


REVIEW ARTICLE

# Does the Helping Babies Breathe Programme impact on neonatal resuscitation care practices? Results from systematic review and meta-analysis

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## Keywords

Helping Babies Breathe, Low-and middle-income countries, Neonatal resuscitation, Ventilation within one minute of birth

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## ABSTRACT

**Aim:** This paper examines the change in neonatal resuscitation practices after the implementation of the Helping Babies Breathe (HBB) programme.

**Methods:** A systematic review was carried out on studies reporting the impact of HBB programmes among the literature found in Medline, POPLINE, LILACS, African Index Medicus, Cochrane, Web of Science and Index Medicus for the Eastern Mediterranean Region database. We selected clinical trials with randomised control, quasi-experimental and cross-sectional designs. We used a data extraction tool to extract information on intervention and outcome reporting. We carried out a meta-analysis of the extracted data on the neonatal resuscitation practices following HBB programme using Review Manager.

**Results:** Four studies that reported on neonatal resuscitation practices before and after the implementation of the HBB programme were identified. The pooled results showed no changes in the use of stimulation (RR-0.54; 95% CI, 0.21–1.42), suctioning (RR-0.48; 95% CI, 0.18–1.27) and bag-and-mask ventilation (RR-0.93; 95% CI, 0.47–1.83) after HBB training. The proportion of babies receiving bag-and-mask ventilation within the Golden Minute of birth increased by more than 2.5 times (RR-2.67; 95% CI, 2.17–3.28).

**Conclusion:** The bag-and-mask ventilation within Golden minute has improved following the HBB programme. Implementation of HBB training improves timely initiation of bag-and-mask ventilation within one minute of birth.

## INTRODUCTION

In 2017, approximately 450 new-borns died every hour with most deaths occurring in the low- and middle-income countries (LMICs) (1,2). Intrapartum-related neonatal deaths represented 10.5% of all deaths of under five-year-olds and 24% of all neonatal deaths in 2013 (3). The burden of lives lost from intrapartum (fresh) stillbirth is estimated at 1.19 million annually (4). More than half of all fresh stillbirths occur in rural Sub-Saharan Africa and South Asia where the coverage of skilled birth attendance and the availability of facilities providing caesarean sections is lowest (5). The reduction of stillbirth and neonatal mortality from intrapartum-related events depend on improved

intrapartum care and resuscitative interventions by the birth attendants skilled in neonatal resuscitation at the time of birth (6,7). Continued efforts are needed to scale up lifesaving interventions to achieve the Sustainable Development Goals target 3.2 of ending preventable deaths of the new-borns and the under five-year-old children (8).

Each year, around 10 million new-borns require some degree of resuscitation after birth such as tactile stimulation or airway clearing or positioning (9). In addition, over one

## Abbreviation

CI, Confidence interval; EPOC, Effective Practice and Organization of Care; GRADE, Grades of Recommendation, Assessment, Development and Evaluation; HBB, Helping Babies Breathe; LMICs, Low- and middle-income countries; OR, Odds ratio; OSCE, Objective Structured Clinical Examination; RoBANSs, risk of Bias Assessment for Non-Randomized Studies; RR, Relative ratio.

## Key notes

- The Helping Babies Breathe programme is a simplified and standardised method to train health service providers on a neonatal resuscitation protocol using adult learning techniques.
- We conducted a systematic review of the studies that reported basic neonatal resuscitation practices before and after the implementation of the HBB programme.
- The effect of HBB training improved the timing of initiation of bag-mask ventilation within one minute.

million new-borns with complications were related to prematurity, such as respiratory distress syndrome, require assistance to breathe at birth (10,11). More than 95% of babies respond to simple interventions such as drying, stimulation, warmth, suctioning and ventilation with a bag-and-mask (9,12). It is estimated that the training of birth attendants on basic neonatal resuscitation in the LMICs could avert 30% of intrapartum-related neonatal deaths (13). However, lack of guidance for programme planners on the most effective package of interventions to reduce mortality remains a challenge (14).

In 2010, the *American Academy of Pediatrics* and partners in the *Helping Babies Breathe Global Development Alliance* began disseminating the Helping Babies Breathe (HBB) programme of measures, which is based on the *International Liaison Committee on Resuscitation Consensus on Science* and *World Health Organization Guidelines on Basic New-born Resuscitation* (15). HBB training focuses on peer-to-peer learning and enhancing skills on neonatal resuscitation through training courses of one to three days. The HBB programme is particularly meant for settings where a single birth attendant attends to the mothers and the new-borns. The resuscitation protocol of HBB programme calls for initiating bag-and-mask ventilation as soon as possible after birth within a recommended time of one minute after birth (16).

By 2017, the HBB programme had been implemented in more than 77 countries equipping hundreds of thousands of health service providers to carry out neonatal resuscitation (17). The HBB programme is recognised as a cost-effective intervention that improves perinatal outcomes in the LMICs (18).

Several studies have reported improved perinatal outcomes at birth due to the implementation of the HBB programme (19–21). Several lessons have been learned from implementing the programme in health facilities and community settings (22,23).

A systematic review of the implementation of the HBB programme in the LMICs by Dol et al. (24) found that it had reduced intrapartum stillbirths by 34% (RR-0.66; CI 95% 0.52–0.85) and first day mortality by 30% (RR-0.70; CI 95% 0.51–0.98). While neonatal outcomes and provider skills following HBB training are highlighted, the review provides limited analysis of the basic neonatal resuscitation practices especially the practice of resuscitation within the Golden Minute. Since the causal pathway for reducing mortality from HBB programme first requires improvement in the health workers practice in basic neonatal resuscitation protocol. This systematic review primarily aims to evaluate the change in the basic neonatal resuscitation practices (stimulation, suctioning, bag-and-mask ventilation and bag-and-mask ventilation within one minute) following the HBB training implementation.

## METHODS

This paper reports the findings of a systematic review of the literature on the impact of the HBB training in basic neonatal resuscitation care practices in a PICO format.

## Participant(P)

This review looked at studies of skilled and non-skilled health workers providing care to new-borns at the time of birth. Skilled health workers are medical doctors, nurses, midwives and assistant nurses who are formally trained in midwifery skills. Non-skilled health workers are community health workers who may not have been formally trained in midwifery.

## Intervention (I)

The review covered observational studies of clinical practices for immediate newborn care and neonatal resuscitation gathered from independent data collection systems. It covered basic neonatal resuscitation in non-breathing babies using the HBB protocol.

## Comparison (C)

Routine perinatal care practice before HBB programme was used as a comparator intervention.

## Outcome(O)

Studies that reported on any of the following basic neonatal resuscitation practices were included in the review:

- Stimulation involves additional manoeuvre provided to help the non-breathing babies transition from the intra-uterine to the extra-uterine life.
- Suctioning involves the removal of secretions in non-breathing babies through the use of suction machines.
- Bag-and-mask ventilation involves assistance for ventilation provided to the non-breathing babies using the bag and mask.
- Bag-and-mask ventilation within Golden Minute – the initiation of bag-and-mask ventilation within the first minute of life for the non-breathing babies.
- Effective ventilation – Ventilation at the rate of 40–60 ventilations per minute with the baby's chest rising.

## Literature search

All the relevant peer-reviewed literature published between January 2010 and July 2018 that reported findings on neonatal resuscitation practices after the implementation of the HBB programme among health workers in the LMICs were searched. English language literature was searched in the PubMed, POPLINE, Google scholar, African Index Medicus, Cochrane, Web of Science and Index Medicus for the Eastern Mediterranean Region database. Due to the limited literature on the subject, the search strategy was broadened using a range of search terms. The key words, including 'helping babies breathe', 'developing countries', 'low-income countries', 'middle-income countries', 'low-and middle-income countries', 'training', 'education', 'nurse', 'physician', 'midwives', 'traditional birth attendants', 'health workers', 'new-born', 'infant', 'neonatal', 'resuscitation' and 'birth asphyxia' were used in different combinations. Two reviewers were involved in reviewing the search results (Data S1).

Other resources were searched in Open Grey search engine and the neonatal resuscitation and paediatric academy websites. The clinicaltrials.gov database was searched for relevant clinical trials.

### Selection of studies

The selected studies included randomised controlled trials; cluster randomised trials; quasi-experimental studies (including quasi-randomised trials); controlled before and after studies; cohort, case control and analytical cross-sectional studies that had evaluated the effects of the HBB programme. These studies were required to report on at least one of the outcomes of the HBB programme (stimulation, suctioning, bag-and-mask ventilation and bag-and-mask ventilation within one minute or the Golden Minute of birth in the non-breathing babies) reported as adherence by trainees to the HBB protocol practices directly observed by an evaluator or by other methods of documentation. The current review considered all relevant studies on health service providers providing essential neonatal care at birth. These providers include skilled and non-skilled healthcare staff and birth attendants who were present and had provided care at birth and post-birth (e.g. nurses, doctors, midwives and community health service providers).

Despite the HBB programme having a primary focus on training skilled providers, both skilled and non-skilled health service providers were included in this review as the programme asserts that its recommended practices can be taught to the traditional birth attendants as well (25).

### Exclusion criteria

All studies in high income country settings and studies reporting only on the impact of other neonatal resuscitation guidelines or other interventions were excluded from the review. Only studies that reported on knowledge checks, including pre- and post-evaluations of training through Objective Structured Clinical Examination (OSCE) and other methods, were excluded as they mainly reported on the level of knowledge immediately after training and not on the changes in practice.

### Quality of evidence

The quality of evidence was assessed using the Grades of Recommendation, Assessment, Development and Evaluation (GRADE) criteria (26,27). GRADE is a systematic approach to making judgments about the quality of evidence and the strength of recommendations (28). Modified GRADE criteria were used to evaluate the level of evidence applying methods adapted by the Child Health Epidemiology Reference Group (29).

### Data extraction

Data were extracted from the selected studies using an adapted Effective Practice and Organization of Care data collection template (30). Information was extracted on region, country, year of publication, author, evaluation design, site of study, study population, intervention,

intervention implementation strategy, reported outcome, effect size and adjusted effect size.

### Assessment of bias

The risk of bias of the selected studies was assessed using the Risk of Bias Assessment for Non-Randomized Studies (RoBANSs) tool (31). The domains assessed included: selection of participants, confounding variables, intervention (exposure) measurement, blinding of outcome assessment, incomplete outcome data and selective outcome reporting. For each domain, two of the authors independently assigned either 'low risk', 'high risk' or 'unclear risk'.

### Measurement of effect

Risk ratios (RRs) or odds ratios (ORs) was used to compare the performance of the before and after HBB training groups for dichotomous outcomes. All effects were presented with 95% confidence intervals (CIs).

### Assessment of heterogeneity

Heterogeneity among the studies was assessed using the chi-square test and the  $I^2$  statistic. A chi-square p-value of  $<0.10$  and a  $I^2$  statistic value  $>50\%$  was used to denote a significant level of heterogeneity (32).

### Data synthesis for meta-analysis

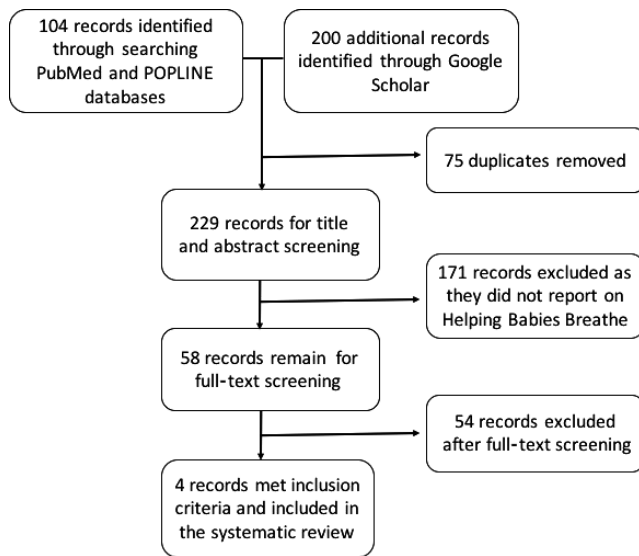
A final data sheet was prepared after checking for agreements between the independently extracted data by the two review authors. The RevMan version 5.3 software (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration) was used to conduct meta-analysis and to generate the forest plots (33). A fixed effect meta-analysis was used when the assessments of heterogeneity did not reveal heterogeneity. In the presence of heterogeneity (as identified by a chi-square test p-value less than 0.1 or an  $I^2$  statistic greater than 50%), a random-effect meta-analysis was done.

## RESULTS

### Search results

One hundred four relevant records were found by searching the PubMed and POPLINE databases while an additional 200 records were retrieved from the Google Scholar® search. The removal of duplicates left 229 records for further selection. The titles and abstracts of these records were screened for use of the terms, 'stimulation', 'suctioning', 'bag-and-mask ventilation' and 'Golden Minute bag-and-mask ventilation' to evaluate the impact of the HBB programme on neonatal care practices during birth (before and after HBB programme implementation). This screening resulted in 58 relevant records.

The full-text screening of the 58 records identified four studies that fully met the criteria for inclusion in the systematic review. All these studies are observational before and after HBB programme studies conducted in India and Kenya (Goudar et al. (21), Nepal (KC et al. (19), Sudan (Arabi et al. (34) and Tanzania (Msemu et al. (20) (Fig. 1).



**Figure 1** Study flow diagram.

Four articles were not included in the review even though they matched the inclusion criteria as they were covered in the above four studies. The Wrammert 2017 (35) is covered in KC 2016 (23); Ersdal 2013 (22), Mduma 2015 (36) and Vossius 2014 (18) are covered in Msemu 2013 (20).

### Methodological quality of included studies

The application of the RoBANS risk assessment tool showed that the four studies had an overall low risk of bias (31) (Table 1). The fact that the four studies were observational studies conducted in different countries and settings increased the likelihood of heterogeneous findings compared to randomised controlled trials. Meta-analysis was conducted for the four studies, and forest plot was generated even where the test of heterogeneity revealed  $I^2$  statistics to be  $>50\%$ . These circumstances are discussed for each outcome below.

Two of the four studies were set in Africa only, one in South Asia only, and one in both South Asia and Africa (19–21,34). The HBB programme was implemented using different strategies to encourage the retention of knowledge and skills. All the studies were carried out in different types of settings, Arabi et al. (34) observed village midwives working in community settings, Goudar et al. (21) skilled birth attendants working in primary healthcare centres,

Msemu et al. (20) skilled hospital birth attendants working in district and referral hospital and KC et al. skilled birth attendants, obstetricians, paediatricians and medical doctors working in a tertiary hospital (21) (Table 2).

### The use of stimulation

The use of stimulation to help non-breathing babies transition from intra-uterine to extra-uterine life was reported by all four of the studies (Table 3). Stimulation was reported as occurring in 340 out of every 1000 births before the HBB programme while the anticipated use of stimulation after the programme implementation was calculated to be 198 (72–484) per 1000 births (Table 4). The use of stimulation decreased by 46% after the HBB programme implementation with a RR of 0.54 (0.21–1.42). However, there was no statistical difference between the use of stimulation before and after the HBB programme ( $p = 0.21$ ; Fig. 2).

### The use of suctioning

The use of suctioning to remove secretions in non-breathing babies was also reported by all four studies (Table 3). It was carried out in 265 of every 1000 births before the HBB programme while the anticipated use of suctioning after the programme implementation was calculated to be 127 (48–337) per 1000 births (Table 4). Its use was thus 52% lower afterwards with a RR of 0.48 (0.18–1.27). However, there was no statistical difference between the use of suctioning before and after the HBB programme was implemented ( $p = 0.14$ ; Fig. 3).

### Bag-and-mask ventilation

The use of bag-and-mask ventilation was reported by two of the four studies on non-breathing babies (Table 3). The rate of bag-and-mask ventilation was 64 per 1000 births before the HBB programme while the anticipated use of bag-and-mask ventilation after the programme implementation was calculated to be 59 (30–117) per 1000 births (Table 4). The use of bag-and-mask ventilation was thus 8% lower afterwards with a RR of 0.93 (0.47–1.83). However, there was no statistical difference between the use of bag-and-mask ventilation before and after the HBB programme ( $p = 0.84$ ; Fig. 4).

### Bag-and-mask ventilation within the Golden Minute

The use of bag-and-mask ventilation within 60 seconds of birth (the Golden Minute) on non-breathing babies was reported by two of the four studies (Table 3). Seventy four

**Table 1** Assessment of risk of bias of the four studies reviewed for the impact of the HBB programme

Bias	Arabi et al. (35)	Goudar et al. (21)	KC et al. (23)	Msemu et al. (22)
Selection of participants	Low risk	Low risk	Low risk	Low risk
Confounding variables	Low risk	High risk	Low risk	Low risk
Intervention (exposure) measurement	Low risk	Low risk	Low risk	Unclear risk
Blinding of outcome assessment	High risk	Low risk	Low risk	Low risk
Incomplete outcome data	Low risk	Unclear risk	Unclear risk	Low risk
Selective outcome reporting	Low risk	Low risk	Low risk	Low risk

**Table 2** Characteristics of the four studies included in this review

Author (year)	Training setting	Participants	Number of births conducted		Outcomes
			A: pre-HBB	B: post-HBB	
Arabi et al. (2017)	Community based	Village midwives	A: 1350 B: 3040		Drying of new-borns Stimulation Mouth to mouth ventilation Bag-and-mask ventilation
Goudar et al.(2013)	Facility based Primary Health Centres and hospitals	Birth attendants	A: 4187 B: 5411		Stimulation Bag-and-mask ventilation Golden minute bag-and-mask ventilation
KC et al. (2016)	Facility based (tertiary maternity hospital)	Obstetricians, anaesthesiologists, medical doctors, nurse midwives, and nurse students	A: 9588 B: 15 520		Stimulation Suctioning Golden minute bag-and-mask ventilation
Msemo et al. (2013)	Facility based (district, regional and referral hospitals)	Hospital birth attendants	A: 8124 B: 78 500		Stimulation Suctioning Bag-and-mask ventilation

**Table 3** Narrative summary of the use of stimulation, suctioning and bag-and-mask ventilation by health service providers before and after HBB training (four included studies)

Neonatal care practice	Study (year)	Events		Total		Relative risk (95% CI)
		A: pre-HBB	B: post-HBB	A: pre-HBB	B: post-HBB	
Use of stimulation	Arabi et al. (2017)	A:175	B: 58	A: 1346	B: 3033	0.15 (0.11, 0.20)
	Goudar et al. (2013)	A: 662	B: 490	A: 4187	B: 5411	0.57 (0.51, 0.64)
	KC et al. (2016)	A: 233	B: 151	A: 488	B: 588	0.54 (0.46, 0.63)
	Msemo et al. (2013)	A: 3657	B: 67 232	A: 7862	B: 76 817	1.88 (1.84, 1.93)
Use of suctioning	Arabi et al. (2017)	A: 1011	B: 437	A: 1346	B: 3033	0.19 (0.17, 0.21)
	Goudar et al. (2013)	A: 1117	B: 543	A: 4187	B: 5411	0.38 (0.34, 0.41)
	KC et al. (2016)	A: 422	B: 264	A: 488	B: 588	0.52 (0.47, 0.57)
	Msemo et al. (2013)	A: 1133	B: 16 103	A: 7862	B: 76 817	1.45(1.38, 1.54)
Use of bag-and-mask ventilation	Goudar et al. (2013)	A: 128	B: 219	A: 4187	B: 5411	1.32 (1.07, 1.64)
	Msemo et al. (2013)	A: 659	B: 4244	A: 8124	B: 78 500	0.67 (0.62, 0.72)
Use of bag-and-mask ventilation within Golden Minute	Goudar et al. (2013)	A:95	B: 144	A: 1212	B: 645	2.85 (2.24, 3.62)
	KC et al. (2016)	A: 31	B: 87	A:488	B:588	2.33 (1.57, 3.45)

of every 1000 new-borns were resuscitated using bag-and-mask ventilation within the Golden Minute before the HBB programme while the anticipated use of bag-and-mask ventilation within the Golden Minute after the programme implementation was calculated to be 198 (161–243) per

1000 new-borns per 1000 births (Table 4). Resuscitation using bag-and-mask ventilation within the Golden Minute was therefore 2.67 times higher after the programme with a RR of 2.67 (2.17–3.28) suggesting that the programme had encouraged the greater use of bag and mask within the first minute of birth. This difference was statistically significant ( $p < 0.001$ ; Fig. 5).

## DISCUSSION

This review assessed the impact of the HBB programme interventions on neonatal resuscitation practices in the LMICs in Asia and Africa. The meta-analysis has pooled a large amount of data and identified a uniform direction of the effect on neonatal resuscitation practices. This review found increased practice of bag-and-mask ventilation in the critical Golden Minute after birth, but no changes in the practice of stimulation, suctioning and bag-and-mask ventilation following the implementation of the HBB programme.

Among the several recognised risks of the HBB programme, implementation is the over use of suctioning and bag-and-mask ventilation leading to engagement of the staff efforts that could have been utilised for required care for other babies (37). Overuse of the interventions may also pose threats of injuries to the new-born. However, there has been no significant change in the rate of use of suctioning as well as bag-and-mask ventilation, which has been observed in this systematic review. One of the most important aspects of effective ventilation for non-breathing babies is to initiate it as soon as possible.

The fact that this review only covered observational studies meant that there was a high level of heterogeneity in terms of participants (village midwives, birth attendants, nurses and specialty physicians), settings (community settings, health centres and hospitals), days of HBB training

**Table 4** Summary of the effects of the Helping Babies Breathe programme on perinatal care practices in low- and middle-income countries (four included studies)

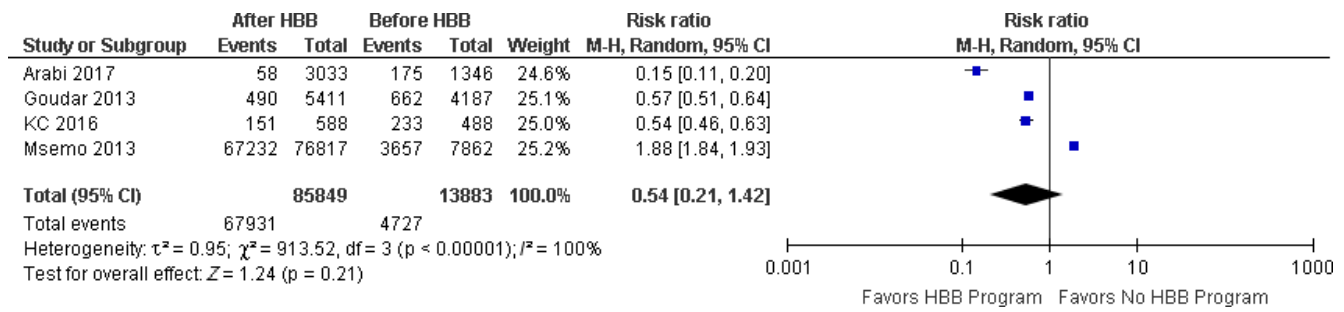
Outcomes	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Quality of the evidence (GRADE)
	Before HBB programme	After HBB programme			
Use of stimulation*	340 per 1000	198 per 1000 (72–483)	RR 0.54 (0.21–1.42)	99 732 (4 observational studies)	⊕⊕○○ Low
Use of suctioning*	265 per 1000	127 per 1000 (48–337)	RR 0.48 (0.18–1.27)	99 732 (4 observational studies)	⊕⊕○○ Low
Bag-and-mask ventilation†	64 per 1000	59 per 1000 (30–117)	RR 0.93 (0.47–1.83)	96 222 (2 observational studies)	⊕⊕○○ Low
Bag-and-mask ventilation within Golden Minute‡	74 per 1000	198 per 1000 (161–243)	RR 2.67 (2.17–3.28)	2933 (2 observational studies)	⊕⊕○○ Low

CI = Confidence interval; RR = Risk ratio.

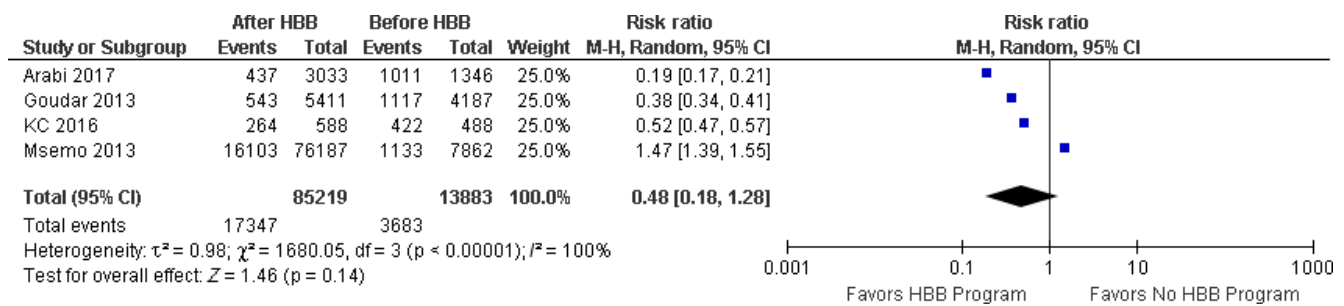
\*I<sup>2</sup> = 100%.

†I<sup>2</sup> = 97%.

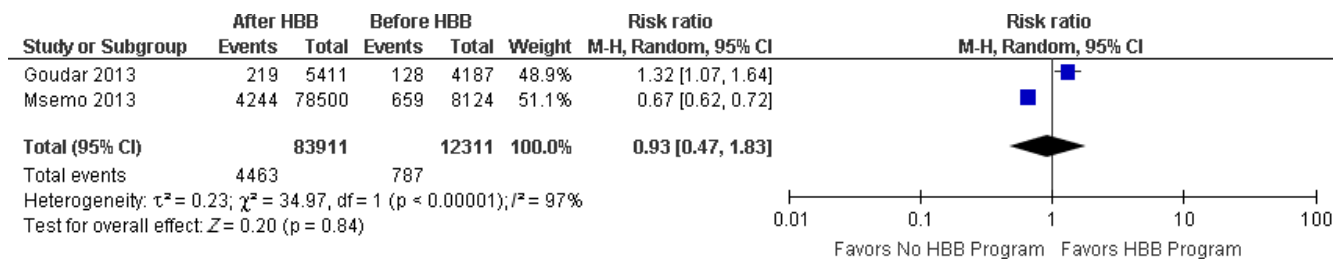
‡I<sup>2</sup> = 0%.



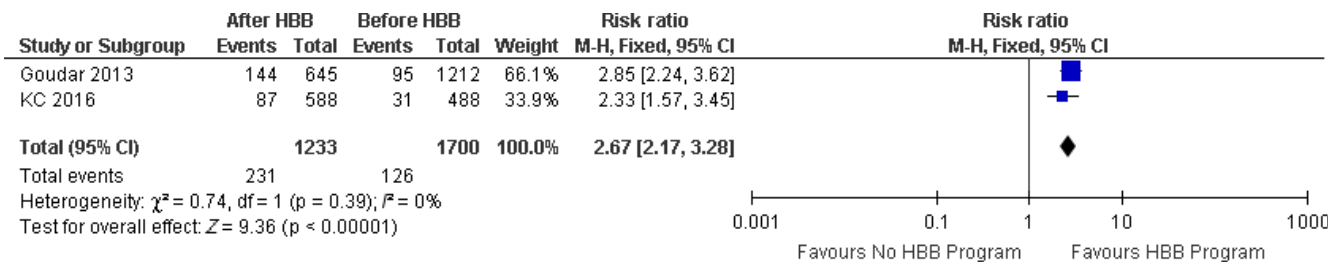
**Figure 2** Use of stimulation of babies before and after implementation of HBB programme.



**Figure 3** Use of suctioning before and after implementation of HBB programme.



**Figure 4** Use of bag-and-mask ventilation before and after implementation of HBB programme.



**Figure 5** Use of bag-and-mask ventilation within Golden Minute before and after implementation of HBB programme.

(one to three days) and countries (India, Kenya, Nepal, Sudan and Tanzania). The statistical heterogeneity was also high ( $I^2$  upto 97% and 100%). In view of scarce literature and non-randomised controlled trials being found on this subject, we attempted to pool the results of the four observational studies through meta-analysis to aggregate the available evidence so far. To address the heterogeneity, the study used the random effect model to conduct meta-analysis as per the Cochrane handbook (32).

Although a minimal risk of bias was observed in the studies included in this, as all the studies were observational studies, the quality of evidence is low compared to the evidence that would have been generated through randomised controlled trials. The HBB training along with quality improvement cycles was used in the Nepal study (21), and HBB along with regular peer-peer skills practice was used as the HBB intervention in Sudan study (34). Although two of the four studies mentioned that refresher courses were run for trainees sometime after the initial training, this review considered all studies as long as HBB training was the main intervention.

## CONCLUSION

The evidence generated from this review suggests that the HBB programme has improved timely initiation of bag-and-mask ventilation in the LMICs. Timely intervention for babies requiring ventilation saves lives.

## FUNDING

None.

## CONFLICT OF INTERESTS

Two of the co-authors had been co-investigators in one of the HBB research papers in this review. However, both of them had no influence in the data extraction or article selection process.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

### Data S1 Search Strategy.