|---------|-----------------|
| Age in years                   |                            |                        |         |                 |
| 25-35                          | 25                         | 20                     | 0.130   | Chi-square      |
| ≥36 above                      | 15                         | 10                     | 0.719   |                 |
| Gender                         |                            |                        |         |                 |
| Male                           | 7                          | 8                      | 0.071   | Chi-square      |
| Female                         | 33                         | 24                     | 0.790   |                 |
| Education level                |                            |                        |         |                 |
| Primary eight                  | 6                          | 4                      | 0.748   | Fisher Exact    |
| Secondary                      | 3                          | 4                      | 0.781   |                 |
| College/tertiary               | 31                         | 22                     | 0.097   | Chi-square      |
| Diploma in Midwifery           | 1                          | 0                      | 0.623   | Fisher Exact    |
| Community H.W Training         | 1                          | 1                      | 0.009   | Fisher Exact    |
| Professional qualification     |                            |                        |         |                 |
| Nurse                          | 12                         | 10                     | 0.097   | Fisher Exact    |
| Midwives                       | 17                         | 11                     | 0.097   |                 |
| Maternal Child health officer  | 3                          | 1                      | 0.33    | Fisher Exact    |
| Nurse practitioner             | 1                          | 0                      | 0.33    | Fisher Exact    |
| Clinical officer               | 2                          | 2                      | 0.67    | Fisher Exact    |
| Community Health workers       | 4                          | 2                      | 0.67    | Fisher Exact    |
| Skilled birth attendants       | 1                          | 1                      | 0.33    | Fisher Exact    |
| Intern Doctor                  | 1                          | 1                      | 0.33    | Fisher Exact    |
| Primary area                   |                            |                        |         |                 |
| Newborn care                   | 11                         | 8                      | 5.987   | Fisher Exact    |
| Sick children ward             | 4                          | 1                      | 0.33    | Fisher Exact    |
| Maternal and newborn care      | 25                         | 17                     | 0.097   | Fisher Exact    |
| Obstetrics/Obstetrician        | 8                          | 4                      | 0.097   | Fisher Exact    |
| Current place of work          |                            |                        |         |                 |
| Maternity ward                 | 23                         | 19                     | 0.129   | Fisher Exact    |
| Children ward                  | 16                         | 17                     | 0.129   | Fisher Exact    |
| Operating theater (OT)         | 1                          | 4                      | 0.129   | Fisher Exact    |
| Monthly income                 |                            |                        |         | Chi-square      |
| 300-1000 SSP                   | 18                         | 8                      | 2.896   | Chi-square      |
| 1001-2,000 SSP                 | 14                         | 16                     | 0.235   | Fisher Exact    |
| 2,001 SSP and above            | 8                          | 6                      | 0.023   | Fisher Exact    |
| Duration of practice           |                            |                        |         | Chi-square      |
| ≤1 year                        | 12                         | 6                      | 0.980   | Chi-square      |
| Two – three years              | 10                         | 8                      | 0.806   | Fisher Exact    |
| Four – five years              | 5                          | 5                      | 0.33    | Fisher Exact    |
| Over five years                | 13                         | 11                     | 0.33    | Fisher Exact    |
| Knowledge                      |                            |                        |         |                 |
| Baseline                       | 17                         | 48                     | 0.6     | Unpaired test   |
| Psychomotor skill              | Baseline (pretest)         | 10                    | *       | *               |
| Simple Competency              | Baseline (pretest)         | 10                    | *       | *               |
| Complex competency             | Baseline (pretest)         | 7                     | *       | *               |

Significant level at 0.05. The 25-35 years in case of age is based on the fact that it represents the youthful age group. Fishers Exact test have been used for cell counts less than 5. *psychomotor skill and competency for simple and complex neonatal resuscitation at baseline cannot be compared due to lack of assessment for control at baseline.
significant change in the competency for complex neonatal resuscitation (p>0.05). Between the intervention and control group, health workers in intervention group showed significant increase in competency compared to control group (p<0.05) (Table 2).

**Early neonatal mortality**

A total of 4981 live births were recorded in the hospital registry; 2127 live births registered before implementation from November 2016 to February 2017, and 2854 after implementation from March to June 2017. All births were attended by the health workers in the study during implementation (Figure 2).

**Early newborn death within 24 hours**

Table 3 is the composite summary of early newborn mortality due to asphyxia within 24 hours in intervention and control. When compared at pre and post implementation, there was significant reduction in the intervention than the control group in term of newborn mortality within 24 hours. Newborn mortality reduced from 51.9% pre implementation to 23.5% post implementation. The percentage decreased in the control group remained insignificant (48.1% to 48.1%) both pre and post implementation.

The reduction and changes within the pre intervention and post implementation

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### Table 2. HBB health worker's knowledge, psychomotor skills, competency for simple and complex neonatal resuscitation of the health workers at pretest immediate intervention and 3 moths follow up.

|                          | Intervention Mean df. (CI) | P-Value | Control Mean df. (CI) | P-Value |
|--------------------------|-----------------------------|---------|------------------------|---------|
| **Knowledge**            |                             |         |                        |         |
| Pre-test                 | 42.5± 17.3                  |         | 48.0±13.9              |         |
| Immediate post intervention | 97.8±3.4                  | <0.001  | 51.2±11.2              | 0.9     |
| 3 months follow-up       | 84.7±7.7                    | <0.001  | 50.9±15.7              | 0.9     |
| **Psychomotor skills**   |                             |         |                        |         |
| Pre-test                 | 26.1±19.9                   |         |                        |         |
| Immediate post test      | 94.4±8.5                    | <0.001  | 43.8±16.7              | 0.37    |
| 3 months follow-up       | 95.4±6.8                    | <0.001  | 40.9±18.9              | 0.37    |
| **Competency for simple neonatal resuscitation** |             |         |                        |         |
| Pre-test                 | 26.9±14.6                   | -**     |                        |         |
| Intermediate             | 88.8±8.5                    | <0.001  | 38.9±8.5               | -       |
| 3 months follow-up       | 89.3±8.1                    |           | 41.3±14.4              | 0.36    |

Data are expressed as Mean difference. *Significant level at 0.005 post intervention and 3 months follow up. P-Value within intervention group tested by repeated ANOVA, 0.001 and 0.001 between immediate post intervention and 3 months follow up. **No baseline conducted for control group for bag and mask, OSCE A and B due to logistical problems, and time.
period on reduction of among the interven-
tion and control group was tested using per-
son chi squared. Within the intervention
group, there was significant change ratio of
early newborn mortality compared to the
control group within the 24 hours after con-
ducting resuscitation (p<0.05).

Discussion

The professional background of the health workers in the intervention group who attended the HBB training in Juba Teaching Hospital had similar characteristics, and the working environment of the control group (Wau Teaching Hospital) was situated 100 kilometers away from the interven-
tion site. Both the intervention and control hospitals are teaching hospital with a
similar setup and are supported by the gov-
ernment of South Sudan. This generalized
the findings on the evaluation made in other
health care settings and public hospitals in
the country as well other low-income devel-
oping countries with a similar setting.

During our study, we administered the
OSCE A and B to the intervention group
pre-test, post-test, and at the three-month
follow-up, and at post-test and three-month
follow-up in the control group because of
the insecurity which was not safe for the
trainers and the participants to undertake
the assessment. Frequently, the OSCE A
and B were considered too difficult to be
administered to the participants during the
pre-training period. Administering the
OSCE A and B pre-training helped us estab-
lish the health workers’ skills and competen-
cy pre training and aided the design of
the educational instruction approach. Based
on the pre-assessment of the practical skill
and competency of health workers in the
intervention group, we tailored support to
each of the participant’s ability and under-
standing of the training, and that facilitated
the good result at post training. Our study
introduced and implemented a quality
improvement cycle as a means of improv-
ing the knowledge, skills, and competency of
the health workers in the long term.

The HBB training implementation con-
tributed to the improvement of the knowl-
dge of the health workers from interven-
tion Hospital after a two-day training.
However, the level of knowledge attained
at post-training declined at the end of imple-
mentation period. Meanwhile there was no
significant increase in knowledge among
the health worker in the control site.

The study on HBB training in South
Sudan has shown that the HBB knowledge
MCQ written scores improved by 55.3%
from 42.5% at pre-training to 97.8% imme-
diately after post training (pre-test) (Table
2). This result concurred with a similar
study in Kenya which has showed that,
passing rate of the knowledge MCQ-based
test increased from 75% to 95% after a sim-
ilar training intervention. The use of the
simulated-based environment for teaching
and learning had greatly improved the health workers HBB knowledge and skill in
neonatal resuscitation; however, this knowl-
dge was not retained at three months.

Among the points of interest is that the
practical psychomotor skill and competency
of the health workers improved greatly and
were retained after three months. Surpris-
ingly, the health workers retained the
skill and competency at three months
despite the similar major studies about
retention of practical skills and competency
conducted in Rwanda and Kenya that indi-
cated that it was mostly difficult to retain
the skill and competency at three to six
months after the Helping Babies Training
Intervention.

The persistence of the practical skill and
competency among the trainees could be
attributed to the implementation of quality
improvement cycle during our study with a
focus on the practical application of the
HBB steps and problem solving. Many
studies on HBB reported a decline in the
knowledge and practical skill within three
to six months of receiving the neonatal
resuscitation training.12 Similarly, it was
reported that the practical skill and compen-
tency fades faster than the knowledge.13

Our study finding confirmed that the
HBB is a practical course that requires
actions with periodic reinforcement of the
skill through review and problem solving
and self-assessment of retention and skill
learned. Furthermore, an evaluation study
conducted in Ghana on the retention of
knowledge and practical skills and the com-
petency of health workers at 9-12 months
after training on modified neonatal resusci-
tation program indicated that the knowledge
and skill remained stable within the period
of 9-12 months post training. This mostly
concurs with the retention of practical skill
and competency found among the health
workers from the Juba Teaching Hospital.

Table 3. Early newborn mortality.

| Variable                          | Before Intervention | After Intervention | P Value |
|----------------------------------|---------------------|--------------------|---------|
|                                  | Frequency           | Percent (%)        | Frequency | Percent (%) |         |
| Total live births                | Intervention        | 1116               | 52.40    | 1112       | 53.9    | -       |
|                                  | Control             | 1011               | 47.50    | 950        | 46      | -       |
|                                  | Total               | 2127               | 99.9     | 2062       | 99.9    | -       |
| Newborn Birth Asphyxia           | Intervention        | 88                 | 55.7     | 125        | 57.1    | 0.18    |
|                                  | Control             | 70                 | 44.3     | 94         | 42.9    | -       |
|                                  | Total               | 158                | 100      | 219        |         |         |
| Newborn resuscitated using HBB   | Intervention        | 0                  | 0        | 124        | 98.4    | 0.001*  |
|                                  | Control             | 0                  | 0        | 2          | 1.6     | 0.114   |
|                                  | Total               | 0                  | 0        | 126        |         |         |
| Asphyxia deaths                  | Intervention        | 26                 | 50.9     | 4          | 30.7    | 0.001*  |
|                                  | Control             | 25                 | 49       | 9          | 69.2    | 0.110   |
|                                  | Total               | 51                 | 100      | 13         |         |         |
| Death within 24 hours            | Intervention        | 14                 | 51.9     | 4          | 23.5    | 0.001*  |
|                                  | Control             | 13                 | 48.1     | 13         | 48.1    | 0.110   |
|                                  | Total               | 27                 | 100      | 17         |         |         |
| Death after 24 hours             | Intervention        | 12                 | 50.0     | 9          | 33.3    | 0.000*  |
|                                  | Control             | 12                 | 50.0     | 18         | 66.7    | 0.112   |
|                                  | Total               | 24                 | 100      | 37         |         |         |

*Significant level at 0.05. Rounded at 1 decimal place. Tested by Pearson Chi square test 2x2 sided significance for birth asphyxia, newborn death within and after 24 hours before and after implementation.
Many of the researchers who conducted a similar study advocated for the means of retention of knowledge, skill, and competencies among the trainees and suggested refresher training courses between the post training and implementation period.14

During the study evaluation of the HBB training, we found out that 5.2% failed the written test at post training, and this further increased to 19% at the end of three months. Similarly, 11.9% failed the practical skills at post-test and 18.3% at three months and the passing scores were not met (Table 2). Our failure rate in the study among the health workers was similar to other studies conducted by Singhal et al indicating that health workers skills and competency for neonatal intubation and ventilation remained very limited after training our results of the failure rate among the health workers was demonstrated by other studies reporting the limited skills and competency in neonatal intubation and ventilation.15

The training intervention revealed a potential benefit of not only improving the knowledge, skills, and competency of the health workers but has also impacted on the newborn outcomes. A remarkable decline in the newborn mortality ratio due to asphyxia was noted among the intervention Hospital. The early newborn infant deaths within 24 hours due to asphyxia reduced from 51.9% to 233.5%. The association between knowledge and neonatal reduction at the same period was not explored in this study. On the Global context, a few studies have demonstrated the long term of effects of the HBB training of health workers in the early neonatal outcomes. Similarly, a large before-and-after design study conducted in Tanzania showed that training in and the targeted implementation of the HBB program was associated with a significant reduction in the primary outcome of the early neonatal mortality (within 24 hours) and the rate of fresh stillbirths and early perinatal mortality. The ratio of early newborn mortality in the control site (48.1% to 48.1% both pre and post implementation). Although, there was notably decreased in the ratio of early newborn deaths at intervention site, the three months period for baseline and implementation was not enough make the interpretation of the result conclusive and generalized.

The strengths of our study was the use of the research instruments that was previously validated, standardized, and adapted from the American Academy of Pediatrics and was used to evaluate the HBB knowledge, skills, and competency of the health workers in the similar setting in low-income countries like Kenya, Rwanda, and Uganda.17 Despite the study being extensive, there were many limitations to it: some due to the inherent issues with the study design used and some due to the conflict, time, and finances that had direct and indirect effects on the study result. First, the study’s ability to evaluate resuscitation practices was limited by the small number of infants who required active resuscitation; however, the authors were able to demonstrate improvements in preparation for the resuscitation.

Second, the pre- and post-design of the study with the introduction of the quality improvement cycle limited the researchers’ ability to determine the effects of the HBB training alone. It also hindered them from experiencing the changes in the knowledge, skills, and competency during the implementation let alone the significant reduction of the early neonatal mortality. However, no ongoing similar intervention was performed at the hospital during our implementation.

Third: Our study did not assess the control group for the psychomotor skill and competency attributed to the prevailing security and this affected our comparison of intervention and control group at baseline.

The study strongly recommends that since the HBB training had an positive impact on the knowledge, skill, and competency of health workers in the hospital setting and in the reduction of early neonatal mortality, training must be provided by the Ministry of Health and other supporting organizations in the country particularly in rural setting where this protocol has put emphasis. The training must be conducted and an in-phased approach must be used when training the first pool of facilitators and health workers where neonatal mortality indicators are highest. It is recommended that similar research on HBB should consider assessing both groups (Intervention and Control) at baseline for knowledge, psychomotor skills and competency.

Conclusions

The study has demonstrated that the health workers from Juba Teaching Hospital in South Sudan significantly improved their knowledge, practical and competency on neonatal resuscitation after participating in a two-day training course. With the ongoing conflict, it was expected that training of health workers in HBB might not have the hypothesized impact, but this was proven to be wrong; however, the knowledge was found to decline during the three-month follow-up. Interestingly, the practical skill and competency of the health workers remained intact over the three-month period and even continued to increase strongly among the health workers evaluated. Additionally, the training and implementation had a positive effect on the survival rate of neonates evaluated in the teaching hospitals. Overall, a significant reduction in early newborn mortality rates due to asphyxia-related illness was noted after the implementation. This may prove directly replicable in other similar settings, not only in South Sudan, but also in other low-income countries.

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