Int Health 2019; **11**: 52–63
doi:10.1093/inthealth/ihy062 Advance Access publication 22 September 2018

ORIGINAL ARTICLE

Combining bottleneck analysis and quality improvement as a novel methodology to improve the quality of neonatal care in a northeastern state of India: a feasibility study

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Received 8 May 2018; revised 23 July 2018; editorial decision 23 July 2018; accepted 10 August 2018

Background: The State of Meghalaya, India, has some of the worst newborn health outcomes in the country. State health authorities commissioned an assessment of newborn service delivery to improve services. This study proposes bottleneck analysis (BNA) and quality improvement (QI) methods as a combined method to improve compliance with evidence-based neonatal interventions in newborn health facilities.

Methods: An adapted Every Newborn BNA tool was applied to collect data on barriers to providing quality care in five district hospitals. Subsequently, health workers were coached to use QI methodology to overcome identified bottlenecks. Data from QI projects were analysed using run charts.

Results: BNA revealed that interventions directed toward basic newborn care and special newborn care facilities needed attention. Facilities that undertook QI projects showed an improvement in neonates having early initiation of breastfeeding within the first hour of birth, from 64% to a peak of 94% in one facility and from 75% to 91% in another. Skin-to-skin contact increased from 49% to a peak of 78% and is sustained at 58%. Improved performance has been sustained in some facilities.

Conclusions: The combination of BNA and QI is a successful method for identifying and overcoming bottlenecks in newborn care in resource-limited settings.

Keywords: bottleneck analysis, district hospitals, India, newborn care, quality improvement

Introduction

India contributes 25% of global newborn deaths.[1] With the introduction of the National Rural Health Mission in 2005, there has been a tremendous expansion in the infrastructure and human resources directed toward the welfare of newborns.[2] This has led to a significant reduction in the infant mortality rate from 59 per 1000 live births in 2005 to 36 by 2016, a reduction of 41%.[3,4]

Care for sick newborns is especially variable, and access to special newborn care units in healthcare facilities for the population ranges from 6% to 30% across India.[5] There are multiple reasons for this variation that need to be addressed by context-specific strategies that not only enhance newborn survival but also increase quality of services.

The State of Meghalaya in the northeastern part of India occupies a unique geographical and sociocultural milieu (Table 1) that affects the coverage of newborn care services.

Table 1. Sociodemographic details of the districts where the facilities are located[32,33]

Parameters	East Khasi Hills District	West Garo Hills District	East Garo Hills District	Jantia Hills District
District HQ	Shillong	Tura	William Nagar	Jowai
Population	824 000	642 000	317 000	392 000
Sex ratio (0–6 y)	961	980	975	969
Sex ratio (total)	1008	979	968	1008
Literacy rate, %	70.9	56.5	61.9	49.3
Gross state domestic product per capita for Meghalaya (US$)	1300			

This is evident from the state's infant mortality rate of 42 deaths per 1000 live births compared with the national average of 37 and an institutional delivery rate of 52% compared with the national average of 79%.[4,6]

Recognizing the need to provide better care, the National Health Mission (NHM) Meghalaya commissioned an evaluation of facility-based newborn care in terms of bottlenecks and quality of care and solicited recommendations for its improvement. The study was initiated in August 2015 with the aims of developing a roadmap document for the state's five neonatal health facilities at district hospitals, highlighting short-, medium-, and long-term interventions to accelerate newborn care in the state, and helping the state explore quality improvement (QI) strategies to improve newborn care delivery in existing healthcare facilities in line with the guidelines of the India Newborn Action Plan.[7]

It has been seen in countries with high neonatal and infant mortality that the implementation of early breastfeeding, kangaroo mother care (KMC) and skin-to-skin contact at birth provides a significant reduction in morbidity and mortality.[8–10] In addition, they also contribute to reducing hospital stays and costs to the family.[9]

This study proposes bottleneck analysis (BNA) and QI as a combined method to improve compliance with the existing evidence-based neonatal key interventions, such as KMC, breastfeeding within 1 h of birth and early initiation of skin-to-skin contact. QI helps the healthcare staff focus their attention on fixing the identified and prioritised problems using simple QI steps without the need for additional resources.[11]

BNA was developed as a tool under the Every Newborn Action Plan (ENAP)[12] for identifying problems in the health system that hamper scale-up of newborn care interventions and/or programmes. On the other hand, QI is about finding contextual solutions to problems of health facilities.[13] Currently there is no study in the existing literature that utilises the BNA tool to identify problems at the health facility level and subsequently uses QI methods to find sustainable solutions to these identified problems. This study used the BNA tool for systematically identifying challenges and then QI to find implementable solutions in the State of Meghalaya. This combined approach can help in the identification of key bottlenecks, prioritising key areas for interventions and improving their compliance across health facilities.

Materials and methods

Assessment of quality of care

We adapted the Every Newborn Bottleneck Analysis Tool[14] to incorporate Government of India guidelines[15] and to focus on facility-based care. We used this adapted Facility Bottleneck Analysis (F-BNA) tool and healthcare provider interviews to identify barriers to quality of care. The tool assessed bottleneck criteria (any constraints to a health system building block that limits its performance in delivering effective health services) for four health system building blocks: health workforce, essential medical products and technology, health service delivery, and community ownership and participation. These were used for evaluating bottlenecks in nine critical newborn care interventions: management of preterm birth, skilled care at birth, basic emergency obstetric care (BEmOC), comprehensive emergency obstetric care (CEmOC), basic newborn care, neonatal resuscitation, KMC, treatment of severe infections and inpatient supportive care for sick and small newborns. These nine interventions are a set of defined strategies identified for averting neonatal deaths and improving newborn health.[5] Items in the original tool that focused on the health system building blocks above the facility, e.g., 'Leadership and governance', 'Health finance' and 'Health information systems', were excluded from the F-BNA tool. A checklist of essential medical products and technologies was also appended to the tool.

Settings

BNA was undertaken at five district hospitals with operational district-level neonatal units across the state: North-East Indira Gandhi Regional Institute of Health and Medical Sciences (NEIGRIHMS), Shillong; Ganesh Das Hospital, Shillong; District Hospital, William Nagar; District Hospital, Jowai; and Maternity and Child Hospital (MCH), Tura. Of these hospitals, three facilities, namely NEIGRIHMS, Ganesh Das Hospital and MCH Tura, undertook QI projects subsequent to the BNA.

The demographic details of the participating districts where these hospitals are located are shown in Table 1. These data highlight the variability in resource availability between the districts. The combined population in the study area was nearly 2.2 million, which is greater than the population of 88 countries in the world.[16]

All five district hospitals in Meghalaya with neonatal health facilities were assessed between August 2015 and April 2016 using the adapted tool. Data for the evaluation were obtained from reports prepared by district health facilities and onsite records at the facilities (e.g., admission registers, birth registers, equipment maintenance reports, service records, indent books, stock books, follow-up records and individual patient case records). Five teams of two people each (neonatologists, paediatricians or public health specialists) worked in tandem with neonatal unit and district hospital staff and NHM officials to conduct the assessment. After the assessment, the team debriefed the newborn care staff. Onsite data thus collected were subsequently collated at a central site within 48 h of visit completion. Data accuracy was ensured through physical verification of source files, onsite interviews and direct inspection of data sets. In case of interobserver variability, verbal consensus was reached between both assessors before the final entry was made. Data cleaning was done at the central facility. We used the four-category grading system as proposed by the Every Newborn BNA Tool and converted the grades into numerical values: 'Good'=2 points, 'Needs some improvement'=4 points, 'Needs major improvements'=6 points and 'Inadequate (major bottleneck)'=8 points.[14]

QI intervention to improve quality of care

The government of Meghalaya was interested in testing QI methods and asked the three district-level neonatal health facilities that were most accessible from the state headquarters to try this approach. In July 2016, external coaches from the Nationwide Quality of Care Network (NQOCN) and the US Agency for International Development (USAID) Applying Science to Strengthen and Improve Systems (ASSIST) project provided 1 d of training in QI approaches to staff from these three facilities using the Point of Care Quality Improvement (POCQI) training materials developed by World Health Organization South East Asia Regional Office.[11] Staff were trained to identify problems to address, form improvement teams, analyse problems to identify root causes, test and adapt possible solutions and implement changes to fix their problems. QI teams were formed at these facilities comprising 6–10 staff members representing doctors, nurses and support staff in the labour rooms and neonatal units. These teams initiated QI projects in three key interventions: improving KMC duration, increasing initiation of breastfeeding within the first hour of birth and increasing skin-to-skin contact immediately after birth. These interventions were selected based on higher scores in the BNA assessment and prioritisation techniques. After the initial training, the QI coaches provided three onsite support visits, provided telephone support[17] to these facilities every month between December 2016 and July 2017 and organised peer-to-peer learning sessions in December 2016, March 2017 and July 2017. The overall scheme for this study is shown in Figure 1.

Data from the sites implementing QI projects were collected by the facility QI teams, discussed with the team leaders and shared with the QI coaches. All efforts were made to ensure the validity of the data by direct observation or using prerecorded data sets from registers/computerised data. Ongoing improvement data were collected by the recorder of the concerned QI team. This was

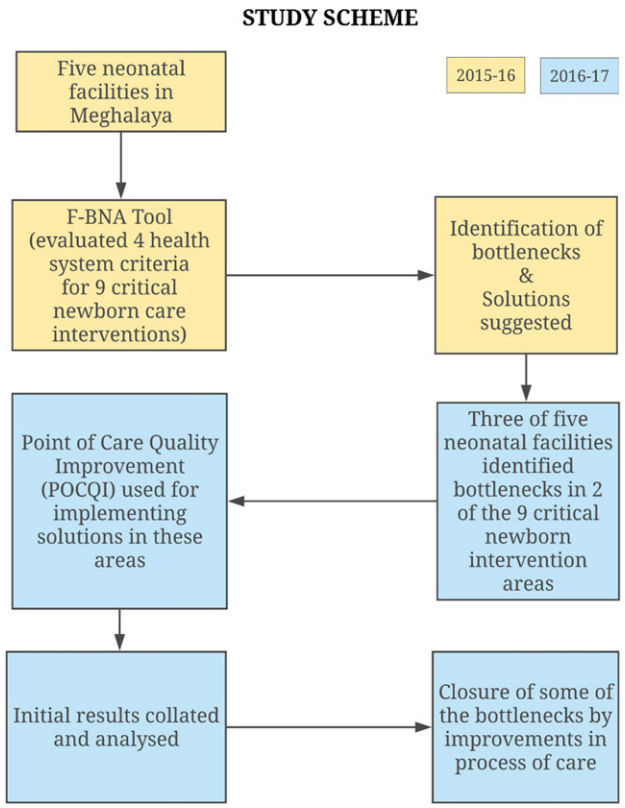

Figure 1. Study scheme showing integration of the Facility Bottleneck Analysis (F-BNA) tool and QI methodology. (Source: Authors)

reviewed at a predetermined frequency with the teams and the QI coaches. The QI coaches investigated any significant shift in the data values.

The whole process was led by the team leaders, who were trained in the process of recording and analysing the data as a part of the QI training they received. The data thus generated were shared with the central team and also presented in dissemination and experience-sharing meetings held at the state level. The data were plotted on time-series charts to understand the trend of the above-mentioned processes of newborn care.[18] The NQOCN network was created in August 2017 by QI teams across India and is present in more than 10 states in India, supporting nearly 70 facilities undertaking QI in newborn care.[19]

Statistical analysis

Data were analysed using SPSS version 20 (IBM, Armonk, NY, USA), and construction of the BNA graphs was done in Excel 2016 (Microsoft, Redmond, WA, USA). The scores for each of the interventions across facilities were represented as a sum with respect to the four bottleneck scoring criteria. The Kruskal–Wallis test was used for further analysis of the BNA data. The data were represented as time-series charts for further interpretation and, where appropriate, analysed using run chart rules. We recalculated the run chart medians whenever we identified a shift in the data using rules to define a shift as described by Anhøj and Olesen.[20]

Ethical considerations

The study was undertaken on behalf of NHM Meghalaya for QI; hence no ethical permissions were needed. The study involved the use of existing data, documents and records. The anonymity of the subjects was maintained, and they could not be identified directly or through identifiers linked to the subject. The analysis of bottlenecks led to the identification of areas with a scope for improvement. Application of the POCQI methodology ensured no risky interventions with a potential of harm were incorporated into the system as a policy and only beneficial processes were identified and hardwired into the system.

Results

Findings from assessments

The findings from the assessments of the five facilities are shown in Table 2. The table shows that for all five hospitals, the health system building block with the most bottlenecks identified was community ownership and participation, followed by health workforce, health service delivery, and essential medical products and technology, in descending order. Data from the five hospitals were analysed by Kruskal–Wallis test across the four bottleneck criteria (health service delivery, health workforce, essential medical products and technology, and community ownership and participation). No significant difference was seen between these hospitals across the nine critical newborn care interventions.

We grouped the scores for interventions based on the care locations where they were performed. Three such 'care areas' were defined: labour room interventions (BEmOC and CEmOC), basic newborn care interventions (management of preterm birth, skilled care at birth, basic newborn care, neonatal resuscitation and KMC) and neonatal care interventions (treatment of severe infections and inpatient supportive care for sick and small newborns). Scores were poor in all care areas (Table 3), with neonatal care interventions showing the greatest weakness.

Table 2. Grading of bottlenecks by building block and facility for each critical newborn care intervention

Facilities/Interventions	PRE	SCB	BEmOC	CEmOC	BNC	NRE	KMC	INF	SNB
Health Workforce									
FACILITY-A	6	8	2	6	6	6	4	6	6
FACILITY-B	8	6	6	8	6	8	8	6	8
FACILITY-C	6	8	4	4	6	6	6	6	6
FACILITY-D	6	4	2	2	4	4	2	6	6
FACILITY-E	6	6	6	8	4	6	4	4	4
Essential Medical Products and Technology									
FACILITY-A	2	8	2	2	4	4	2	4	4
FACILITY-B	8	2	4	6	2	4	8	4	8
FACILITY-C	2	8	4	2	6	4	4	4	2
FACILITY-D	2	4	2	4	8	4	8	4	4
FACILITY-E	4	2	4	6	2	2	2	2	2
Health Service Delivery									
FACILITY-A	4	4	4	4	6	6	4	6	6
FACILITY-B	8	6	4	6	8	8	8	8	8
FACILITY-C	4	8	4	2	6	6	6	4	4
FACILITY-D	4	4	4	4	6	4	6	4	6
FACILITY-E	2	4	4	6	2	2	2	2	2
Community Ownership and Participation									
FACILITY-A	6	6	4	6	6	8	4	6	8
FACILITY-B	8	8	8	8	8	8	8	8	8
FACILITY-C	4	4	4	6	6	6	6	4	6
FACILITY-D	4	4	4	2	6	8	6	6	6
FACILITY-E	8	8	8	8	6	6	4	6	6

Interventions: PRE=management of pre-term birth; SCB=skilled care at birth; BEmOC=basic emergency obstetric care; CEmOC=comprehensive emergency obstetric care; BNC=basic newborn care; NRE=neonatal resuscitation; KMC=kangaroo mother care; INF=treatment of severe \infections; and SNB=inpatient supportive care for sick and small newborns.

Bottleneck Criteria:				
Colour code				
Grades	Good *(not a bottleneck for improving newborn care)*	Needs some improvements *(minor bottleneck to improving newborn care)*	Needs major improvements *(significant bottleneck to improving newborn care)*	Inadequate *(major bottleneck to improving newborn care)*
Score	2	4	6	8

Interventions to improve quality of care

Facilities A and E each undertook a project to improve the duration of KMC for low-birthweight newborns. Facilities C and E each undertook a project to initiate breastfeeding in the first hour of life. Facility E undertook a project to improve immediate skin-to-skin contact after delivery. The projects to improve breastfeeding and skin-to-skin care only collected 1 week of baseline data, so run charts were not constructed.

Improving KMC duration: Newborns in the neonatal unit in facility A had a baseline KMC duration of 163 minutes per baby per day (calculated using the first six data points). This increased to a median of 211 minutes per baby per day on week 4 of the QI intervention and was sustained for 21 weeks, at which point the facility stopped collecting data (Figure 2). Newborns in the neonatal unit in facility E had a baseline KMC duration of 216.5 minutes per baby per day (calculated using the first six data points). This increased to a median of 318.5 minutes per baby per day on week 3 of the QI intervention; the median then decreased to 300 minutes per baby per day on week 35 of the QI project and was then sustained for the remaining 11 weeks until final data collection for this paper (Figure 3).

Early initiation of breastfeeding within the first hour of birth: Facility C collected 1 week of baseline data showing that 29% of newborns initiated breastfeeding in the first hour of life. This increased to a median of 94% on week 2 of the QI project and was sustained for 9 weeks, at which point they stopped collecting data weekly and moved to monthly data collection, during which time a median of 79% of newborns initiated breastfeeding in the first hour of life over a period of 20 weeks (Figure 4). Facility E collected 1 week of baseline data showing that 56% of newborns initiated breastfeeding in the first hour of life. This increased to a median of 84% in week 2 of the QI project and was sustained for 6 weeks, at which point they stopped collecting data on a weekly basis and moved to monthly data collection, during which time a median of 78% of newborns initiated breastfeeding in the first hour of life over a period of 20 weeks (Figure 5).

Skin-to-skin contact and delivery of basic newborn care to babies on mothers' abdomen immediately after birth: Facility E collected 1 week of baseline data showing that 15% of infants received immediate skin-to-skin contact. This increased to a median of 68% in week 2 of the QI project and was sustained for 8 weeks, at which point they stopped collecting data on a

Table 3. Weighted scores for bottlenecks in different care areas across five hospitals

Care area interventions (n)	Health workforce	Essential medical products	Health service delivery	Community ownership and participation	Total score[a]
Labour room interventions (2) [score range]	24 [10–40]	18 [10–40]	21 [10–40]	29 [10–40]	92 [40–160]
Basic newborn care interventions (5) [score range]	27.2 [10–40]	19.6 [10–40]	24 [10–40]	31.2 [10–40]	102 [40–160]
Neonatal care interventions (2) [score range]	29 [10–40]	19 [10–40]	25 [10–40]	32 [10–40]	105 [40–160]

Scores have been weighted for a single intervention.
A lower score is better.
For each bottleneck criterion, the minimum weighted score is 10 and the maximum weighted score is 40.
[a]Minimum total score is 40 and maximum total score is 160.

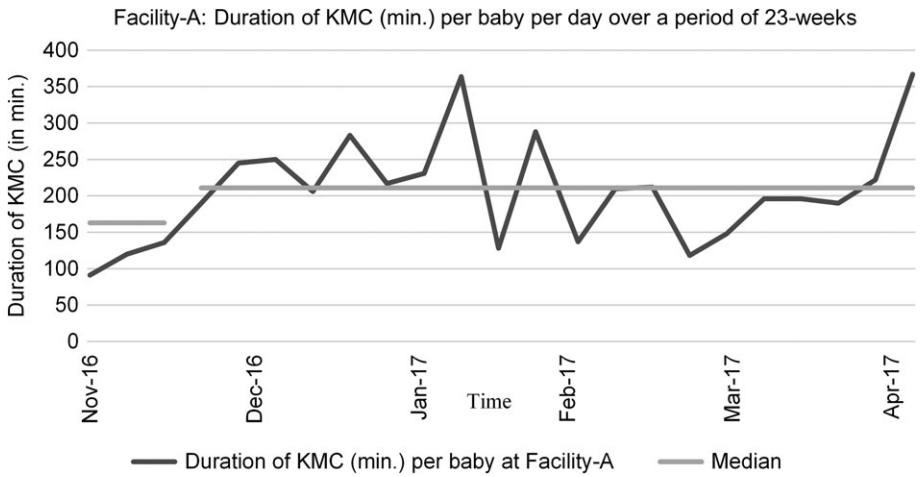

Figure 2. Duration of kangaroo mother care (KMC) (minutes) per baby at Facility A.

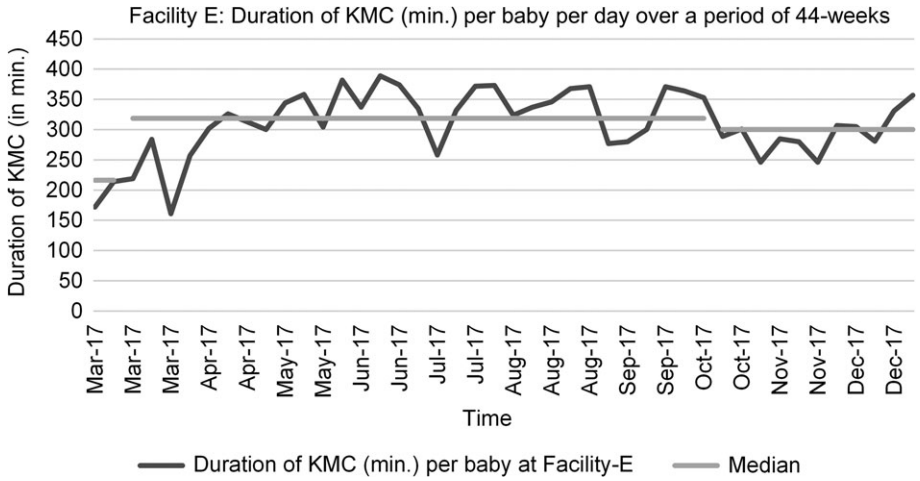

Figure 3. Duration of kangaroo mother care (KMC) (minutes) per baby at Facility E.

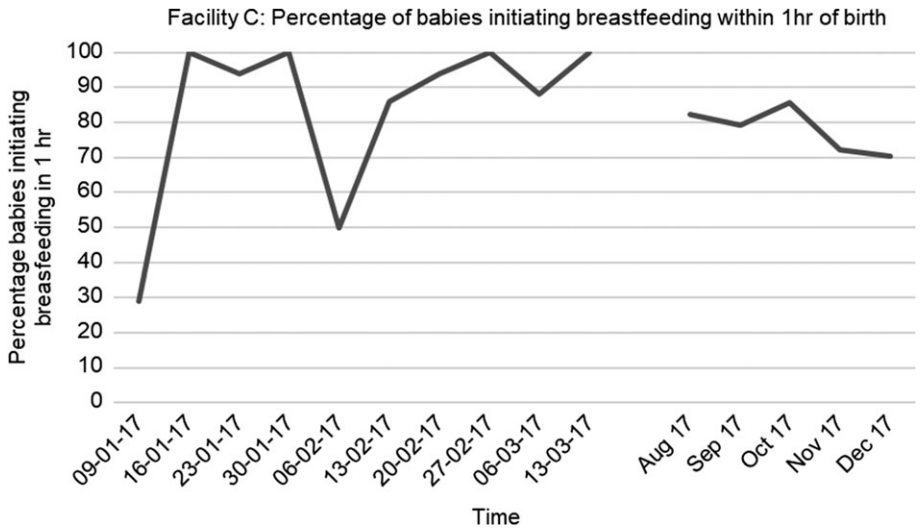

Figure 4. Percentage of babies breastfed within 1 h of birth at Facility C.

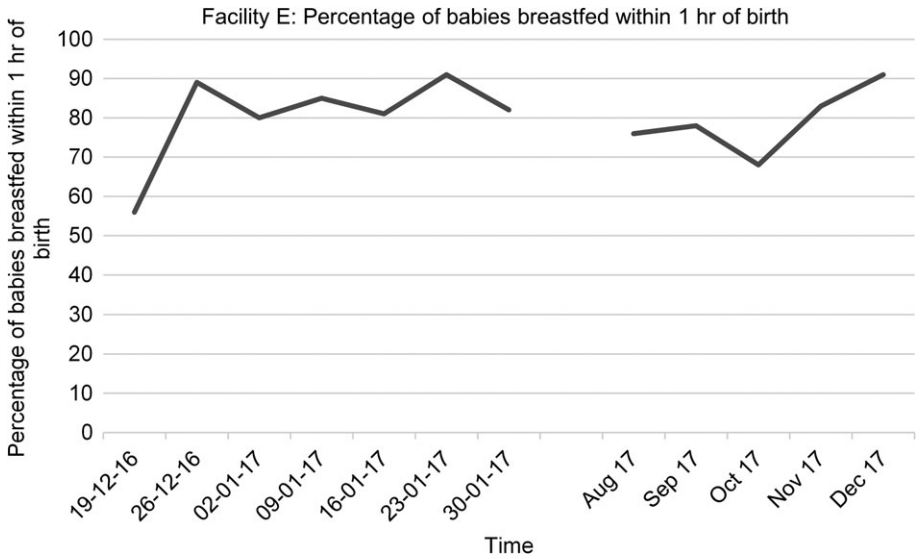

Figure 5. Percentage of babies breastfed within 1 h of birth at Facility E.

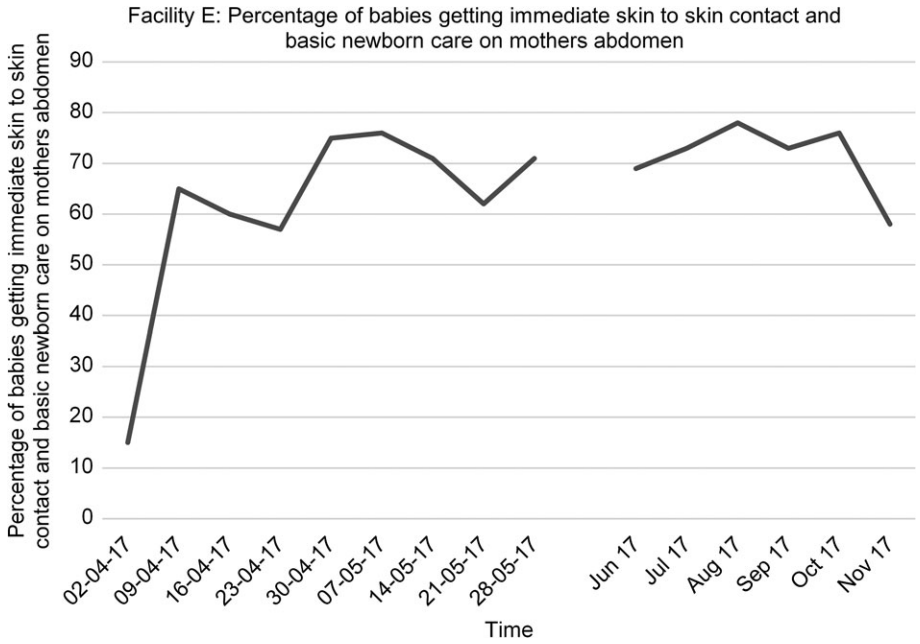

Figure 6. Percentage of babies getting immediate skin-to-skin contact and basic newborn care on the mother's abdomen at Facility E.

weekly basis and moved to monthly data collection, during which time a median of 73% of newborns received immediate skin-to-skin contact and basic newborn care on mothers' abdomen over a period of 24 weeks (Figure 6).

Discussion

We adapted the Every Newborn BNA tool to suit the needs of district-level facilities. Other adaptations have been field tested by previous researchers as well.[21–23] After identifying problems by using this tool, we supported health workers using QI methods to solve these problems. This study has demonstrated a novel methodology for assessing health system bottlenecks at the level of the facility and fixing the identified bottlenecks using the QI approach. Numerous quality-assessment tools are in use in the contemporary health systems. Most of these are labour intensive and emphasise infrastructure, human resources and other resources, which may not ensure delivery of quality care. Good infrastructure does not always translate to good quality of care.[24] Most of the healthcare accreditation models are deficient in the attributes of QI and promote a documentation-focussed approach to safety improvements and healthcare management integration.[25] This can cause routinization and bureaucratization and may encourage finding solutions based on predefined methods.[26]

Evaluation of health systems using the BNA methodology can identify areas for improvement but does not necessarily lead to improvement. QI methods provide health workers with the skills and tools to fix the identified problems. A recent systematic review of QI collaboratives mentioned that QI methods, when combined with peer-to-peer learning, are effective in improving targeted clinical processes and outcomes.[27]

These methods have also been found to be effective in India.[28,29] Based on our experience of using the F-BNA tool to identify problems and QI methods to address these problems, we propose that this methodology can help in the identification of health system bottlenecks at the facility level, their prioritisation, and improvement in these key areas. This methodology is of prime importance in low- and middle-income countries (LMICs) where resource constraints are a constant problem. Similar studies in newborn care have shown that the BNA tool can be used for gap identification and prioritising interventions in newborn care services in LMICs (Table 4).

Our study illustrates that a facility-level QI strategy, when applied to key interventions like KMC, initiation of early breastfeeding and initiation of skin-to-skin contact at birth, augments the existing health services and improves the processes of care. While the initial QI training and onsite support were provided by external staff from the ASSIST project and NQOCN, this onsite support ended in July 2017. After that, these facilities were still linked into the NQOCN and presented their projects at a meeting in December 2017. Despite the end of support, results were sustained in Facilities C and E.

The current study utilised the F-BNA tool and followed it up with incorporation of the POCQI model in health settings of northeastern India. We believe that this approach would be generalizable in other settings in India and other LMICs. The study has robust internal validity and is contextually appropriate for similar LMIC settings where the suggested algorithm in Figure 7 can be used to guide state- and district-level decision making. However, QI alone cannot overcome all the strategic bottlenecks in health system areas such as health workforce, health financing, equipment and supplies and community participation. These must be addressed at the state or national level using appropriate administrative mechanisms.[30]

Table 4. Summary of various BNAs affecting newborn care

Number	BNA studies	Methodology	Assessment of health coverage and levels of care
1a	BNA of use of antenatal corticosteroids (ACSs) (2015)[34]	– ENAP workshop involving technical experts from 12 high-burden countries identified the intervention-specific bottlenecks to scale-up of newborn care services. – Quantitative and qualitative methods were used to analyse the bottleneck data, combined with literature review, to present priority bottlenecks and actions relevant to different health system building blocks.	– Conducted at the level of 12 high-burden countries. – Identified bottlenecks related to the use of ACSs: supply of medical products, health service delivery, and health information systems. – Health information systems should include gestational age assessment and tracking of ACS coverage, use and outcomes.
1b	BNA of neonatal infections (2015)[35]		– Conducted at the level of 12 high-burden countries. – Major bottlenecks identified were health workforce and community ownership and partnership. – Poor health information system and limited funding were constraints to increase access to quality newborn care. – Augmentation of skilled health workforce, use of simplified antibiotic regimens and development of national guidelines.
1c	BNA of KMC (2015)[36]		– Conducted at the level of 12 high-burden countries. – Community ownership and health financing were major bottlenecks, followed by leadership and governance and health workforce. – Countries should implement a scale-up plan for KMC as per their local context.
1d	BNA of BEmOC and CEmOC (2015)[37]		– Conducted at the level of 12 high-burden countries. – Health financing, health workforce and health service delivery were the major bottlenecks. – Improving quality of care and establishing public–private partnerships were suggested measures.
1e	BNA of mothers and newborns (care around birth) (2015)[38]		– Conducted at the level of 12 high-burden countries. – Context-specific solutions are required for identified bottlenecks for each intervention. – Health information gaps and leadership and governance were also identified as important bottlenecks.
1f	BNA for basic newborn care and neonatal resuscitation (2015)[39]		– Conducted at the level of 12 high-burden countries. – Overall bottlenecks for neonatal resuscitation were graded as being more severe than for basic newborn care. – For basic newborn care, health workforce, health financing and health service delivery were major bottlenecks. – For neonatal resuscitation, health workforce and essential medical products and technology were the main constraints hampering health service delivery.
1g	BNA for small and sick newborns (2015)[40]		– Conducted at the level of 12 high-burden countries. – Major bottlenecks were health workforce and health financing followed by community ownership and partnership. – Insurance schemes are needed to improve inpatient care.

Continued

Table 4. *Continued*

Number	BNA studies	Methodology	Assessment of health coverage and levels of care
2	BNA in Ghana (2016)[18]	– Mixed-method approach for assessing regional newborn care health services. – Assessments done in two regions over a 4-y period.	– Modified Every Newborn BNA tool provided data-driven planning for newborn care services for the country at all levels of care. – Service coverage indicators used to assess supply side (commodities, human resource and access), demand side (service utilization) and quality/effective coverage of health services indicators.
3	BNA in Uganda (2016)[19]	– Modified Tanahashi model to assess bottlenecks for effective coverage of NHM services. – Cross-sectional household and health facility surveys used for the assessment.	– Assessment done in two districts. – Tracer interventions were the use of iron and folic acid, intermittent presumptive treatment for malaria, human immunodeficiency virus counselling and testing and syphilis testing.
4	BNA in Tanzania (2015)[20]	– Adapted Tanahashi model for bottleneck assessment of intervention coverage, access, health facility readiness and clinical practice.	– Household and district-level facility survey in two districts. – Tracers used for syphilis and maternal care (pre-eclampsia, use of partograph, active management of third stage of labour and postpartum care). – Health facility readiness was the largest bottleneck for most interventions.
5	Current study (Meghalaya, India)	– Adapted Every Newborn BNA tool (F-BNA tool) to identify bottlenecks at the facility level. – Used QI methodology (e.g., POCQI) to overcome some of the bottlenecks experienced by these facilities. – Mixed approach methods of using F-BNA tool and QI methods.	– Assessment done at district-level newborn care facilities of the state. – Community participation, health workforce and health service delivery were the most significant bottlenecks identified at the facility level. – QI methodology was applied to KMC, early initiation of breastfeeding and initiation of skin-to-skin contact at birth at the individual facility level to improve newborn care service delivery.

ACS: antenatal corticosteroids; BEmOC: basic emergency obstetric care; BNA: bottleneck analysis; CEmOC: comprehensive emergency obstetric care; F-BNA: Facility Bottleneck Analysis; KMC: kangaroo mother care; NHM: National Health Mission; POCQI: Point of Care Quality Improvement; QI: quality improvement.

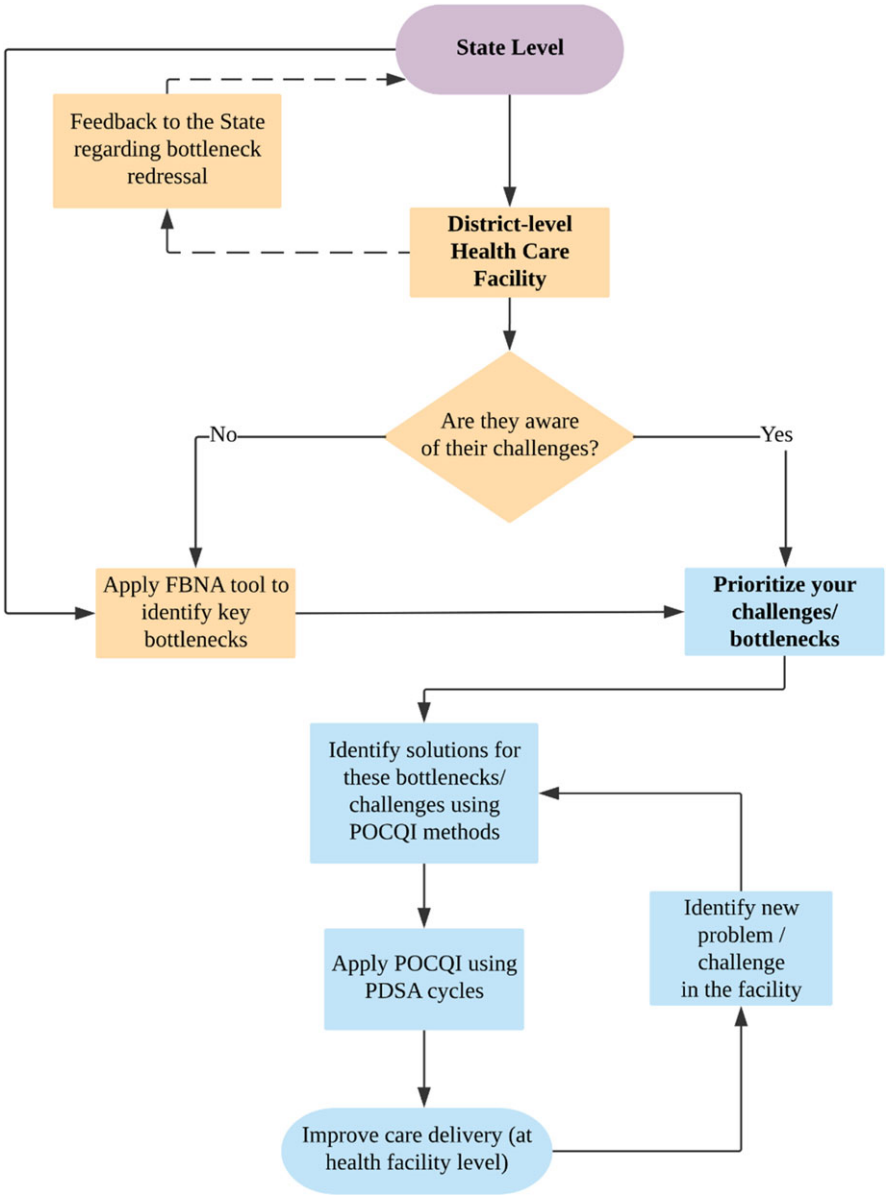

Figure 7. Suggested process for health administrators to use BNA along with QI to effect improvement in health services. (Source: Authors) FBNA: Facility Bottleneck Analysis; POCQI: Point of Care Quality Improvement; PDSA: Plan-Do-Study-Act.

Limitations

As mentioned previously, bottlenecks pertaining to leadership and governance, health financing and the health information system were not analysed with the F-BNA tool. The intended outcome was to help the state identify and overcome bottlenecks at the facility level. Similarly, a QI strategy was implemented only in the selected interventions of KMC, early initiation of breastfeeding and initiation of skin-to-skin contact at birth, as chosen voluntarily by the concerned health facilities. More studies involving larger numbers of health facilities are needed to further validate this methodology. Human factors, effective leadership and organizational culture, which were not evaluated by us, play an important role in any improvement process. These need to be evaluated more intensively in further studies. The facilities analysed were similar with respect to the main bottlenecks affecting the health system building blocks. The fact that only five facilities were evaluated may have contributed to the observed lack of significant differences across interventions.

Conclusions

The current study has demonstrated a unique model that has been used for the first time in field settings to deliver improvements in quality of care using a combination of BNA and POCQI.

It can also be used by decision makers for resource-neutral interventions to overcome identified bottlenecks with the use of QI strategies (see Figure 7). We need to identify and empower teams in peripheral facilities by introducing them to the basics of the QI methodology. As has been recently mentioned, it is imperative now to address the whole system and facilitate a health system quality revolution rather than tinkering at the edges of individual services.[31]

Authors' contributions: VD, SS, RG and HP performed the literature search, designed the study, adapted the study tool, were part of the team performing the BNA and QI, analysed the data and drafted the manuscript. LR, HG, SS and HB were part of the team that helped in data collection and analysis and implementation of the QI process in facilities. PP and NL helped in the literature search, data analysis, interpretation, implementation of the QI process and drafting of the manuscript. VD will be the guarantor for this paper. All authors provided feedback to the draft manuscript and approved the final version of the manuscript.

Acknowledgements: None.

Funding: This work was supported by the National Health Mission Meghalaya for BNA and preparation of a roadmap document for improving the quality of newborn care services in the state. They facilitated access to facilities and data and funded the data analysis, interpretation and publication of the roadmap document. Subsequently they supported and funded initial QI training for staff in the district neonatal units. USAID and the ASSIST project had no role in the above-mentioned processes; however, they funded the trainers at the initial QI trainings and providing coaching support (both in person and virtual) at district-level facilities under cooperative agreement AID-OAA-A-12-00101. The funders had no role in the drafting or submission of this manuscript. The corresponding author has full access to all the data in the study and had final responsibility for the decision to submit for publication.

Competing interests: None declared.

Ethics approval: The data pertain to a combined methodology of using assessment and QI interventions and are taken from hospital records, and hence no ethical clearance was required. However, permission was obtained from all hospital, state health and district health officials before starting the intervention.

References

1 United Nations Children's Fund. Levels and trends in child mortality report 2017. New York: United Nations Children's Fund, 2017. https://www.unicef.org/publications/index_101071.html (accessed 10 January 2018).

2 Nandan D. National rural health mission: turning into reality. Indian J Community Med 2010;35(4):453–4.

3 Registrar General of India. SRS Bulletin 2005. New Delhi: Sample Registration System, Government of India, 2005. http://www.censusindia.gov.in/vital_statistics/SRS_Bulletins/SRS_Bulletins_links/SRS_Bulletin_April_2005.pdf (accessed 18 December 2017).

4 Registrar General of India. SRS Bulletin 2016. New Delhi: Sample Registration System, Government of India, 2016. http://www.censusindia.gov.in/vital_statistics/SRS_Bulletins/SRS%20Bulletin%20Dec-2016.pdf (accessed 18 December 2017).

5 Dickson KE, Simen-Kapeu A, Kinney MV et al. Every Newborn: health-systems bottlenecks and strategies to accelerate scale-up in countries. Lancet 2014;384(9941):438–54.

6 International Institute of Population Sciences. NFHS-4: India Report. Mumbai: International Institute of Population Sciences, 2017. http://rchiips.org/nfhs/NFHS-4Reports/India.pdf (accessed 5 January 2018).

7 Ministry of Health and Family Welfare. India Newborn Action Plan (INAP). New Delhi: Ministry of Health and Family Welfare, 2014. http://nhm.gov.in/india-newborn-action-plan.html (accessed 10 January 2018).

8 Smith ER, Hurt L, Chowdhury R et al. Delayed breastfeeding initiation and infant survival: a systematic review and meta-analysis. PLoS One 2017;12(7):e0180722.

9 Conde-Agudelo A, Belizan JM, Diaz-Rossello J. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. Cochrane Database Syst Rev 2011;3:CD002771.

10 Moore ER, Bergman N, Anderson GC et al. Early skin-to-skin contact for mothers and their healthy newborn infants. Cochrane Database Syst Rev 2016;11:CD003519.

11 Deorari A, Mehta R, Livesley N. Improving the quality of care for mothers and newborns in health facilities: point of care quality improvement. Facilitator manual. New Delhi: World Health Organization Regional Office for South-East Asia, 2017. http://www.pocqi.org/wp-content/uploads/2018/01/POCQI-Facilitator-Manual.pdf (accessed 5 January 2018).

12 Moxon SG, Ruysen H, Kerber KJ et al. Count every newborn: a measurement improvement roadmap for coverage data. BMC Pregnancy Childbirth 2015;15(Suppl 2):S8.

13 Kaplan HC, Provost LP, Froehle CM et al. The Model for Understanding Success in Quality (MUSIQ): building a theory of context in healthcare quality improvement. BMJ Qual Saf 2012;21(1):13–20.

14 Healthy Newborn Network. Every Newborn BNA Tool. https://www.healthynewbornnetwork.org/hnn-content/uploads/Every-Newborn-BNA-tool-12-August-2013-1.docx (accessed 15 December 2017).

15 Ministry of Health and Family Welfare. Facility based newborn care operational guide 2011. New Delhi: Ministry of Health and Family Welfare, 2011. http://nhm.gov.in/images/pdf/programmes/child-health/guidelines/fbnc_operational_guide.zip (accessed 5 January 2018).

16 United Nations. World population prospects—population division. New York: United Nations. https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_Volume-II-Demographic-Profiles.pdf (accessed 10 January 2018).

17 Joshi P, Thukral A, Joshi M et al. Comparing the effectiveness of webinars and participatory learning on essential newborn care (ENBC) in the class room in terms of acquisition of knowledge and skills of student nurses: a randomized controlled trial. Indian J Pediatr 2012;80(2):168–70.

18 Langley GJ. The improvement guide: a practical approach to enhancing organizational performance 2nd ed. San Francisco, CA: Jossey-Bass, 2014.

19 Quality of Care Network, World Health Organization. Vikram Datta's presentation on quality of care improvement for newborn health—the example of the National Quality of Care Network, India. http://qualityofcarenetwork.org/content/vikram-dattas-presentation-quality-care-improvement-newborn-health-example-national-quality (accessed 10 January 2018).

20 Anhøj J, Olesen AV. Run charts revisited: a simulation study of run chart rules for detection of non-random variation in health care processes. PLoS One 2014;9(11):e113825.

21 Yawson A, Awoonor-Williams J, Sagoe-Moses I et al. Bottleneck analysis approach to accelerate newborn care services in two regions in Ghana: implications for national newborn care. Public Health 2016; 141:245–54.

22 Henriksson DK, Fredriksson M, Waiswa P et al. Bottleneck analysis at district level to illustrate gaps within the district health system in Uganda. Global Health Action 2017;10(1):1327256.

23 Baker U, Peterson S, Marchant T et al. Identifying implementation bottlenecks for maternal and newborn health interventions in rural districts of the United Republic of Tanzania. Bull World Health Org 2015;93:380–9.

24 Tabrizi JS, Gharibi F, Wilson AJ. Advantages and disadvantages of health care accreditation models. Health Promot Perspect 2011;1(1):1–31.

25 Leslie HH, Sun Z, Kruk ME. Association between infrastructure and observed quality of care in 4 healthcare services: a cross-sectional study of 4,300 facilities in 8 countries. PLoS Med 2017;14(12):e1002464.

26 Jaafaripooyan E. Potential pros and cons of external healthcare performance evaluation systems: real-life perspectives on Iranian hospital evaluation and accreditation program. Int J Health Policy Manag 2014;3(4):191–8.

27 Wells S, Tamir O, Gray J et al. Are quality improvement collaboratives effective? A systematic review. BMJ Qual Saf 2018;27(3):226–40.

28 Sarin E, Kole SK, Patel R et al. Evaluation of a quality improvement intervention for obstetric and neonatal care in selected public health facilities across six states of India. BMC Pregnancy Childbirth 2017;17:134.

29 Datta V, Saili A, Goel S et al. Reducing hypothermia in newborns admitted to a neonatal care unit in a large academic hospital in New Delhi, India. BMJ Open Qual 2017;6:e000183.

30 Kringos DS, Sunol R, Wagner C et al. The influence of context on the effectiveness of hospital quality improvement strategies: a review of systematic reviews. BMC Health Serv Res 2015;15:277.

31 Are we ready for a quality revolution? Lancet Glob Health 2018;6(2): PE121.

32 Registrar General of India. Census of India. New Delhi: Government of India. http://www.censusindia.gov.in/2011census/population_enumeration.html (accessed 18 December 2017).

33 Reserve Bank of India. Handbook of statistics on Indian states Mumbai: Reserve Bank of India, 2016.

34 Liu G, Segrè J, Gülmezoglu AM et al. Antenatal corticosteroids for management of preterm birth: a multi-country analysis of health system bottlenecks and potential solutions. BMC Pregnancy Childbirth 2015;15(Suppl 2):S3.

35 Simen-Kapeu A, Seale AC, Wall S et al. Treatment of neonatal infections: a multi-country analysis of health system bottlenecks and potential solutions. BMC Pregnancy Childbirth 2015; 15(Suppl 2):S6.

36 Vesel L, Bergh A-M, Kerber KJ et al. Kangaroo mother care: a multi-country analysis of health system bottlenecks and potential solutions. BMC Pregnancy Childbirth 2015;15(Suppl 2):S5.

37 Sharma G, Mathai M, Dickson KE et al. Quality care during labour and birth: a multi-country analysis of health system bottlenecks and potential solutions. BMC Pregnancy Childbirth 2015;15(Suppl 2):S2.

38 Dickson KE, Kinney MV, Moxon SG et al. Scaling up quality care for mothers and newborns around the time of birth: an overview of methods and analyses of intervention-specific bottlenecks and solutions. BMC Pregnancy Childbirth 2015;15(Suppl 2):S1.

39 Enweronu-Laryea C, Dickson KE, Moxon SG et al. Basic newborn care and neonatal resuscitation: a multi-country analysis of health system bottlenecks and potential solutions. BMC Pregnancy Childbirth 2015;15(Suppl 2):S4.

40 Moxon SG, Lawn JE, Dickson KE et al. Inpatient care of small and sick newborns: a multi-country analysis of health system bottlenecks and potential solutions. BMC Pregnancy Childbirth 2015;15 (Suppl 2):S7.