Reducing Perinatal Mortality in Nepal Using Helping Babies Breathe

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abstract

BACKGROUND AND OBJECTIVE: Newborns are at the highest risk of dying around the time of birth, due to intrapartum-related complications. Our study's objective was to improve adherence to the Helping Babies Breathe (HBB) neonatal resuscitation protocol and reduce perinatal mortality by using a quality improvement cycle (QIC) in a tertiary hospital in Nepal.

METHODS: The HBB QIC was implemented through a multifaceted approach, including the formation of quality improvement teams; development of quality improvement goals, objectives, and standards; HBB protocol training; weekly review meetings; daily skill checks; use of self-evaluation checklists; and refresher training. A cohort design, including a nested case-control study was used to measure changes in clinical outcomes and adherence to the resuscitation protocol through video recording, before and after implementation of the QIC.

RESULTS: The intrapartum stillbirth rate decreased from 9.0 to 3.2 per thousand deliveries, and first-day mortality from 5.2 to 1.9 per thousand live births after intervention, demonstrating a reduction of approximately half in the odds of intrapartum stillbirth (adjusted odds ratio [OR] 0.46, 95% confidence interval [CI] 0.32–0.66) and first-day mortality (adjusted OR 0.51, 95% CI 0.31–0.83). After intervention, the odds of inappropriate use of suction and stimulation decreased by 87% (OR 0.13, 95% CI 0.09–0.17) and 62% (OR 0.38, 95% CI 0.29–0.49), respectively. Before intervention, none of the infants received bag-and-mask ventilation within 1 minute of birth, compared with 83.9% of infants after.

CONCLUSIONS: The HBB QIC reduced intrapartum stillbirth and first-day neonatal mortality and led to use of suctioning and stimulation more frequently. The HBB QIC requires further testing in primary settings across Nepal.

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Drs KC and Ewald conceptualized and designed the study and drafted the initial manuscript; Dr Wrammert conceptualized the study design and tools and reviewed and revised the manuscript; Dr Clark conceptualized and designed the study, carried out the initial Helping Babies Breathe training, and revised the manuscript; Mr Vitrakoti and Drs Chaudhary, Pun, and Raaijmakers reviewed and revised the initial manuscript; Dr Målqvist conceptualized and designed the study, conducted data analysis, and revised the initial manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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The time between a hypoxic event during labor or delivery and death can be short; an infant who does not breathe at birth could die in less than an hour.[1] Globally, an estimated 1.2 million stillbirths occur after the onset of labor and 1 million live-born infants die on their birth day, indicating the importance of timely, high-quality care around the time of birth.[2,3] In Nepal, 36% of neonatal deaths are due to intrapartum-related complications and 23% of stillbirths occur during the intrapartum period.[1]

The first minute after an infant is born is the crucial window for neonatal resuscitation for the 10 million nonbreathing infants born annually.[4] Resuscitation training in facilities can reduce intrapartum-related neonatal deaths by 30%.[5] A basic neonatal resuscitation protocol called Helping Babies Breathe

(HBB) has been developed for use in low-resource settings.[6,7] It was designed to improve health workers' awareness of the need to initiate neonatal resuscitation within the so-called "Golden Minute," to improve their clinical skills, and to increase adherence to neonatal resuscitation protocol.

Given the context of inadequate use of neonatal resuscitation and care at the time of birth at Paropakar Maternity and Women's Hospital, and with the availability of the HBB protocol for neonatal resuscitation, we developed and implemented a quality improvement cycle (QIC).[1] Our objective was to improve adherence to the HBB neonatal resuscitation protocol and reduce perinatal mortality by using a QIC in a tertiary hospital in Nepal.

METHODS

Ethical Consideration

This study was approved by the hospital's institutional review committee, Nepal Health Research Council, and Uppsala University, and was registered as a clinical trial.[8]

Study Design

All women delivering at ≥22 weeks of gestation in the hospital during the study period were included in the study. A prospective cohort study was conducted to evaluate the change in mortality and stillbirth rate before and after implementation of the HBB QIC. A case-control design was nested within this cohort to evaluate the odds of change in mortality before and after implementation of the HBB QIC. For the nested case-control design, all women with stillbirths and neonatal deaths were included as cases and 20% of women were randomly selected to be controls on admission. Any woman with a death or stillbirth in the control population was recategorized and included in the case population. The random selection of women for the control population was done by using a lottery technique at the time of admission. The lottery was done by using an opaque jar with 20 yellow balls and 80 white balls; for each woman admitted for delivery a ball was drawn, if a yellow ball was selected, the woman was selected as the control population. To evaluate the change in health worker performance of neonatal resuscitation by using video recording, all the infants of the control population were taken.

Setting

Paropakar Maternity and Women's Hospital is a tertiary hospital with 415 beds, providing obstetric and gynecologic services in Kathmandu, Nepal. In 2012, there were ~22 000 deliveries at the hospital, with a stillbirth rate of 19 per 1000 deliveries and an early neonatal mortality rate of 9 per 1000 live births.[9] Three units are assigned to provide delivery services: the Maternal and Newborn Service Center, the Labor Room, and the Operation Theater. The 3 units each have a different mix of human resources (Table 1).

This study comprised 2 phases. The first was a baseline period from July until December 2012 that also included the planning of the QIC for HBB. The second phase was the implementation of the HBB QIC from January until September 2013.

Planning of the QIC

In November 2012, the process of development of HBB QIC was initiated with a workshop with hospital leadership to review the current adherence to neonatal resuscitation and develop interventions to improve practice. A quality improvement team (QIT) was formed to develop a QIC to improve adherence to neonatal resuscitation with staff at each delivery unit. The QIT finalized the QIC as HBB QIC, which included HBB training, weekly review and reflection meetings, daily bag-and-mask skill checks, self-evaluations, peer review of the HBB protocol adherence, daily debrief, and refresher training. Please refer to Table 2 for detail of process of development of HBB QIC.

Implementation of HBB QIC

From the first week of January 2013, the HBB QIC implementation was initiated with a 2-day training on the HBB QIC. Directly after the training, bag-and-mask kits and

TABLE 1 Human Resources and Set-up of Each Delivery Unit

Delivery Units	Type of HW	Number of HW	No. of Delivery Beds	Type of Delivery Service	No. of Neonatal Resuscitation Tables
Maternal and Newborn Service Center room	Nurse midwives	11	8	Low-risk delivery	1
Labor room	Obstetricians, medical doctors, nurse midwives, medical and nurse students	11	9	Low- and high-risk delivery	3
Operating room	Anesthesiologist, obstetricians, medical doctors, nurse midwives	11	1	Cesarean delivery	1

A "nurse midwife" is a nurse with 3 months of supplementary training in skilled birth attendance. HW, health workers.

TABLE 2 Process for Development of HBB QIC and Detail of Activities, Facilitators, and Participants Involved in Each Component of HBB QIC

Component	Activity	Facilitators and Participants
Development of HBB QIC during the baseline period		
Review and reflection workshop on neonatal resuscitation	Review of the practices on neonatal resuscitation and intrapartum outcomes based on the data of 4-month baseline period. Causal analysis for inadequate adherence to neonatal resuscitation. Decision was made to form a QIT with the hospital director as leader to develop QIC to improve adherence to neonatal resuscitation protocol.	Facilitator: Study team Participants: Hospital director, head of pediatric department, nursing matron, nursing supervisors, and unit in-charges
QIT meeting to develop QIC	The QIT conducted meeting with staff at each delivery unit to discuss the causes for inadequate adherence to neonatal resuscitation and identify intervention to improve it. The meeting identified need for continuous skill enhancement, equipment support, and periodic review and reflection meetings.	Facilitator: Hospital director, head of pediatric department, nursing matron, nursing supervisors, and unit in-charges Participants: Staff of the delivery units
QIT's plan on QIC	QIT decided to set up goal to reduce intrapartum-related death by 50% through implementation of neonatal resuscitation protocol-HBB QIC. The QIC will include HBB training, weekly review and reflection meetings, daily bag-and-mask skill checks, self-evaluation, peer review of HBB protocol, and refresher HBB training. To monitor the progress on HBB QIC implementation, a progress board will be created for placement at each delivery unit. A daily brief will be done to QIT by unit in-charge on progress of HBB QIC implementation.	Facilitator: Hospital director, head of pediatric department, nursing matron, nursing supervisors, and unit in-charges Participants: Staff of the delivery units
Detail of each component of HBB QIC		
HBB QIC training	Two-day training. First day on HBB knowledge and skills as per standard package and second day on components of HBB QIC standards, training of trainers on how to conduct weekly review and reflection meeting, how to fill self-evaluation checklists, and conduct peer evaluations.	Facilitators: HBB trainers Participants: Staff of the delivery units
Setting up HBB QIC standards	At each unit, development of QIC goals and objectives, development of a place for daily bag-and-mask skill checks, QIC weekly review and reflection meetings, use of self-evaluation checklists, and peer reviews after each resuscitation.	Facilitators: Study team Participants: Staff of the delivery units
QIC weekly review and reflection meeting	At each unit, the unit in-charge facilitates the weekly review and reflection meetings on the progress of implementation of HBB QIC standards.	Facilitators: HBB trainers Participants: Staff of the delivery units
Daily bag-and-mask skill check	At each unit, each staff does a bag-and-mask skill check on mannequin before starting duty.	Facilitators: Unit in-charge Participants: Staff of the delivery units
Self-evaluation checklist after each delivery	A self-evaluation checklist, which consists of a list of steps for immediate newborn care and neonatal resuscitation as per HBB protocol with checkboxes. After completing care of each newborn, the nurse midwife will fill out the self-evaluation checklist based on the steps completed as per the HBB protocol.	Facilitators: Unit in-charge Participants: Staff of the delivery units
Peer review after each resuscitation	A mounted poster with the steps of the HBB protocol will be attached at each resuscitation table, so that peers can review with the colleague completing resuscitation on whether the steps were followed.	Facilitators: Unit in-charge Participants: Staff of the delivery units
Refresher training	A 1-day training to all the delivery unit staff on the HBB protocol after 6 months.	Facilitators: HBB trainers Participants: Staff of the delivery units
Progress board	A HBB QIC progress board, which monitors the progress on HBB QIC implementation placed in each unit. Daily records of the number of deliveries, nonbreathing infants, resuscitation cases (including resuscitation within 1 min), fresh stillbirths, neonatal deaths, and daily skill checks will be recorded.	Facilitators: Unit-in-charge Participants: Staff of the delivery units
Daily debrief to QIT	Every day, the hospital director as the lead of QIT, will be debriefed on the progress of the HBB QIC based on the presentation made by the unit in-charge on daily skill checks, use of self-evaluation HBB checklists, and conduction of weekly review and reflection meetings.	Facilitators: QIT Participants: Staff of the delivery units

penguin suction devices were provided to each delivery unit. Additionally, an HBB mannequin was placed at the entry of each delivery unit for daily skill checks; self-evaluation checklists were attached to each clinical record form; and HBB schematic posters were placed in front of each resuscitation table for peer review. Weekly review and reflection meetings were conducted to discuss progress on the implementation of HBB QIC standards. During the daily debriefing by the unit in-charge to the QIT, the progress on implementation of QIC standards was reviewed. HBB refresher training was conducted after 6 months with staff in all delivery units.

Measures

Outcome measures included perinatal mortality, stillbirth, antepartum stillbirth, intrapartum

TABLE 3 Definition of Primary Outcomes

Variable	Definition
Perinatal mortality	Deaths during the perinatal period (surrounding birth), including stillbirths of viable fetuses with gestational age beyond 22 wk or birth weight >500 g and neonatal deaths occurring within the first 7 d of life.
Stillbirth	Birth of a viable fetus with gestational age beyond 22 wk or birth weight >500 g, an Apgar score of 0 at 1 and 5 min.
Antepartum stillbirth	Birth of a viable fetus with gestational age beyond 22 wk or birth weight >500 g, an Apgar score of 0 at 1 and 5 min, signs of maceration, and no fetal heart sound at admission or at the onset of labor.
Intrapartum stillbirth	Birth of a viable fetus with gestational age beyond 22 wk or birth weight >500 g, an Apgar score of 0 at 1 and 5 min, with no signs of maceration and who had fetal heart sound at admission and at the onset of labor.
First-day neonatal mortality	Death of a live-born infant within 24 h of birth.

stillbirth, and first-day neonatal mortality (Table 3). The process outcomes related to clinical adherence included use of stimulation or suction and initiation of bag-and-mask ventilation within 60 seconds of birth.

For data collection, a surveillance system was established in the admission, delivery, and postnatal units. Twelve surveillance officers who were trained on tracking, data retrieval, and interviews were stationed in these units 24 hours a day. Data on obstetric history, intrapartum and postpartum clinical progress, and outcomes for the case and control populations were retrieved from clinical journals. Information on the infant's birth weight, gestational age, Apgar score at 1 and 5 minutes, and gender was collected. Interviews were conducted with mothers to obtain information on education, socioeconomic background, and antenatal care (ANC) attendance.

To evaluate clinical adherence, a motion-triggered video recorder was mounted on the radiant warmer above each resuscitation table. The recorder was positioned to provide a field of view that included the entire infant but only the hands of resuscitation team members. It was connected to a 24-hour clock to time-stamp images. Surveillance officers who were trained in reviewing the tapes evaluated the immediate care of infants who were brought to the table for resuscitation. The evaluation was based on a video-record form, which included time of delivery, time the infant was brought to the table, use of suction and/or stimulation and their duration, time when bag-and-mask ventilation began and duration of ventilation, additional resuscitation measures provided, and time of the newborn's first cry. To reduce interobserver variation, a blinded assessment of video recording was done for each of the control group infants by a second officer.[10]

All the record forms, interviews, and video-record forms were reevaluated by a research coordinator (RV) and rechecked for discrepancies by a data entry officer before data entry occurred. Ten percent of all forms were verified against the primary source of data. Census and Survey Processing System was used for data entry and a data management officer cleaned the data before transferring it into the Statistical Package for the Social Sciences (IBM SPSS Statistics, IBM Corporation, Chicago, IL) for statistical analysis. To ensure data privacy, each control and case population participant was recoded and indexed. Video records were backed up every week to prevent data loss. An independent data-monitoring committee, which was formed before the study started in June 2012, performed quarterly reviews of interim data for completeness, quality, and adherence to ethical requirements.

The background characteristics were categorized as follows. Maternal education was categorized as secondary education or higher versus primary school or lower. Wealth quintile was categorized as a measure of socioeconomic position, constructed as 1 to 5 with first being the poorest and fifth being the wealthiest.[11–13] A binary variable was then created to categorize women as poor (ie, those belonging to the poorest quintile) and nonpoor, and those belonging to any of the other 4 quintiles for regression analysis. Maternal age was categorized into 5-year interval categories; parity as primiparous, multiparous (1–2), or multiparous (≥3); ANC attendance, as having attended the recommended 4 (or more) visits compared with <4; gender as boys or girls; number of births as singleton or multiple; birth weight as <1500, 1500–2499, or ≥2500 g; and gestational age as ≤32, 33–36, or ≥37 weeks, based on last menstrual period.

Analysis

A power analysis based on the prestudy perinatal mortality and delivery rate at the hospital indicated that a reduction of 20% in perinatal mortality would be detectable within the set time frame (α 0.05, β 0.20).

Pearson's χ^2 test was used to compare stillbirth and mortality rates among the cohort population during the baseline and intervention periods. Background characteristics of the control population were compared between baseline and intervention groups by using Wilcoxon rank-sum tests and Pearson's χ^2 test. Statistical significance was decided at $P < .05$.

Multiple logistic regression analysis was used to determine if the implementation of the HBB QIC was associated with a change in outcome

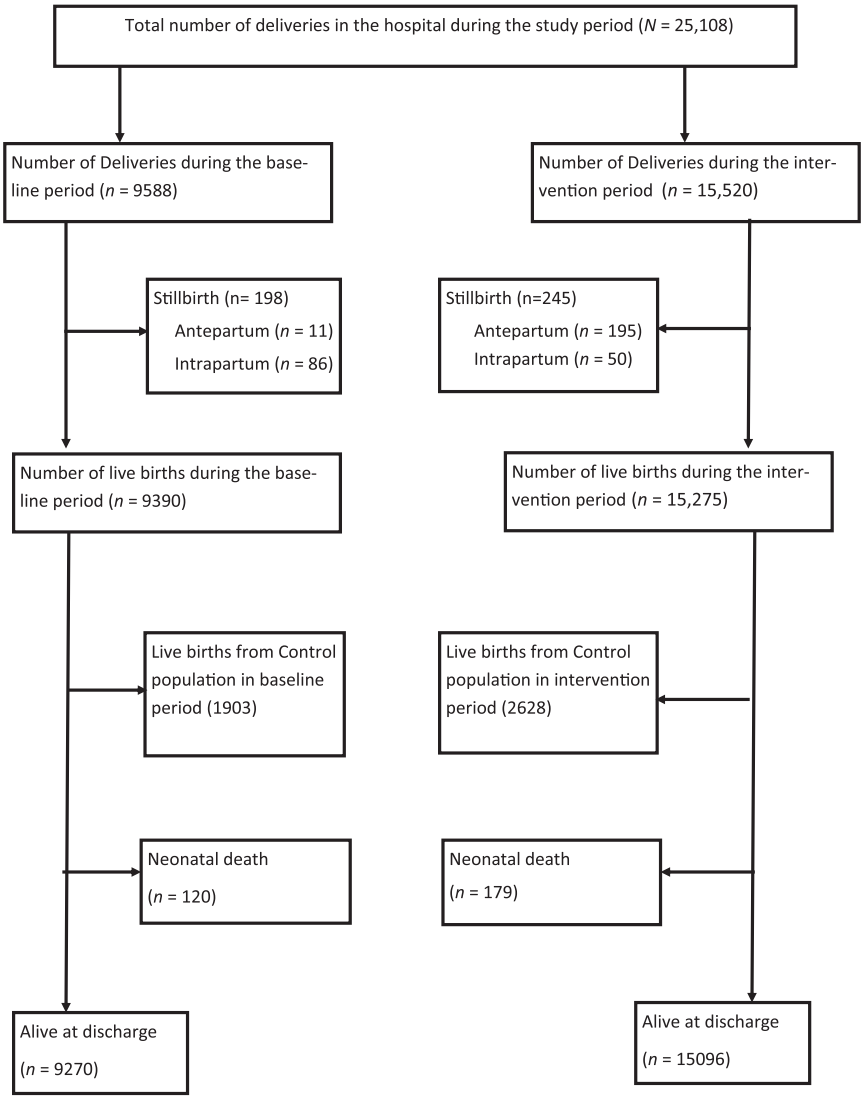

FIGURE 1
Flowchart showing the baseline and intervention populations.

measures of cases, compared with the control population. To create the multiple logistic regression models, adjustments were made for the background characteristics that were significantly different between the baseline and intervention control populations. Univariate logistic regression analysis was conducted within the control population to identify any change in health workers' practice of neonatal resuscitation after implementation of HBB QIC.

We used run charts to assess outcome measures on intrapartum stillbirth rate, first-day neonatal mortality, and bag-and-mask ventilation within 1 minute on a monthly basis over the time with the median line. The run charts were annotated with the activities conducted during different times. For missing data, a multiple imputation method was used.[14]

RESULTS

The run charts showed the decline in the intrapartum stillbirth and first-day neonatal mortality rates (Fig 1) and the increase in the bag-and-mask ventilation within 1 minute (Fig 2), in relation to the introduction of different HBB QIC activities. In the first 3 months of the intervention period, there was a sharp decline in mortality when the HBB QIC training and HBB QIC were conducted. This change was sustained until 6 months, when the HBB QIC was continued. There was a slight decline in mortality and a slight increase in bag-and-mask ventilation within 1 minute when the refresher HBB training was conducted in the seventh month, and when other HBB QIC components were continued.

A total of 9588 and 15 520 deliveries took place at the hospital in the baseline and intervention periods, respectively (Fig 3). During this study, perinatal mortality was lower in the intervention than in the baseline period (23.3 vs 30.9/1000 deliveries). A total of 443 stillbirths occurred throughout both periods, of which 307 were antepartum stillbirths and 136 were intrapartum stillbirths. The intrapartum stillbirth rate was lower in the intervention period compared with baseline (3.2 vs 9.0/1000 deliveries). The first-day mortality rate decreased from 5.2 to 1.9 per 1000 live births from the baseline to the intervention period. During the study period, 299 neonatal deaths occurred, with 209 dying in the first 7 days of life and 78 in the first 24 hours (Table 4).

During the baseline and intervention periods, 488 and 588 infants were resuscitated, respectively, in the control population. The odds of performing stimulation or suction decreased by 62% (odds ratio [OR] 0.38, 95% confidence interval [CI] 0.29–0.49) and 87% (OR 0.13, 95% CI 0.09–0.17), respectively, after HBB QIC implementation. The odds for bag-and-mask ventilation increased >2 times (OR 2.56, 95% CI 1.67–3.93) (Table 5). In the control population, during the baseline period, none of the nonbreathing infants (0/31) received bag-and-mask ventilation within 1 minute. In the control population, during the intervention period, 83.9% (73/87) of the infants received ventilation within 1 minute.

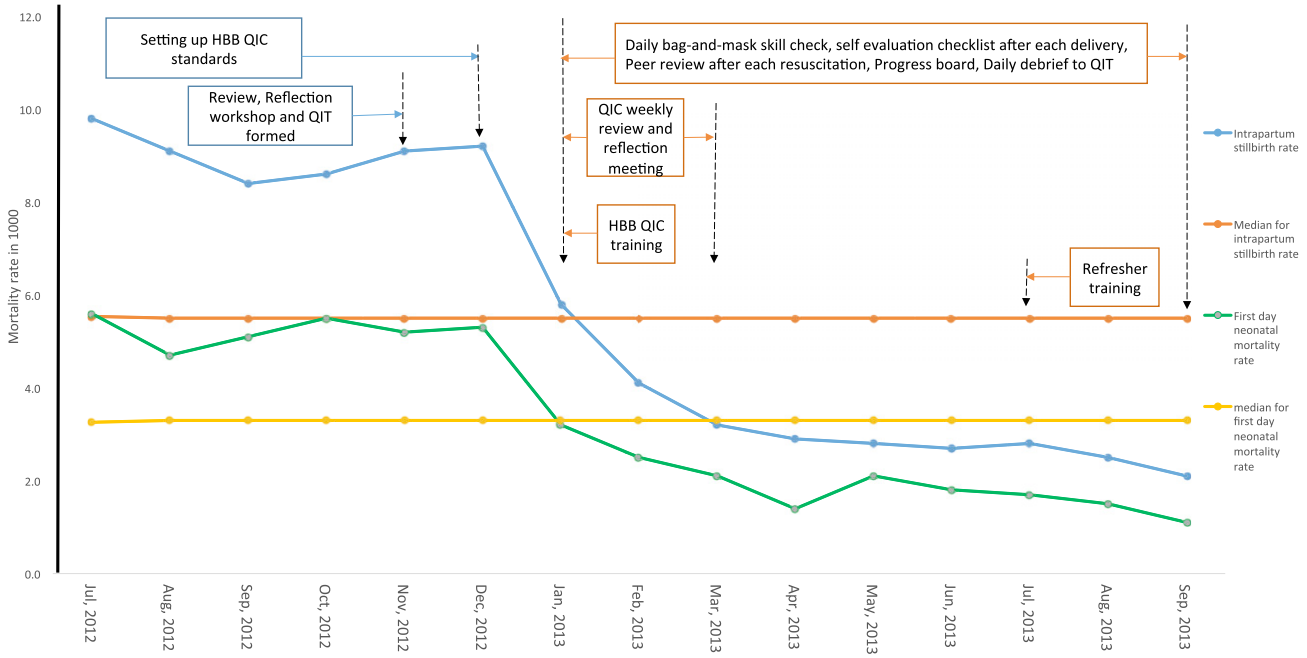

FIGURE 2
The run chart. The intrapartum stillbirth rate, first-day neonatal mortality rate on a monthly basis over time with median line. The run chart is annotated with the activities conducted during different times.

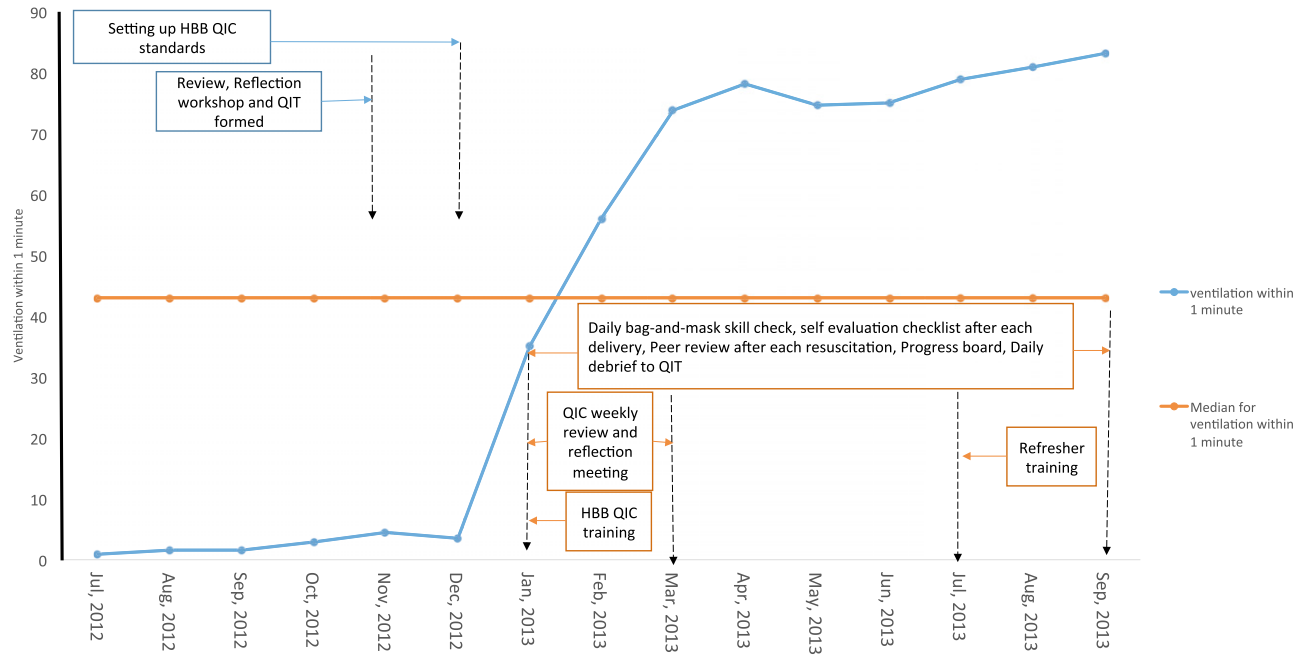

FIGURE 3
The run chart. The percentage of bag-and-mask ventilation within 1 minute on a monthly basis over time with median line. The run chart is annotated with the activities conducted during different times.

During the entire study period, 4891 women were selected to be part of the control group. Of them, 360 women were discharged without delivery and therefore the control population included 4531 deliveries. Comparison of the background characteristics for the 1903 and 2628 women in the baseline and intervention control population groups showed no differences in maternal education, wealth status, ethnicity, maternal age, parity, gender of newborn, number of newborns, or birth weight. The baseline and intervention

TABLE 4 Birth Outcomes in Baseline and Intervention Populations Among the Cohort Population

	Baseline, 6 mo			Intervention, 9 mo			*P*[a]
	n	Rate per 1000 Deliveries	95% CI	*n*	Rate per 1000 Deliveries	95% CI	
Total deliveries	9588			15 520			
Perinatal mortality	290	30.9	27.5–34.6	362	23.3	21.0–25.8	<.001
Total stillbirths	198	20.7	17.9–23.7	245	15.8	13.9–17.9	.01
Antepartum stillbirths	112	11.7	9.6–14.0	195	12.7	10.9–14.4	NS
Intrapartum stillbirths	86	9.0	7.0–10.8	50	3.2	2.4–4.2	<.001
	n	Rate per 1000 Live Births	95% CI	*n*	Rate per 1000 Live Births	95% CI	
Live births	9390			15 275			
First-day neonatal mortality rate	49	5.2	3.9–6.9	29	1.9	1.3–2.7	<.001

NS, not significant.

[a] *P* value determined by Pearson's χ^2 test.

control populations were different in attendance of ANC visits and gestational age of the infant (Table 6).

Multiple regression analysis was conducted to assess the change in outcome measures before and after implementation of the HBB QIC. The analysis showed that the risk for intrapartum stillbirth decreased by 54% (adjusted OR 0.46, 95% CI 0.32–0.66), and for first-day neonatal mortality by 49% (adjusted OR 0.51, 95% CI 0.31–0.83), after adjusting for ANC attendance and gestational age. There was no change in overall stillbirth or neonatal mortality after adjusting for potential confounders (Table 7).

TABLE 5 Use of Stimulation, Suction, and Bag-and-Mask Before and After HBB QIC Among the Control Population That Received Resuscitation Observed by Using Video (Charge-Coupled Device) Recording

	Baseline,[a] *n* = 488, *n* (%)	Intervention,[b] *n* = 588, *n* (%)	Adjusted OR[c]	95% CI	
				Lower	Upper
Stimulation					
No	255 (52.3)	437 (74.3)	Ref		
Yes	233 (47.7)	151 (25.7)	0.38	0.29	0.49
Suctioning					
No	66 (13.5)	324 (55.1)	Ref		
Yes	422 (86.5)	264 (44.9)	0.13	0.09	0.17
Bag-and-mask use					
No	457 (93.6)	501 (85.2)	Ref		
Yes	31 (6.4)	87 (14.8)	2.56	1.67	3.93

[a] The control infants in the baseline period who received resuscitation.

[b] The control infants in the intervention period who received resuscitation.

[c] Univariate analyses for likelihood of clinical adherence-related outcome (ie, stimulation, suction, bag-and-mask ventilation within 60 s).

DISCUSSION

We demonstrated that the implementation of an HBB QIC was associated with an improvement in the adherence of health workers' practice to neonatal resuscitation protocols, with reduction in intrapartum stillbirth and first-day neonatal mortality. The current study further demonstrated the association between implementation of an HBB QIC and a decline in the overuse of suctioning and stimulation in breathing infants, as well as in those nonbreathing infants, for which the health worker moved more quickly to initiate bag-and-mask ventilation. This is the first study that provided, through the use of video recordings, clear evidence on the improvement of health workers' performance after intervention. Bag-and-mask ventilation within the Golden Minute increased by 84% from before to after implementation. Most importantly, we demonstrated that a quality improvement approach to enhance neonatal resuscitation practices in a tertiary hospital is feasible and can result in substantial improvement in clinical outcomes. The overall neonatal mortality rate did not appear to have been impacted by the intervention, suggesting more effective intervention to be implemented beyond the immediate newborn period to change the overall outcome.

A previous study looking at the impact of the implementation of an HBB program in health facilities in Tanzania found a significant reduction in the rate of intrapartum stillbirth (relative risk 0.76, 95% CI 0.64–0.90).[15] Similarly, another study from India found that implementation of HBB training was associated with a significant reduction in intrapartum stillbirth (OR 0.54, 95% CI 0.37–0.78).[16] The reduction of intrapartum stillbirths in both of these studies was less pronounced, however. This is potentially due to the QIC component in our study, as the HBB protocol was continuously reinforced throughout the intervention period. Furthermore, the combination of a reduction in unnecessary practices with the timely initiation of indicated assisted ventilation suggests retention and fidelity of resuscitation techniques at a higher level than previously reported.[16]

Our study has some limitations. First, as a prospective cohort study with a nested case-control design, we can make inferences on the association between the intervention and the desired effects; however, causation cannot be established. Second, a package of interventions made up the QIC, and thus we could not unbundle the package to demonstrate the association of individual components with the outcome. Third, there might have been measurement bias based on the inaccurate identification and/or documentation of an infant as stillborn rather than live-born with neonatal death, thus leading to differential misclassification of individual outcomes and exposures. Multivariate logistic regression analysis was used to control the potentially confounding background characteristics that were significantly different between baseline and intervention control populations. Additionally, because the surveillance officers were aware of the study hypothesis, there might have been selective gathering of interview data, either consciously or subconsciously.

There are several potential reasons that we were able to improve adherence to neonatal resuscitation by using the HBB QIC approach. First, the hospital leadership recognized the inadequate adherence to standard protocols within the hospital, and thus identified a need for change. Furthermore, the multidisciplinary QIT, which included hospital staff members, was responsible for developing the quality improvement plan and conducting daily debriefings of the HBB QIC implementation progress. There are several previous studies that have shown that leadership plays a crucial role in the quality improvement process.[17,18]

Second, the unit-based review and reflection on the root causes

TABLE 6 Background Characteristics of the Control Population (n = 4531) During the Baseline and Intervention Periods

Variable	Baseline, n = 1903		Intervention, n = 2628		P[a]
	n	%	n	%	
Maternal education[b]					
≥6 y of schooling	1017	65.4	1750	67.4	
Primary school (5 y) or less	539	34.6	846	32.6	.18
Wealth status					
Nonpoor	1504	79.0	2121	80.7	
Poor	399	21.0	507	19.3	.16
Maternal age groups, y					
<20	506	26.6	732	27.9	
20–25	856	45.0	1115	42.4	
26–30	405	21.3	581	22.1	
>30	136	7.1	200	7.6	.40
Parity					
Primipara	1016	53.4	1428	54.3	
Mulitpara, 1–2	806	42.4	1081	41.1	
Multipara, ≥3	81	4.3	119	4.5	.68
ANC attendance					
≥4 ANC visits	570	30.0	889	33.8	
<4 ANC visits	1333	70.0	1739	66.2	.01
Gender of newborn					
Girl	884	46.5	1232	46.9	
Boy	1019	53.5	1396	53.1	.78
No. of newborns					
Singleton	1898	99.7	2626	99.9	
Multiple births	5	0.3	2	0.1	.24
Birth weight					
Very low birth weight, <1500 g	36	1.9	41	1.6	
Low birth weight, 1500–2499 g	223	11.7	264	10.0	
Normal birth weight, ≥2500 g	1644	86.4	2323	88.4	.13
Gestational age, wk					
<33	55	2.9	46	1.8	
33–36	130	6.8	302	6.7	
≥37	1718	90.3	2280	91.1	.03

[a] P values determined by using Wilcoxon rank-sum tests and Pearson's χ^2 test.
[b] The maternal education variable is missing 379 values, 347 in the baseline period and 32 in the intervention period.

TABLE 7 Risk of Mortality Outcomes Before and After HBB Intervention in the Case-Control Population

	Adjusted OR[a]	95% CI	
		Lower	Upper
Perinatal mortality			
No	Ref		
Yes	1.03	0.84	1.25
Stillbirths			
No	Ref		
Yes	1.04	0.84	1.30
Intrapartum stillbirths			
No	Ref		
Yes	0.46	0.32	0.66
First-day mortality			
No	Ref		
Yes	0.51	0.31	0.83
Intrapartum-related deaths			
No	Ref		
Yes	0.47	0.35	0.63

[a] Multivariate regression analyses for likelihood of mortality-related outcome (ie, perinatal mortality, stillbirth, first-day mortality, intrapartum-related death), adjusted for full ANC attendance (at least 4 visits or less) and gestational age (more or less than 37 wk).

of poor performance of neonatal resuscitation and development of the quality improvement goals, objectives, and standards, allowed individual health workers to discuss their experiences and to be involved in the creation of the QIC. This process can create an environment that is conducive for implementing a quality improvement plan and for building teamwork.[19–21] Third, the introduction of self-evaluation checklists, in general, can improve compliance with best clinical practice.[22] And finally, the HBB QIC progress boards placed in each unit provided a constant reminder to the staff of the quality improvement effort. Displaying data on implementation progress at each nursing station, in each delivery unit, allowed for constant review of and identification of potential problems in the implementation of the QIC, which has also been demonstrated in other quality improvement studies.[20,22]

A cost-effectiveness evaluation of an HBB program in a hospital of Tanzania revealed that HBB is a low-cost intervention.[23] The HBB QIC as implemented in our study is also an affordable intervention.

CONCLUSIONS

This study in Nepal has demonstrated a significant reduction in intrapartum stillbirth and first-day neonatal mortality, as well as an increased adherence to the HBB protocol among health workers at a tertiary hospital. A new approach for improving clinical performance for neonatal resuscitation by using an HBB QIC has been identified and can be readily implemented in similar hospital settings. Further studies evaluating whether the HBB QIC can improve the performance of health workers in district hospitals and peripheral health facilities are needed.

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ABBREVIATIONS

ANC: antenatal care
CI: confidence interval
HBB: Helping Babies Breathe
OR: odds ratio
QIC: quality improvement cycle
QIT: quality improvement team

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