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REGULAR ARTICLE

Using quality improvement to decrease birth asphyxia rates after 'Helping Babies Breathe' training in Kenya

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ABSTRACT

Aim: The Helping Babies Breathe (HBB) programme is known to decrease neonatal mortality in low-resource settings but gaps in care still exist. This study describes the use of quality improvement to sustain gains in birth asphyxia-related mortality after HBB.

Methods: Tenwek Hospital, a rural referral hospital in Kenya, identified high rates of birth asphyxia (BA). They developed a goal to decrease the suspected hypoxic-ischaemic encephalopathy (SHIE) rate by 50% within six months after HBB. Rapid cycles of change were used to test interventions including training, retention and engagement for staff/trainees and improved data collection. Run charts followed the rate over time, and chi-square analysis was used.

Results: Ninety-six providers received HBB from September to November 2014. Over 4000 delivery records were reviewed. Ten months of baseline data showed a median SHIE rate of 14.7/1000 live births (LB) with wide variability. Ten months post-HBB, the SHIE rate decreased by 53% to 7.1/1000 LB ($p = 0.01$). SHIE rates increased after initial decline; investigation determined that half the trained midwives had been transferred. Presenting data to administration resulted in staff retention. Rates have after remained above goal with narrowing control limits.

Conclusion: Focused quality improvement can sustain and advance gains in neonatal outcomes post-HBB training.

INTRODUCTION

Over 660,000 neonatal deaths are from intrapartum-related events (previously termed "birth asphyxia") and now account for a greater number of under-5 deaths than malaria or HIV (1–3). The survivors often have significant morbidity and account for 42 million disability-adjusted life-years (DALYs) globally (2,3). In Kenya, intrapartum-related deaths are the third leading cause of childhood death (4–6). Neonatal resuscitation is a known method to prevent significant birth asphyxia morbidity and mortality. When capacity in neonatal resuscitation is lacking, there is a missed opportunity to save neonatal lives (7–9). However, a recent survey showed that 85% of Sub-Saharan Africa facilities lacked supplies or skilled personnel to perform neonatal resuscitation (10). In a Kenyan study, only 30% of front line neonatal providers could pass a neonatal resuscitation assessment: 70% of providers cited a lack of initial/refresher training in neonatal resuscitation as a key reason for lacking confidence in skills (11).

Increasing numbers of Kenyan mothers give birth in facilities, yet multiple studies suggest there is a paradoxical increase in neonatal morbidity/mortality in the inpatient

Abbreviations
BA, Birth asphyxia; DALYS, Disability-adjusted life-years; HBB, Helping Babies Breathe; NHIE, Near miss hypoxic ischemic encephalopathy; NRP, Neonatal resuscitation program; QI, Quality improvement; SHIE, Suspected hypoxic ischemic encephalopathy.

Key notes
- Helping Babies Breathe (HBB) is a neonatal resuscitation programme shown to decrease mortality but challenged in sustaining gains.
- This study describes a rural Kenyan hospital health professional team's use of quality improvement techniques to decrease HIE rates after HBB.
- In combination with HBB training, improvement of staff communication, ongoing refresher training, retention of skilled staff, and other interventions, the HIE rate decreased by over 50% over 10 months.

setting due to varying levels of quality care (5,6). Globally, facility deliveries are not associated with a subsequent reduction in perinatal mortality due to key quality gaps, including inadequate staffing, widespread use of inexperienced trainees as front line workers and overcrowded facilities (12–18).

Helping Babies Breathe (HBB) is an evidence-based curriculum for neonatal resuscitation designed to train health professionals in low-resource settings. The HBB Action Plan is centred on basic care for all babies (warmth, drying, stimulation and suctioning) and ventilation within the important 'Golden Minute' of life (19–25). Studies evaluating HBB have shown decreases in neonatal mortality and stillbirth rates (20–26). However, HBB training alone cannot completely mitigate the gaps in care related to neonatal mortality. Supervised practices for skill retention, while successful at maintaining or further reducing neonatal mortality rates, can be challenging in resource-limited settings (23–28). Frameworks have been developed to guide quality improvement (QI) of perinatal outcomes in low-resource settings, and many of the key quality indicators discussed are steps of the HBB Action Plan (19–21,25–28), thus making HBB training a way to introduce QI methodology in the context of facility-based settings that need to improve maternal and newborn care (19,25–28).

Our goal with this report is to describe a study utilising quality improvement at a rural Kenyan referral hospital. The hospital's Neonatal Task Force identified high birth asphyxia (BA) rates as a quality gap. Starting with HBB implementation, they sought to reduce the hospital's BA rates by 50% over a six-month time period. We describe the methods and challenges, as our experience may be applicable to other facilities in low-resource settings for their own QI efforts.

METHODS

Context

Tenwek Hospital in Bomet, Kenya is a rural teaching hospital that serves as the high-risk obstetric and neonatal referral centre for southwest Kenya with close to 3000 deliveries annually with a 25% Caesarean section rate. The infant mortality rate for Bomet County is 54/1000 live births, higher than the overall rate for Kenya, at 48/1000 live births. Prior to the study, the facility rates of infant mortality, birth asphyxia case fatality and stillbirths were unknown (29).

The hospital has a special care nursery to provide neonatal care, including continuous positive airway pressure, oxygen and antibiotics. There is an annual admission rate of approximately 1500 per year, including outborn admissions/referrals (29). Babies that require more than brief bag-mask ventilation (BMV) are admitted for observation to the nursery due to risk of birth asphyxia complications (28). Treatment includes fluid restriction and modified cooling protocol, respiratory support (brief mechanical ventilation, bubble continuous positive airway pressure and oxygen are available), while babies are watched for findings consistent with hypoxic-ischaemic encephalopathy.

A single nurse-midwife with one-two nursing student assistants typically attended deliveries and resuscitations. Besides nurse-midwife students from the nursing school, there were also clinical and medical interns, who were officers-in-training. The paediatric team, consisting of a medical or clinical intern supervised by a paediatric consultant, was called for high-risk deliveries only. The nurse-midwives, and the obstetrician, when available, classified high-risk deliveries, which, by policy, included newborns <37 weeks, nonreassuring foetal heart tones and the presence of meconium-stained amniotic fluid. The timing of the call to paediatrics varied widely, and often paediatrics arrived after the delivery. The midwife and/or paediatric intern documented resuscitations in the maternity discharge ledger and in the neonatal chart only if the baby survived to nursery admission from delivery room. Six months prior to the QI project, the hospital transitioned to an electronic medical record further aiding in the potential to track outcomes.

In January 2014, after a series of neonatal deaths, the Tenwek Neonatal Task Force was formed to improve local perinatal outcomes and data collection of perinatal statistics. The Task Force included the two nurse-midwives in charge of obstetrics and newborn nursery, the nurse-midwife clinical instructor for the nursing school, the obstetrician and paediatrician.

Identification of Problems, Planning of Interventions and Measures

The Task Force recognised a need for neonatal resuscitation training: in the previous five years, adoption of the American Academy of Pediatrics Neonatal Resuscitation Program (NRP) had been attempted twice. However, these initiatives were not sustained primarily due to a lack of trained local providers, simulators and planning for ongoing recertification. In addition, some of the content of NRP did not reflect the resources available at the hospital, making sustainability a challenge. Therefore, the Task Force wanted to build a sustainable neonatal resuscitation programme, and chose HBB for its affordability, emphasis on preparation, basic resuscitation practices to which the majority of newborns respond, and the use of a low- tech, high-fidelity simulator for ongoing practice and retention of skills. While previous initiatives of neonatal resuscitation training focused on nurse-midwives and physicians only, all staff who took care of mothers and babies were required by maternity/nursery ward and education leadership to take the HBB course.

The Task Force invited a visiting HBB Master Trainer from North America to join the team and train its members in HBB and QI methodology. The Master Trainer was on staff for one year (July 2014-June 2015), served as a paediatrician–educator and had QI training allowing her to serve as a QI champion. Prior to the initial HBB training for all maternal/newborn staff, from July to September 2014, baseline delivery room practices were observed, staff

members were interviewed, and Task Force members were trained as HBB Master Trainers to help the team adapt the curriculum to local practices.

From baseline observations and HBB trainings, Task Force members identified gaps in care compared to what was recommended by the HBB course. From mid-September to November 2014, thirteen six–eight hour workshops were held to train 96 staff members in the HBB intervention. The Task Force created a process map reviewing labour and delivery, intrapartum, postpartum and neonatal care processes at Tenwek that affected the global aim of improving both long-term neonatal and maternal outcomes (Fig. 1). They overwhelming agreed that they wanted to study and reduce mortality and morbidity from BA. A midwife commented: 'It is what kills our children. . .,' while an outpatient paediatric provider commented: '. . .in clinic there are too many babies who survive BA that then don't grow and develop'. The Task Force recognised significant quality gaps related to antepartum care before maternal admission and during the labour and delivery process that, if improved, would also impact mortality and morbidity from BA. However, those processes included external factors that would be more difficult to change, and as they wanted to start with small successes and build from there, they chose to focus on the postnatal drivers related to resuscitation and nursery care. They created an AIM statement to decrease the BA rate by 50%; from an observed baseline of 15.2/1000 live births to 7.6/1000 live births, over six months after the initial HBB trainings and formulated a key driver diagram (Fig. 2).

Given a lack of diagnostics like blood gases, electroencephalography or neuroimaging to diagnose birth asphyxia, clinical criteria were used to define the condition and combined with the Sarnat score, a clinical grading system used to grade the severity of hypoxic-ischaemic encephalopathy (HIE).[30] We recognised that birth asphyxia can occur in the antepartum, intrapartum or postpartum period, but we were only able to define birth asphyxia based on postnatal findings of HIE. Suspected hypoxic-ischaemic encephalopathy (SHIE) cases were evaluated by one of two paediatric providers. SHIE cases were defined by the presence of seizures in the setting of a normal glucose and laboratory, the absence of findings of central nervous system infection, and/or at least a Grade II (moderate) Sarnat score (30). Babies were classified as 'near miss HIE' (NHIE) if they required bag-mask ventilation but did not develop seizures and had a Grade 1 (mild) Sarnat score or normal examination for 36–48 hours after birth. The population evaluated included term neonates delivered and resuscitated at Tenwek who were admitted to the nursery for observation. Newborns referred to Tenwek postnatally, for example, after a home birth, were excluded. The team also attempted to study delivery room deaths and stillbirths but numerous challenges arose in defining and differentiating between the two due to intermittent foetal heart rate monitoring, and referrals from home or even more resource-limited facilities.

As no consistent documentation for babies with BA existed at baseline, the Task Force determined possible cases of BA from retrospective review of the nursery discharge ledger and billing data from January to November 2014. The Task Force and nursery staff reviewed the chart of each possible case to confirm the definition of SHIE was met.

Three and six months following the initial course, all staff participated in planned supervised simulation practice with the HBB Master Trainer as part of both the QI project and ongoing desire of building a sustainable education programme. In addition, the staff were encouraged to

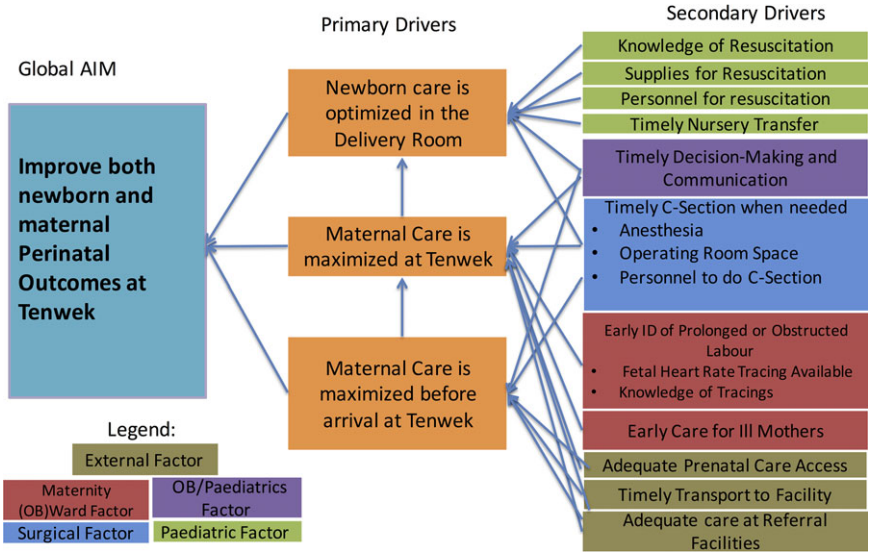

Figure 1 Flow chart diagram of perinatal care at Tenwek Hospital. The circle indicates the processes chosen by the team for focused improvement team activities.

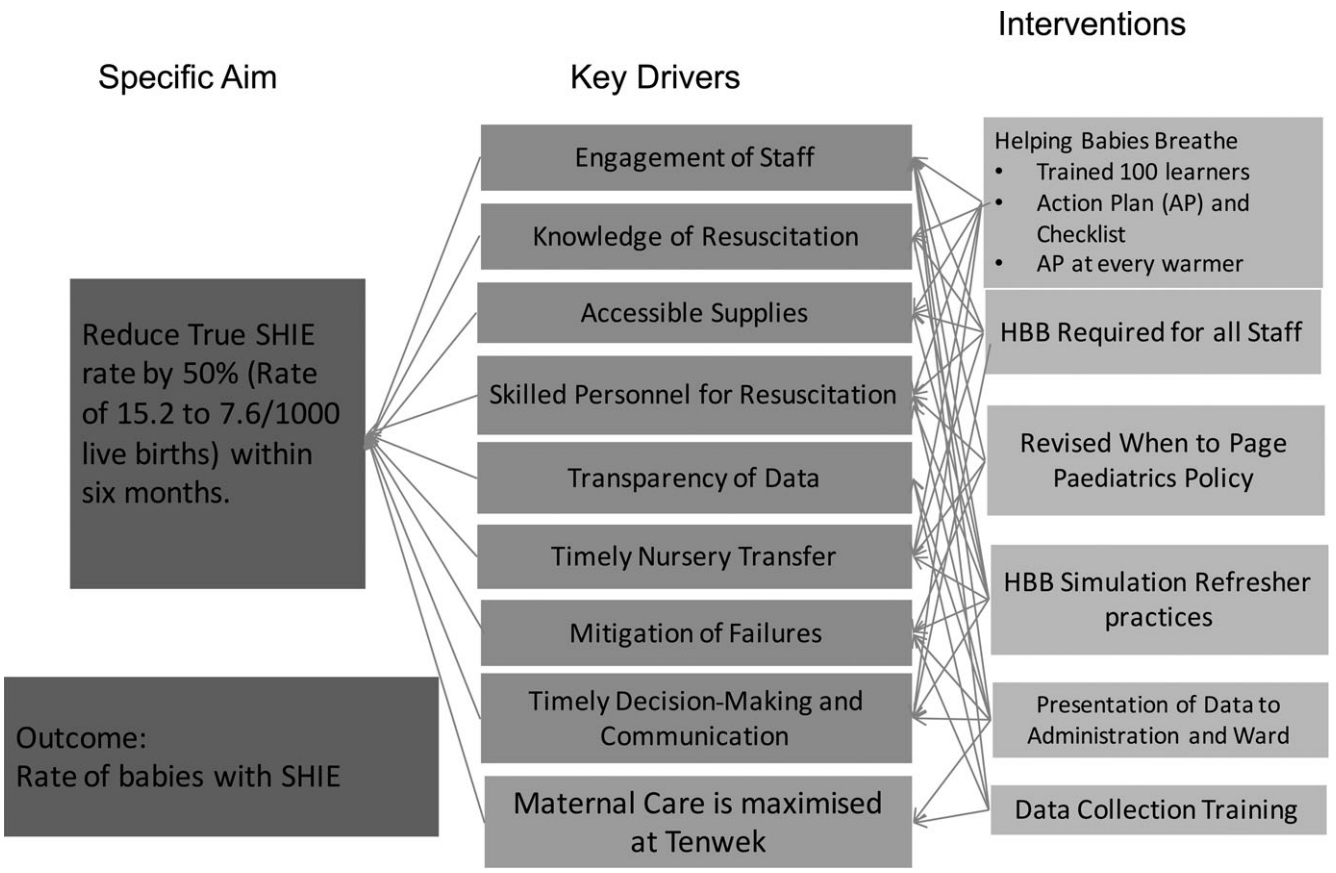

Figure 2 Project-specific drivers and specific aim.

participate in peer-directed Just-in-Time practice in newly established simulation 'corners', where a mannequin and resuscitation equipment were easily accessible for the purpose of impromptu practices. A separate concurrent investigation studied whether supervised practices with the Master Trainer plus Just-in-Time practices were helpful to maintain resuscitation skills. As part of the planned HBB intervention, checklists were hung at the practice corners and in delivery room to reinforce resuscitation skills and re-processing of resuscitation equipment.

Data analysis

A run chart plotted the number of SHIE cases per 1000 live births by month. Rapid cycles of change were used to test proposed interventions for improvement, and then to track over time if these changes showed sustained improvement. We used the method of statistical process control to evaluate whether statistically significant improvement had occurred: eight consecutive points below the baseline mean would demonstrate that a significant decrease in SHIE had been achieved. Rates of SHIE, near misses and SHIE-related deaths were also compared in the pre- and post-HBB time periods, January–November 2014 and December 2014–September 2015, respectively, using a chi-square statistic, with $p < 0.05$ considered significant.

RESULTS

Interventions

Data were collected from January 2014 to September 2015; baseline data collection took place from January 2014 to September 2014, when HBB trainings started. In the 21 months studied, there were 4128 deliveries, including 41 cases of SHIE and 35 near misses. On the statistical process control chart, all points after HBB implementation (thus greater than eight) were under the baseline mean of 15.2 per 1000 LB indicating a significant change in the system, and thus, the decision was made to move the mean line after November 2014 (Fig. 3). The SHIE rate decreased by 53% during this post-HBB period. Furthermore, chi-square analysis comparing the rate of SHIE cases pre- and post-HBB training showed a decrease from 16.9 to 7.0 per 1000 LB between the two periods ($p = 0.01$). In contrast the number of NHIE cases increased from 4.7 to 9.5 per 1000 LB ($p = 0.07$). Comparing the combined cases of BA and near misses (21.4 to 16.4 per 1000 LB) between time periods did not show a significant difference ($p = 0.2$; Table 1).

BA rates during the baseline data collection period (July–September 2014) demonstrated a decline. An increasing trend was observed during the HBB training period (September–November 2014; Fig. 3). After

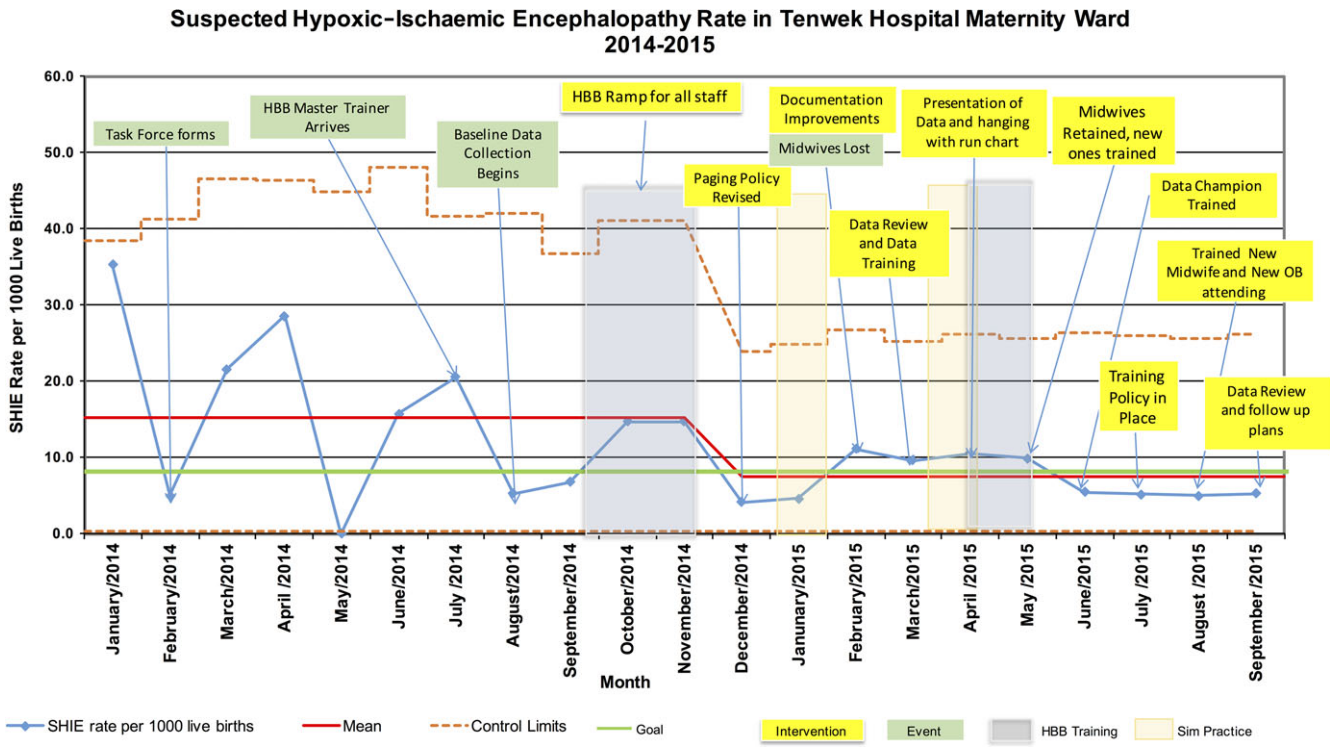

Figure 3 Control run chart showing the quality improvement interventions' impact on the suspected hypoxic ischemic encephalopathy (SHIE) rate at Tenwek Hospital from 2014 to 2015. The dashed lines on either side are control limits, and the middle red line is the mean, these are set from baseline data initially. Eight consecutive points of above or below the mean is considered a statistically significant change in the system. After 10 months of retrospective and prospective baseline data collection, HBB was implemented for all staff. In the 10 months following HBB, SHIE rates were consistently under the baseline mean. Thus after eight consecutive months (December–July) under the baseline mean of 15.2 there was significant change in the system thus the mean was shifted to a new baseline mean of 7.4. Boxes indicate interventions and events and shading indicates training or simulation practice periods.

Table 1 Suspected HIE and Near Miss HIE case summary table

Population	Before HBB	After HBB	p-values
Total deliveries	2106	2011	–
SHIE cases per 1000 LB	16.7 (N = 32)	7.0 (N = 14)	p = 0.01
Near miss HIE cases per 1000 LB	4.7 (N = 10)	9.5 (N = 19)	p = 0.07
SHIE+ near miss HIE per 1000 LB	21.4 (N = 45)	16.4 (N = 33)	p = 0.2
Deaths attributed to SHIE per 1000 LB	4.3 (N = 9)	2.0 (N = 4)	p = 0.2

reviewing baseline and training period data, policy changes were made in timing of pages for high-risk deliveries. The revised policy stated that paediatric attendance would be for all deliveries where midwives had any concerns, that only nurse-midwives (not their students) could call, and the call would be made immediately when a problem was identified. To further decrease lag time between resuscitation and nursery admission, paediatrics or nurse-midwives would alert the special care nurses about the high-risk delivery. In January and early February 2015, multiple interventions were made to improve data collection including meeting with staff to discuss the importance of completing resuscitation documentation for the electronic medical record and coordination of care with the nursery staff. The Master Trainer introduced a data collection sheet as an example of pertinent data to include in charting.

The SHIE rate decreased to 4.5 per 1000 LB initially after HBB but rose again from February to April 2015 to a high of 11 per 1000 LB (Fig. 3). The Task Force noted that half the HBB-trained nurse-midwives were transferred to other departments and replaced by staff without HBB training. Using real-time data analysis with the run chart on the ward and case review the team realised the majority SHIE cases in this period were with new midwives without HBB. This trend and the run charts were shared with hospital administration, and policy was changed to retain HBB-trained staff in the Labor/Delivery setting by protecting them from transfer, and to train new nurse-midwives and neonatal nurses during orientation.

When the visiting HBB Master Trainer left, there was a staff celebration and presentation of results. All staff were given the opportunity to sign a poster adjacent to the run chart signifying their role in sustained improvement and ongoing commitment to improving perinatal outcomes. The

Task Force also appointed a data collection champion to take over the Master Trainer's role. The champion and Task Force members were trained in ongoing data review. To assure no cases were missed, the data champion checked for missed SHIE cases among discharge billing data using standardised diagnoses used by the centre (neonatal encephalopathy, birth asphyxia and HIE) to further improve data collection. Since the retention of midwives in April 2015, the run chart demonstrated five months of a downward trend in BA rates, with last four months having a SHIE rate below goal (Fig. 3).

The Task Force did not specifically target neonatal deaths and stillbirths in the delivery room. Delivery room deaths attributed to SHIE did decrease from 4.27 to 1.98 per 1000 LB; however, the decrease was not statistically significant. ($p = 0.30$; Table 1). Among the SHIE and NHIE cases, there was a myriad of maternal and neonatal complications, including abruption, uterine rupture, cord prolapse, maternal eclampsia,. However, individual complications were relatively rare events that happened at similar rates before and after initial interventions.

DISCUSSION

Suspected hypoxic-ischaemic encephalopathy rates were successfully reduced by 53% in a rural Kenyan hospital after implementing HBB trainings, a system for ongoing practice for skill maintenance, and goal-directed QI efforts by a team. The control chart showed wide variability in SHIE rates at baseline likely indicating a variable or inconsistent clinical practice. However, after initial HBB training, a statistically significant decrease in SHIE rate occurred and was sustained over the course of the study. In addition, control limits narrowed, suggesting more stability and consistency in clinical practice. Furthermore, there was an increasing trend in near miss HIE cases. Considering no antepartum changes were being made to the system, this may represent more babies who were successfully assessed and resuscitated, leading to decreased severity of outcome and better classification of babies as 'fresh stillborn'. Finally, it may simply be further attention was paid to babies in the delivery room by providers due to awareness of the project itself. Similarly, the early decrease in SHIE rate that predated full HBB training may potentially be a Hawthorne Effect from increased attention by providers.

Important changes that drove these results were likely a system for ongoing practice for neonatal resuscitation, improved standardised data collection, a checklist for equipment and preparation for resuscitation and increased skilled staffing at resuscitation. The project improved capacity for data collection and QI methods at the site. Furthermore, after gaining these skills, the Task Force has continued efforts to improve perinatal outcomes even after the Master Trainer left.

This project demonstrates that education coupled with QI approaches can be used by a low-resource setting to achieve improved perinatal outcomes (22–28). Multiple studies in sub-Saharan Africa and Kenya show quality gaps that are leading to paradoxical higher rates of neonatal mortality and morbidity in facility births (4–9). A recent study in Niger and Mali showed that local facilities could be successful at learning improvement methodology, implementing high-impact changes including postpartum haemorrhage management and essential care for every baby packages (28). Further work done specifically after HBB training has shown that local ownership, systems of ongoing practice, case audits and efforts of quality improvement teams can build on the initial gains after an HBB workshop (31,36); our study adds to the body of literature documenting the importance of ongoing QI efforts to sustain and further accelerate gains after an initial training. In fact, an introduction of QI is now an essential part of the second edition of HBB, which was released in 2016 (19).

While the Neonatal Task Force had success in reducing rates of BA-related mortality, the team faced a myriad of limitations and challenges. These included documentation inconsistencies, particularly in the baseline period, limited time for research and limited resources and personnel, all in the setting of a high-volume, high-acuity labour ward and nursery. The Task Force did have the benefit of a Master Trainer and later a data champion who was able to facilitate and coach them in QI methodologies, which may not be possible for all facilities.

The Neonatal Task Force had to create a data collection system, appoint a specific data collection champion, and use a combination of retrospective chart review and prospective observation to determine what data were already being collected in order to track their results. Retrospective chart and billing review for baseline data were challenged by providers' inconsistent documentation of examination findings and nursery course, and this may have underestimated near misses (mildly affected babies that had unremarkable nursery courses). Attempts to mitigate this challenge involved having team members perform a case review of babies requiring resuscitation and check multiple sources (billing, chart, discharge ledger).

Ideally, rates of stillbirths and delivery room deaths should be reported (20–22,27). There were barriers to collecting accurate data regarding stillbirths due to inconsistent definitions by staff, a lack of consistent foetal heart rate monitoring and poor documentation to correctly classify stillbirth vs. neonatal death. Further study of stillbirths and delivery room deaths is a possible future direction. Many external factors affect birth asphyxia, such as prenatal care access, timely maternal transport and economic factors, but these were not within the scope of this project to study (Figs. 1 and 2). However, these factors represent important future directions for the team for further decreasing the birth asphyxia rate.

CONCLUSIONS

Significant improvement in the SHIE rate was achieved after HBB training and further decreased and sustained with focused QI efforts within a facility with severe resource limitations. We recommend as implementation of HBB

becomes more widespread, further training in simple QI methodologies can catalyse change within local contexts to improve care for mothers and babies worldwide.

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CONFLICTS OF INTERESTS

The authors declare that they have no conflicts of interest.

FINANCIAL DISCLOSURES

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