USAID
FROM THE AMERICAN PEOPLE

USAID
ASSIST PROJECT
Applying Science to Strengthen and Improve Systems

RESEARCH AND EVALUATION REPORT

Assessment of Effectiveness and Cost-effectiveness of the Quality Improvement (QI) Guide on QI Processes and Maternal and Newborn Care in Uganda

JUNE 2020

This research and evaluation report was prepared by University Research Co., LLC (URC) for review by the United States Agency for International Development (USAID) and authored by Tamar Chitashvili, Simon Sensalire, Eka Cherkezishvili, Lani Marquez, and Sarah Kauder of URC under the USAID Applying Science to Strengthen and Improve Systems (ASSIST) Project. The USAID ASSIST Project was made possible by the generous support of the American people through USAID.

RESEARCH AND EVALUATION REPORT

Assessment of Effectiveness and Cost-effectiveness of the Quality Improvement (QI) Guide on QI Processes and Maternal and Newborn Care in Uganda

JUNE 2020

Tamar Chitashvili, University Research Co., LLC
Simon Sensalire, University Research Co., LLC
Eka Cherkezishvili, University Research Co., LLC
Lani Marquez, University Research Co., LLC
Sarah Kauder, University Research Co., LLC

Acknowledgements

The content of this report was developed through the hard work and dedication of the facility teams in Uganda where this activity took place. Our appreciation also goes out to Lily Kak, Advisor for Office of Maternal-Child Health &Nutrition at USAID Bureau for Global Health for his expertise, guidance, and leadership in supporting this activity from its inception and linking local initiative to improve the quality of newborn and child health services in northern Uganda to inform global maternal and newborn care improvement efforts.

This report was prepared by University Research Co., LLC (URC) under the USAID Applying Science to Strengthen and Improve Systems (ASSIST) Project, which is funded by the American people through USAID's Bureau for Global Health, Office of Health Systems. The project is managed by URC under the terms of Cooperative Agreement Number AID-OAA-A-12-00101. URC's global partners for USAID ASSIST included: American Academy of Pediatrics; EnCompass LLC; FHI 360; Harvard T. H. Chan School of Public Health; HEALTHQUAL International; Initiatives Inc.; Institute for Healthcare Improvement; Johns Hopkins Center for Communication Programs; and WI-HER, LLC.

For more information on the work of the USAID ASSIST Project, please visit https://www.urc-chs.com/assist or write assist-info@urc-chs.com.

Recommended citation

Chitashvili T, Sensalire S, Cherkezishvili E, Marquez L, Kauder S. 2020. Assessment of Effectiveness and Cost-effectiveness of the Quality Improvement Guide on QI processes and Maternal and Newborn Care in Uganda. *Research and Evaluation Report*. Published by the USAID ASSIST Project. Chevy Chase, MD: University Research Co., LLC (URC).

TABLE OF CONTENTS

List of Tables and Figures

Acronyms

AAP	American Academy of Pediatrics
ASSIST	USAID Applying Science to Strengthen and Improve Systems Project
BL	Baseline
CME	Continuing medical education
DHO	District Health Office
DHT	District Health Team
EL	End line
HC	Health center
ICER	Incremental cost-effectiveness ratio
IM	Intramuscular
IV	Intravenous
IMNCI	Integrated management of newborn and childhood illness
MCH	Maternal and child health
MD	Medical doctor
MNH	Maternal and newborn health
MMR	Maternal mortality rate
MNCH	Maternal, newborn, and child health
OPD	Outpatient department
PDSA	Plan-do-study-act
PSBI	Possible severe bacterial infection
PPH	Postpartum hemorrhage
QI	Quality improvement
RDT	Rapid diagnostic test
RRH	Regional Referral Hospital
SAM	Severe acute malnutrition
SPSS	Statistical Package for Social Scientists
S&T GDA	Survive & Thrive Global Development Alliance
TA	Technical assistance
UGX	Ugandan shilling
UNCST	Uganda National Council of Science and Technology
URC	University Research Co., LLC
USAID	United States Agency for International Development
USD	United States dollars
VHT	Village Health Team
WHO	World Health Organization

EXECUTIVE SUMMARY

The quality improvement (QI) guide for mothers and babies was developed through the collaboration of Survive and Thrive Global Development Alliance (S&T GDA) partner organizations to demystify the quality improvement process and scale up QI practices globally. To promote the use of the QI guide at the global level, the Office of Maternal and Child Health and Nutrition of USAID's Bureau for Global Health tasked the USAID Applying Science to Strengthen and Improve Systems (ASSIST) Project to assess the effectiveness and cost-effectiveness of strategies to implement the guide in terms of its ability to initiate and establish continuous improvement processes in medical facilities and ultimately improve maternal and newborn care processes and outcomes. Considering high rates of maternal and neonatal mortality in Uganda and tremendous commitment of the Government of Uganda to improving the care of mothers and babies, in agreement with USAID's global maternal and child health and nutrition and field teams, the effectiveness and cost-effectiveness of the QI guide was tested in service delivery settings in Uganda.

Overall approach and design

This was a prospective, non-randomized, controlled assessment of effectiveness and cost-effectiveness of three QI guide dissemination strategies in participant and control facilities before and after the intervention. The study assessed three different implementation scenarios of the QI guide by comparing the effectiveness and cost-effectiveness across three intervention groups to one control group:

- Intervention group 1 received the QI guide
- Intervention group 2 received the QI guide with a follow-up orientation workshop about the guide
- Intervention group 3 received the QI guide, the orientation workshop, and follow-up coaching support (six coaching visits)
- Control group received evidence-based maternal and newborn health clinical recommendations only. To avoid the possible impact of limited access to clinical guidelines, all intervention groups also received maternal and newborn health (MNH) clinical recommendations.

Main findings

Respondent demographics: The characteristics of key informants were similar between the baseline and end line.

Use of the QI and clinical guides: Key informant interviews at the end line of the study revealed that most respondents in the control (8 out of 9) and group 1 (6 out of 12) had not used either the QI or clinical guides. In group 3, all respondents had used both clinical and QI guides (8 of 9).

Feedback on the QI guide: Key informants of group 1 identified objectives and key knowledge as the most useful sections of the QI guide, while group discussion and tools for identifying barriers were most valued by group 2 and group 3 key informants. Orientation workshop participants mentioned that the guide will be instrumental to provide step-by-step guidance during the implementation of the improvement interventions, help to explain the simple steps of improvement, and guide how to address specific QI problems. The only negative feedback received on the QI guide was the length of the material.

Feedback on the orientation workshop: Orientation workshop participants found the workshop interactive and easy to understand, however, they noted the tight schedule as a challenge and suggested a follow-up meeting to help better utilize the content.

Feedback on the coaching visits: Key informant interviews at the end line revealed very positive attitudes towards the coaching visits. Participants found the coaching visits to be a forum for corrections, knowledge sharing, and skill development. They reported that the coaching helped them to "change the attitude towards QI" and keep them motivated.

QI-related knowledge and attitudes: Assessment of knowledge of key concepts of QI found universal use of QI guide (p=0.02) in the intervention group 3. The knowledge of key QI concepts improved in group 3, compared to other groups, particularly in such practical aspects of QI as focusing on one or two barriers of quality of care at a time, testing on small scale for feasibility, and strategies for prioritizing, measuring, and instituting changes. Knowledge of and positive attitude toward QI was the second highest in intervention group 2. It is important to note that 8% fewer key informants from intervention group 3 considered as essential, key inputs to deliver good quality of care at the end line, compared to baseline. The result suggests deeper understanding of the QI concepts in intervention group 3 (inputs are necessary but not enough to address all gaps in quality of care).

QI experience and activities: About half of the respondents from the control group, intervention group 1, and group 2 and none of the intervention group 3 reported ongoing MNH QI activities in the previous month at baseline. While this remained the same at end line in the control group and intervention group 1, over 80% of respondents at the end line from intervention group 2 and 3 reported ongoing MNH improvement activities during the past month. Separate QI teams for MNH also increased at end line, particularly in intervention group 3 facilities.

Self-reported routine QI processes reached 100% for almost all processes in groups 2 and 3, while these processes worsened in the control group. Intervention group 3 reported the greatest number of QI team meetings in the previous six months (average of 6.2). All respondents from intervention group 3 also reported availability of written QI plans in their health facilities, a sizable improvement compared to baseline. The availability of QI plans did not change dramatically in control and other intervention groups compared to baseline. Across groups and points of data collection, QI teams were not viewed by respondents as making improvement the norm, and the average number of hours spent on QI was lower at end line across all intervention and control groups.

Data collection and use for continuous improvement: Fewer respondents in the control group at end line reported collection and review of performance data compared to baseline (5 of 9, 9 of 9, respectively). The data use patterns were the weakest in group 1 facilities compared to other intervention groups and did not change substantially from baseline. In group 2, data was used to identify what had been learned from the improvement activity and the QI teams analyzed and interpreted data and documented changes, however self-reported data collection and use worsened compared to baseline. In group 3, there was an increase in the use of data to identify what was learned from an improvement activity, in analysis and interpretation of data within the QI team, and in the documentation of changes, written results, and internal and external factors contributing to changes observed. In group 3, self-reported data use for continuous improvement sizably improved at end line and surpassed over 65% for almost all measures.

Supportive supervision and coaching: Across all groups and data collection points, respondents indicated that they had received supportive supervision or coaching in the previous 12 months, mostly from an external coach or supervisor. Control group and group 3 also reported improved regularity of coaching and frequency of the visits (at least monthly). Notably, internal on-site support functions improved in group 2 and group 3 facilities at end line, suggesting the possible effect of the orientation workshop and the use of the QI guide.

While multiple infrastructure and human resource factors were reported as barriers to QI by respondents in intervention group 3 at baseline, their attitude had changed by the end line: none of the care providers identified human-resource related factors as barriers to QI at end line. This is an important shift in perceived barriers to better care that may indicate improved confidence of QI teams in intervention group 3 to solve local problems that are within their control.

Change in MNH care processes and outcomes: **Intervention group 1**: Over 80% of respondents of intervention group 1 reported essential maternal care and care of sick newborns and mothers with or at risk of sepsis as priority areas of focus for improvement activities. According to the medical

documentation review, the intervention did not improve care processes related to essential maternal care (e.g., uterotonic administration after birth or counselling on danger signs, infant feeding, and maternal nutrition) except the provision of immediate postpartum family planning method to the mother before discharge, which improved by 12% from baseline, compared to the control group (p=0.02). Analysis of facility statistics found statistically significant reduction in the institutional maternal mortality rate (MMR) and incidence of obstructed labor in intervention group 1 facilities (p=0.012 and 0.05, respectively). These results, however, are difficult to attribute to the improvement intervention given that respondents of group 1 reported limited use of QI guide (6 out of 12) and we did not see related improvements in care processes based on the information available in the maternal registries. The case fatality among babies with asphyxia increased by 19% (p=0.029).

Intervention group 2: All key informants of group 2 reported working on improving newborn resuscitation, prevention and management of postpartum hemorrhage (PPH), care of preeclampsia/eclampsia, and management of obstructed labor. Review of medical documentation showed 10% improvement in uterotonic administration immediately after birth to prevent PPH (p=0.005) compared to the control group and baseline. However, improvements in care outcomes, except institutional MMR, which was reduced to 492 per 100,000 deliveries (p=0.05), were not statistically significant.

Intervention group 3: According to key informant interviews and coaching reports, the majority of intervention group 3 facilities were focused on improving labor monitoring using the partograph (all four facilities), prevention of PPH (all four facilities), and newborn resuscitation. Routine monitoring of improvement interventions across all sites (where data was available) indicated improved partograph use from 6% at the beginning of February 2018 to 91% at the end of May 2018. Correct partograph use went from 54% to 93% in the same period. Analysis of medical record review showed reduced incidence of obstructed of labor by 26% and reduced fresh stillbirth rate by 4 per 1000 total birth in intervention group 3 facilities, compared to control facilities and baseline, although the results were not statistically significant (p=0.17 and 0.47, respectively).

Weekly monitoring of PPH incidence per 1000 deliveries, reported by all intervention group 3 facilities showed sizable reduction of PPH cases in group 3 facilities from about 48 to 12. This has also been confirmed by review of facility statistics according to which, PPH incidence two months after the intervention was reduced by 15 per 1000 (p=0.08) compared to control facilities and the baseline. A statistically significant reduction was also achieved in the institutional MMR by 284 per 100,000 deliveries (p=0.004) and case fatality rate by 8% (p=0.026) in group 3 facilities, compared to control facilities.

Cost-effectiveness evaluation of the intervention: Decision tree analysis was used to model the cost-effectiveness of the improvement intervention for each intervention group, compared to the control group. The intervention in group 1 (distribution of QI guide) cost 86.8 USD and was not cost-effective as it reduced institutional MMR, incidence of obstructed labor and case fatality from maternal PPH, however increased the case fatality among babies with Asphyxia. The results in intervention group 1 are also difficult to attribute to improvement intervention given that we did not see related improvements in care processes based on the information available in the maternal registries and only half of the respondents reported the use of QI guide. Similarly, intervention in group 2 (QI guide and orientation workshop), which cost 1931.4 USD, was not cost-effective as, in parallel of reducing institutional MMR, incidence of newborn sepsis and case fatalities from maternal PPH and preterm birth, it increased the incidence of newborn asphyxia and stillbirth rate. The intervention 3 was cost-effective as it averted institutional MMR, incidence of PPH and case fatality from maternal PPH. ICER per patient to avert institutional MMR, incidence of PPH and case fatality from PPH was 73.4 USD, 13.9 USD and 215.8 USD respectively. These results were also associated with improvement areas of focus and could be attributed to the intervention as all respondents reported the exposure to the intervention.

Conclusions and recommendations

The study results demonstrate that dissemination of the QI guide with an orientation workshop and coaching support is the most effective implementation strategy in Uganda and other similar settings, compared to control group and changes in other groups, because it strengthened continuous improvement processes in medical facilities and improved maternal and newborn care processes and outcomes in the focused improvement area. The intervention 3 was also cost effective as it averted institutional MMR, incidence of PPH and case fatality from PPH. Considering long-term cost of the coaching model, with the district coach from the district health management team performing coaching support, the intervention 3 could be very cost-effective.

To effectively scale up the implementation of the QI guide in Uganda and other similar settings, the following measures need to be considered:

- Extend the length of the orientation workshop to a minimum of two days
- Strengthen the clinical and QI capacity of District Health Teams and mobilize district-level resources to address resource availability issues within and across health facilities and to provide continuous coaching to health facility teams
- Improve medical documentation and data quality and use, as a critical component of any MNH improvement activity

Scale-up of the proven implementation strategy for the QI guide, focused on continuous coaching and team-based problem solving across Uganda and other similar settings, would likely contribute to health and economic benefits for patients and society. One such opportunity is to scale up the implementation of the QI guide across the global network of Quality of Care for MNCH, implemented in 11 countries.

I. INTRODUCTION

A. Background

There is growing recognition that clinical training and health infrastructure, while essential, are insufficient for improving and sustaining life-saving maternal and newborn health care services in low-resource settings (WHO, 2016a). Instead, broader systems strengthening and continuous quality improvement efforts at the service delivery level are needed to continuously assess gaps in processes and content of care and to plan, test, implement, regularly monitor, refine, and institute changes to deliver services correctly and consistently. Recent evidence also demonstrates that team problem solving is about three times more effective than training. To respond to this need and help frontline care providers continuously improve the quality of their care, *Improving Care for Mothers and Babies: A Guide for Improvement Teams* (QI guide), was recently developed through collaborative efforts of the Survive and Thrive Global Development Alliance (S&T GDA).

Many health care providers are confused by various quality improvement concepts and jargon. This confusion may result from the limited availability of clear and simple guidance on how to actually implement improvement efforts in their facilities. The QI guide was developed to address this need. The purpose of the guide is to demystify the quality improvement process for those who are unfamiliar with quality improvement methods.

The guide provides step-by-step instructions for improvement teams to plan, test, implement, continuously monitor, refine, and sustain interventions to solve their local problems and improve the quality of care for mothers and babies. Users learn how to implement what we know works – high-impact, evidence-based interventions – reliably, in different contexts, and every time for every patient who needs them. The guide can be used by a leader, facilitator, or coach to help others learn about and practice improvement, both in clinical and workshop settings. It may also be used as a self-study manual by improvement teams.

In 2014, a group of clinicians, educators, and improvement scientists began the development of the QI guide. Their efforts were encouraged and supported by the S&T GDA and its QI technical working group, which was led by the USAID Applying Science to Strengthen and Improve Systems (ASSIST) Project. The development of the guide was coordinated by ASSIST and the American Academy of Pediatrics (AAP) and occurred through an iterative process that involved sharing of drafts among the author group (including representatives of AAP, ASSIST, the American College of Nurse-Midwives, and the USAID Maternal and Child Survival Program) by email and discussions during phone conferences and periodic meetings at the offices of the USAID ASSIST Project.

The final version of guide was promoted and distributed through S&T GDA and partner communication channels. To facilitate its use in selected regions, ASSIST helped translate the guide into French, and LDS Charities supported translation into Spanish. All versions are now available through the AAP's International Resources website at: https://internationalresources.aap.org/.

The QI guide and supplemental materials have the potential to reach a vast number of maternal and newborn care providers throughout the world. Where possible, the guide was used as part of the Survive and Thrive Newborn and Maternal health educational modules that was implemented by various S&T GDA partners globally. The guide can be used as a standalone resource to build QI capacity and initiate improvement efforts worldwide. In addition, given the resource constraints confronting many maternal and child health programs in low- and middle-income countries, this tool is increasingly perceived by USAID and GDA partners as a critical resource to help improve QI capacity, establish continuous quality improvement in health care facilities, and accelerate the progress toward ending preventable child and maternal deaths.

To promote and scale up the use of the QI guide at the global level, it was essential to determine the most effective and cost-effective strategies to implement the guide and evaluate its ability to initiate and establish continuous improvement processes in medical facilities and ultimately improve maternal and newborn care processes and outcomes.

The Office of Maternal and Child Health and Nutrition at USAID's Bureau for Global Health asked the USAID ASSIST Project to assess the effectiveness and cost-effectiveness of the QI guide in a Preventing of Child and Maternal Death priority country. Considering high rates of maternal and neonatal mortality in Uganda—Uganda's maternal mortality rate stands high at 336 per 100,000 live births, and neonatal mortality rate is 27/1,000 live births (Uganda Bureau of Statistics and ICF 2018)—and the tremendous commitment of the Government of Uganda to improving the care of mothers and babies, in agreement with USAID's global maternal and child health and nutrition and field teams, the effectiveness and cost-effectiveness of the QI guide was tested in service delivery settings in Uganda.

B. Objectives

The goal of this study was to evaluate the comparative effectiveness and cost-effectiveness of three different implementation strategies for the QI guide as compared to providing only summary clinical recommendations on evidence-based maternal and newborn care practices at health facilities in Uganda (business as usual). The specific objectives of the study were to:

1. Explore key informants' perceptions of and experiences with the QI guide and its implementation strategy.
2. Evaluate the change in QI-related actions (e.g., establishing improvement teams, identifying gaps in quality of care and the particular barriers causing the gap, deciding what to improve, plan, test and implement interventions to address identified gap, routinely monitor the progress of improvement, and institutionalize improvement and successful changes in the facility) and knowledge among health care providers and managers from targeted health facilities using different implementation strategies vs business as usual (control group).
3. Determine the change in quality of maternal and newborn care processes (defined as every patient receiving the recommended services every time it is appropriate) and outcomes from pre-intervention to post-intervention in health facilities which have been exposed to the three different implementation strategies and in the control group.
4. Determine the incremental cost-effectiveness ratio of the different implementation strategies in terms of expenditure per unit of patient care improvement achieved by the implementation strategy compared to the control group.

II. METHODS

A. Study Design

This was a prospective, non-randomized, controlled assessment of effectiveness and cost-effectiveness of three QI guide dissemination strategies in participant and control facilities before and after the intervention. The study assessed three different implementation scenarios of the QI guide by comparing the effectiveness and cost-effectiveness across three intervention groups to one control group. To avoid the possible impact of limited access to evidence-based clinical recommendations (as confounding factors) to the quality of maternal and newborn care processes and outcomes across study groups, all study facilities received clinical materials outlining recommended standards of maternal and newborn care. The four study groups are described as follows:

1. Group #1 (control group) received clinical materials only

Sites in this group were considered the control as they only received the following clinical materials and not the QI guide: 1) relevant sections of the newly updated WHO Guide for Essential Practice for

Pregnancy, Childbirth, Postpartum and Newborn Care (3rd edition) (WHO 2015) ; and 2) WHO Standards for Improving Quality of Maternal and Newborn Care in Health Facilities (WHO 2016a). These documents describe standards of maternal and newborn care around the childbirth and guide assessment of compliance with recommended processes of maternal and newborn care and their outcomes.

1. **Intervention group #1 received:**

- clinical materials and
- the QI guide

Selected sites of intervention group 1 received: 1) relevant sections of the newly updated WHO guide for Essential Practice for Pregnancy, Childbirth, Postpartum and Newborn Care (3rd edition); 2) WHO Standards for Improving Quality of Maternal and Newborn Care in Health Facilities; and 3) the QI guide, *Improving Care for Mothers and Babies: A Guide for Improvement Teams*. In both situations and as appropriate, soft and hard copies of the QI guide and clinical materials were introduced to the MNCH team and facility in-charge by the study team at baseline.

2. **Intervention group #2 received:**

- clinical materials,
- the QI guide, and
- the orientation workshop

Orientation workshop:

A one-day orientation workshop occurred five days after the baseline assessment in February 2018. It was attended by the frontline health workers and their respective facility managers from the eight facilities of intervention groups 2 and 3. The workshop was facilitated by a lead facilitator (MNCH QI Advisor of the USAID ASSIST Project), supported by two other improvement advisors with strong knowledge of QI principles and concepts. A note taker recorded the proceedings of the meeting.

During the meeting, participants were introduced to the strategies on how to use the QI guide. The ASSIST team employed various adult learning methods (e.g., small group discussions, case studies) to familiarize participants with the content of the QI guide, including knowledge of QI concepts and use of different QI tools. In addition, facilitated discussions around different steps of the plan-do-study-act (PDSA) improvement cycle and the QI guide's practice exercises were intended to help participants to apply these concepts and tools in real-life settings. Baseline facility data was used to contextualize the QI guide, identify quality gaps, improvement aims, and develop a PDSA cycle.

The meeting started with an overview of the QI guide. This was followed up by a step-by-step orientation on the different sections of the QI guide describing how a quality improvement team can plan, implement, monitor, and institutionalize quality improvement in their health facility. The orientation included the following topics and consecutive steps of quality improvement:

- Brief overview of the QI guide, including key principles of improvement;
- The model for improvement
- Step 1: Create an improvement team
- Step 2: Decide what to improve
- Step 3: Choose the barriers to overcome

Facility teams going through the QI guide at the start of the orientation workshop

- Step 4: Plan and test change
- Step 5: Determine if the change resulted in improvement and decide on the next steps
- Step 6: Make improvement a norm

Facilitators used a PowerPoint presentation, based on the "key knowledge" sections of the QI guide. Each of the abovementioned topics of the plenary presentations were followed by a small group exercises, using the QI guide and its appendices. The small groups were organized by participating health facility.

Workshop participants were advised to start an improvement process in their respective health facilities and document regularly (weekly) their work in the QI journal (adopted by the Ministry of Health of Uganda throughout the country) to monitor the progress of their improvement efforts. Additional soft and hard copies of QI guide were distributed during the orientation workshop.

3. Intervention group #3 received:

- clinical materials,
- the QI guide,
- orientation workshop, and
- follow-on coaching support

In addition to the orientation workshop and the provision of written materials described above, sites of intervention group 3 also received coaching support at their sites.

Description of coaching support

The coaching support consisted of six site visits per facility (total four facilities) by an experienced coach over a period of three months. Site visits started within one week after the orientation workshop and provided hands-on support to facility providers to form the improvement team (or revise its composition) and plan, test, and monitor changes to address a specific barrier leading to poor quality of maternal or newborn care using the QI guide. The aim of the coaching support was to provide on-the-job QI capacity building of the facility's QI team to help them throughout their improvement process using the QI guide. QI visits were held between February 20, 2018 and June 8, 2018. Each facility received six coaching visits (see **Table 1**).

Table 1. Summary timeline of the coaching visits

Visit #	Dates	Who conducted the coaching
1	February 20-23, 2018	ASSIST coach, experienced in QI
2	March 14-16, 2018	ASSIST coach experienced in QI + district coach
3	April 13-16, 2018	ASSIST coach experienced in QI + district coach
4	April 24-27, 2018	District coach
5	May 15-18, 2018	District coach
6	June 5-8, 2018	District coach

The first coaching visit was conducted by a coach from the USAID ASSIST Project and the second and third coaching visits by both the ASSIST coach and a district coach. The fourth, fifth, and sixth coaching visits were conducted by the district coach alone (**Table 1**). District coaches were staff employed by the district local government either at the district health office or at a health facility. The district coach in this study was a staff member employed by the district local government to work at a local health center level IV (HCIV) in Wakiso District (not the district were the study sites are located). The local district coaches

routinely worked at their health facilities but also provide technical assistance (TA) to other health facility teams within their district and other districts through coaching, mentorship, and support supervision in the area of MNCH. These coaches had technical competence to provide TA since they had been trained in QI and had competence in the subject matter (MNCH) by qualification and practice. To get familiar with the QI guide and its content, the district coach attended the QI guide orientation workshop.

This on-site support approach was designed to build sustainable local capacity in coaching and reduce the cost of the intervention. During each coaching visit the coach worked with the facility team to look at progress towards addressing an identified improvement aim (what changes were tested since the last coaching session, any achievements/results, challenges, what didn't work, etc.) and would support teams to prioritize actions for the next period. At each session the coach would complete a coaching log to document who attended, what was discussed, and other details about the visit. The average number of participants per site at the coaching visit ranged from three (in health center level III) to 15 (in hospital). The duration of a coaching session was between 160 and 195 minutes.

The coaching visit to each site was scheduled at a time agreed upon by the health facility team. The agenda for the meeting included review of QI team composition and functionality, review of data on performance indicators (data collected by the site team), and review of QI projects that team is working on. During the coaching visits, the team reviewed previous action plans to address the gaps in routine assessment and management of women and newborns during childbirth and newborn resuscitation. Through this coaching, the facility MNCH QI team was supported to review the QI team composition and the activity of the team over the period from the last coaching session. If the team had not held any QI meeting to review performance, the discussion focused on the root cause of why the team was unable to meet, and actions to address this root cause were discussed and agreed upon for implementation. The coaches used the QI guide to support the team to review QI team functionality. The coaches then guided the team in the meeting to review data on the performance indicators for the improvement aims they were working on/had prioritized from the orientation workshop. This process involved review of the data that the team had already collected and checking against the data sources (registers) to determine the consistency of the data collected by the team. In case of any mismatch in the data, the team was coached on how to correctly collect the data and clearly define and measure the indicators.

The team's QI documentation journal was also used for this exercise. The session then proceeded with the QI team going through their improvement aim (typically one member presents each improvement project with the other members of the team contributing to the discussion), the gaps that were identified in the baseline performance, and the changes they were testing to address the root causes of performance gaps. During the review, the coaches would assess the teams on the root causes, if they were adequately analyzed using the right problem analysis tools, and if the correct root causes had been identified. The facility QI team would then be assessed and supported to identify and prioritize changes to address the identified root causes and supported to determine if the change tested was effective or not, based on the evidence in their run chart in the documentation journal. The actions taken with the results of the change tested were also discussed to establish if the change was adopted, modified, or discarded. The coaches used the QI guide to help teams in their improvement journey and to document their improvement process in the QI documentation journal.

The coaches then led the discussion to review the previously developed action plans to address gaps identified in the different processes of care (e.g., routine care of mothers during labor and delivery, routine postnatal care of mothers and newborns, and newborn resuscitation). In this exercise, a QI team member of the site would go through the previous action plan to address the identified gaps for the processes of care, highlighting what intervention was planned, whether it was implemented, how it was implemented, and the results observed. Together they highlighted challenges faced, what changes were successful, which ones weren't, and any lessons learned. This was documented in the coaching guide by the coaches, and the site team filled out their action plan template. As part of the coaching visit, the coaches

also interviewed the QI team to assess their use of the QI guide and the clinical recommendations shared by the ASSIST team.

Between face-to-face coaching visits, all facilities also received remote support. Most of these contacts were logistical, reminding teams to update QI journals, collect data, or schedule the subsequent visit. Some communications also included reminders about upcoming coaching visits, guidance for understanding indicators (numerators, denominators, definitions), and checking in on progress on the objectives (changes being tested, etc.). Further details about QI interventions covered during the coaching visits in all four health facilities of intervention group 3 is provided in **Table 2** below.

Table 2. Summary QI interventions covered during the coaching visits

Components of the QI processes/interventions covered during the coaching visit	# of coaching visits with specific practices documented in the coaching log			
	Hospital	HCIII (1)	HCIII (2)	HCIV
General information about the coaching visits				
# coaching visits	6[1]	6	6	6
Average number of participants (range)	15 (8-20)	3.3 (range 2-4)	4.3 (range 3-5)	11.6 (range 11-13)
# of coaching visits with District Health Office (DHO) participation	0	1 (visit 4)	0	0
Average duration of coaching visit (minutes)	195 (range 180-240)	192.5 (range 170-240)	160 (range 125-180)	184 (range 105-240)
Step 1: Creation of an improvement team				
# of coaching visits in which the facility had a QI team	6	5 (not at the first visit)	5 (not at the first visit)	6
Creating an improvement team	3 (visits 1, 3, 6)	1 (visit 1)	2 (visits 1, 6)	2 (visits 1, 6)
Step 2: Deciding what to improve				
Deciding what to improve	3 (visits 1, 5, 6)	5 (visit 1,2,4,5,6)	5 (visits 1,2,4,5,6)	6
Step 3: Choosing the barriers to overcome				
Choosing the barriers to overcome	4 (visits 1, 2, 5, 6)	5 (visit 1,2,4,5,6)	4 (visits 1,2,5,6)	4 (visits 1,2,5,6)
Step 4: Plan, test, and implement changes				
Plan and test changes	5 (visit 1, 2, 3, 5, 6)	6	6	6
Step 5: Determine if the change resulted in improvement				
# of coaching visits for which the team had collected & reviewed data in the previous 15 days	4 (no data collected prior to first visit)	4 (not the first or last visits)	5 (not at the first visit)	3 (visits 3,4,6)
Determining if the change resulted in improvement	4 (visits 2, 3, 5, 6)	5 (visits 2,3,4,5,6)	5 (visits 2,3,4,5,6)	5 (visits 2,3,4,5,6)

[1] Information in the coaching log was not completed for all variables.

Components of the QI processes/interventions covered during the coaching visit	# of coaching visits with specific practices documented in the coaching log			
	Hospital	HCIII (1)	HCIII (2)	HCIV
Step 6: Making improvement the norm				
Share changes that resulted in improvement	4 (visits 2, 3, 5, 6)	4 (visit 3,4,5,6)	4 (visits 3,4,5,6)	4 (visits 3,4,5,6)
Making improvement the norm	4 (visits 2, 3, 5, 6)	4 (visit 3,4,5,6)	4 (visits 3,4,5,6)	4 (visits 3,4,5,6)
Documentation of QI processes				
# of coaching visits during which the QI team took notes of main discussion points and action plans	5	4 (not the first or last visits)	6	5 (visits 2,3,4,5,6)
Use of the QI guide				
# of visits during which the coach used the QI guide	5 (guide not used in first visit)	5 (visits 1,3,4,5,6)	5 (visits 1,2,4,5,6)	5 (visits 1,3,4,5,6)

B. Sampling

1. Study districts

Four districts representing four study groups and similar at baseline were randomly assigned to one of the study groups/control. They were selected in consultation with Ministry of Health according to the following criteria:

- Size of population covered;
- Maternal and newborn care outcomes (e.g., districts with relatively similar maternal and neonatal mortality rates); and
- Neighboring districts to avoid excessive travel costs during the data collection and orientation workshop.

2. Sampling of health facilities

A convenience sample of four facilities in each study district, for a total of 16 facilities, were purposively selected based on the following criteria:

- Representing all levels of health service delivery system where childbirth services are provided (one or two HCIIIs, one or two HCIVs, and/or a general hospital or Regional Referral Hospital in each study district)
- High-volume facilities with an average of 50 deliveries per months
- Facilities not currently receiving (or received during last one year) any external support to improve quality of maternal and newborn care (**Table 3**).

Table 3. Distribution of health facilities by study group and district

Study Group	District	Pre	Post
Control	District 1	4	4
Intervention group 1	District 2	4	4
Intervention group 2	District 3	4	4
Intervention group 3	District 4	4	4
Totals: 4 study groups	4 districts	n=16	n=16

3. Sampling of key informants

Sampling for key informant interviews

Two health workers in the MCH unit and one manager per facility (total 32 health workers and 16 managers or facility in-charges) were purposively selected for interview at baseline and end line because of the leadership aspects associated with QI work and the focus of the study on MNCH services. For this purpose, in each facility, we collected information on all members of the facility QI team involved in improving quality of maternal and newborn care services, including the facility in-charge, using the MNH team list. Where no formal QI team existed in the facility or where there were no maternal and newborn care providers on the existing QI team, information was collected on all care providers and managers involved in maternal and newborn care services at the time of childbirth, including their role in MNH service delivery. All individuals on the list of the MNH team from all facilities were assigned a unique identification number. This was done at the facility orientation meeting, where written materials were distributed. In each facility, from the MNH team list, we selected one manager and two health workers (different provider cadres) who were present in the facility at a time of the assessment and had an important/prominent role in MNH service delivery (e.g., leading or implementing MNH improvement initiatives). The same respondents (using their unique identification number), were invited to participate in the orientation workshop (for facilities belonging to intervention group 2 and intervention group 3) and were interviewed at the end line to examine QI processes and interventions in the facility. If the same respondents were not available in person in the facility on the day of end line data collection, a replacement respondent was selected from the MNH team list who has been employed at the facility for at least five months from the start of the intervention.

One manager (director or facility in-charge) from all 16 study facilities was invited to participate in interviews. A care provider who performs managerial functions and supervises delivery of maternal and newborn care services was interviewed as a manager and as a care provider when the facility in-charge could not be reached at a time of the assessment.

Sampling for knowledge test

In addition to perspectives on QI, all key informants (two providers and one manager) were asked to complete a self-administered knowledge test at baseline and end line. The objective of the knowledge test was to capture the change in knowledge of basic QI concepts between the baseline and end line, and to explore the clarity and user-friendliness of the guide. The sample distribution for health care provider interviews and knowledge test is shown in **Table 4**.

Table 4. Distribution of health care provider interviews and knowledge tests by study group and district

Study Group	District	Pre	Post
Control	District 1	12	12
Intervention group 1	District 2	11	12
Intervention group 2	District 3	8	9
Intervention group 3	District 4	9	12
Totals: 4 study groups	4 districts	n=40	n=45

Sampling of medical documentation

The sampling universe for medical documentation review was every mother and baby pair who received childbirth services five months preceding the intervention (baseline) and five months after start of the intervention[2] for intervention groups #1 and #2. For intervention group #3, the end line was conducted after five months from the initiation of the intervention and two months from the completion of the last coaching visit. The data collection team used the Ministry of Health's integrated maternity registry to retrieve needed data for assessment of maternal and newborn care and outcomes. All registry entries with a delivery that happened in the facility, irrespective of maternal or neonatal care outcomes, were considered eligible for inclusion in the review. The cases when pregnant women were admitted to the facility but referred to other facility before delivery were excluded from the study.

A random sample of mother-baby pairs who received childbirth services was selected from the integrated maternity registry in each facility. The sample size calculation for medical record review was based on the assumed proportions of 0.55 and 0.70 in two groups for dichotomous variables which was expressed as compliance or non-compliance with a given quality indicator with a power of 0.8, alpha of 0.05, and an intra-class correlation of 0.02, which accounts for clustering of patients by facility. This gives a sample size of approximately 230 for each study group and control group (about 57 mother-baby pairs in each facility). Combining both samples for the four groups on the pre-intervention period of 230 and four groups of the post-intervention period of 230 gives a total of 920 mother-baby pairs receiving childbirth services pre-intervention and 920 mother-baby pairs receiving childbirth services post-intervention, hence a total of 1840 registry entries. Acknowledging that the registries are often incomplete, especially prior to the intervention, where the number of deliveries allowed, the sample was adjusted to obtain an additional 13 records than the minimum sample size both at the baseline and end line, for a total sample of 70 registry entries per facility. Thus, in each facility, 70 registry entries, representing childbirth services provided for mother and baby, were randomly selected. This amounted to 1120 registry entries for five months preceding the baseline and 1120 registry entries after five months of initiation of the intervention, at the end line in all 16 facilities. A total sample of 2240 mother and baby pairs receiving childbirth services during the study period was planned to be examined.

If facilities provided childbirth services to fewer than 70 mother and babies during the last five months before the baseline and five months after initiation of the intervention, all registry entries with relevant childbirth services were reviewed during the assessment period. Since the third intervention group had

[2] Distribution of the QI guide.

only two months after completion of the intervention, we randomly selected 70 registry entries after the intervention period (two months before the end line).

The sample distribution for medical documentation review for each study group is provided in **Table 5**. Detailed information about the sample distribution for medical documentation review for each study facility is provided in **Table 21** in **Appendix 1**.

Table 5. Sample distribution for medical documentation reviews by study group

Study Group	District	Baseline	End line	Total
Control	District 1	280	280	560
Intervention group 1	District 2	280	280	560
Intervention group 2	District 3	280	280	560
Intervention group 3	District 4	280	280	560
Totals: 4 study groups	4 districts	1120	1120	2240

In addition to the random sample of 70 registry entries, representing childbirth services of 70 mother and baby pairs, we gathered aggregate data on maternal and newborn care outcomes from all childbirth services during the last five months before the baseline and five months after initiation of the interventions. Because of expected timeline of the study implementation, as noted above, intervention group 3 only had two months after completion of the intervention before the end line assessment. Therefore, the record review in this group was focused on the two months preceding the end line to better ascribe the impact of the intervention on the primary outcomes of the study.

C. Data Collection

1. Data collection methods and tools

The study collected four types of data, namely: interviews with providers and managers, a self-administered knowledge questionnaire, medical documentation review, and collection of cost data. Description of the tools, their purpose, and related study population is in **Table 6**. All data tools were in English and were pre-tested with health workers and health facilities outside of the study sites and districts prior to the study. Interviews with health workers were conducted by data collectors trained in quantitative and qualitative interviewing techniques and included both closed- and open-ended questions. Responses were recorded by hand on hard-copy data collection tools to ensure accuracy of documentation. Data abstraction tools were used to collect and tally data from medical records.

Table 6. Description of assessment tools, study population, and sample size

Name of tool	Time administered	Study population and sample size	Study Objective # Addressed
Tool #1A and 1B: Key informant interview (personal interviews)	1A was administered at baseline and 1B at end line	Two care providers and a manager were purposively selected as key informants per facility (a total of 48 interviews)	1,2
Tool #2 QI knowledge assessment tool (self-administered)	2 was administered at baseline and at end line	The same key informants who participated in the baseline survey (minimum 2 care providers and one manager) from all study facilities	2
Tool #3: Maternal and newborn care medical	Retrospective review of medical documentation in all study facilities during last 5 calendar months	Randomly selected 70 registry entries that document childbirth services provided to mother-baby pairs and their care outcome	3

Name of tool	Time administered	Study population and sample size	Study Objective # Addressed
documentation (registry) review tool	before the baseline and 5 months prior to the end line data collection except for group 3 in which medical documentation covered 2 months prior to end line	(before, during and after delivery) provided to the mother and baby pairs in the facility (total of 70 in each facility and 1120 registry entries from all facilities at baseline and 70 in each facility and 1120 registry entries from all facilities at end line	
Tool #4: Maternal and newborn care outcomes	Retrospective review of medical documentation in all study facilities during last 5 calendar months before the baseline and 5 months prior to the end line data collection and 2 months after the intervention in the case of group 3	Monthly summaries of all childbirth services provided in the facility (available in the integrated maternity registries or tally sheets as summary monthly notes)	3
Tool #5: Health facility coaching log	Completed by coaches during and immediately following the coaching visit	All logs for sites receiving coaching support (4 facilities of Intervention group 3)	2
Costing tables: Project implementation costs and facility QI costs	Collected over the study period	Direct costs for USAID ASSIST staff and others involved in coaching and implementation of the intervention and indirect from staff time involvement in QI activities in health facilities	4
MNH team list	Baseline Orientation workshop End line		1, 2

2. Data collection process

The data collection team was comprised of a field supervisor (local Principal Investigator), two experienced qualitative interviewers selected based on previous experience in qualitative data collection, and four quantitative data collectors with strong clinical content expertise in maternal and newborn health and QI.

The field supervisor, QI coach, and data collectors received a one-day training by ASSIST covering an overview of the assessment and its objectives, a review of all data collection tools and informed consent forms, sampling approaches, techniques for interviewing key informants, guidance on data extraction from the integrated maternity registry during the facility level assessments and coaching, and data capture and management procedures. Data collectors were trained in research ethics with specific emphasis on confidentiality and informed consent of study participants being interviewed. Questionnaires were checked for completeness before leaving the field every day.

The field supervisor was responsible for constructing the MNH team list at the baseline and updating it at the orientation workshop, giving respondents the knowledge questionnaire (self-administered, Tool #2) and compliance with the entire study protocol during data collection. Additionally, the field supervisor reviewed all completed and entered data collection tools for quality and completeness. In the case of qualitative data, the interviewers captured comprehensive notes during each interview using a notebook.

Costs of the improvement intervention were considered from the funder's perspective. USAID ASSIST project expenditures to support the QI interventions (printing clinical materials and the QI guide, cost of the orientation workshop, cost of coaching visits) were extracted from the project's financial reports and included direct costs (reimbursement of project technical staff, consultants, and travel costs for site data collection and coaching) of the intervention for each intervention group. Although participating sites did

not incur additional costs to implement improvement activities, expenses associated with the time care providers spent on training and coaching visits organized by the project were also considered in the cost of the intervention. Based on the level of effort spent on improving components of maternal and newborn care, the estimated cost of improvement interventions targeting priority clinical areas of maternal and newborn care was calculated. Estimation of site expenses was based on the time spent on the improvement interventions, self-reported average monthly salary of care providers and estimated number of working hours per week. Considering multiple internal (changes in price and cost) and external factors (changes in medication prices, financing and reimbursement mechanisms) affecting medical care costs, the analysis did not consider the cost of compliance or non-compliance with evidence-based interventions and only the incremental cost-effectiveness ratio was analyzed. Costs were reported in US dollars (USD) using average exchange rate for 2018 (1USD= 3698.9 UGX).

3. Data analysis

Data entry was conducted in Uganda by data entry clerks with experience in entering health data. All data entry and cleaning were done in Excel.

Descriptive statistics of frequency and percentage distributions were obtained for each set of variables measuring key informant interviews and knowledge tests results, obtained from about 10 key informants for each study group at baseline and end line. The qualitative results of key informant interviews were analyzed using a deductive approach to group the data and then observe patterns of similarities and differences of opinion and experience across knowledge management strategies. These findings were triangulated with coaching logs and other interviewee responses.

Difference-in-differences (diff-in-diff) regression analysis was performed for the process and outcome indicators extracted from medical registers to compare improvement between baseline and end line in each group of the intervention facilities to that of the control facilities. This helped us to measure the impact and the attributability of the intervention from the other possible changes that might have happened during the study period. This analysis was done using SAS University Studio.

In intervention group 3 receiving on-site coaching support, facility teams identified improvement aims and a small set of priority indicators to monitor over time. Analysis of these indicators was done through weekly time-series run charts. According to coaching reports, routine monitoring results were used to guide improvement decisions and next steps.

The cost-effectiveness analysis was conducted from the funder’s perspective. Decision tree analysis was used to model the cost-effectiveness of the improvement intervention for each intervention group, compared to the control group. Considering multiple internal (changes in price and cost) and external factors (changes in medication prices, financing and reimbursement mechanisms) affecting medical care costs, the analysis did not consider all costs of medical care, including the cost of externalities associated with improved compliance or non-compliance with recommended evidence-based clinical practices; only the incremental cost-effectiveness ratio (ICER) was analyzed. We considered all outcome indicators measuring quality of care separately as outcomes of interest for ICERs. For calculation of ICERs for a specific improvement indicator, we used the program cost associated with the relevant maternal and newborn improvement intervention and divided it by the number of patients with the relevant diagnosis/condition related to the improvement indicator to determine a per-patient cost as the denominator. Therefore, the cost-effectiveness assessment results assume that the intervention is implemented as an integrated maternal and newborn improvement activity.

4. Ethical considerations

The research presented no risk to both patients and providers. The study team ensured that the respondents understood the study objectives. The interventions being tried were expected to have a positive effect on the performance of all the providers who delivered care to them in the participating

facilities. It was expected that the societal benefits were significant in terms of identifying the most effective and efficient methods of disseminating methods and building capacity in MNCH care improvement.

The researchers adhered to ethical and moral principles of research, namely: respecting the autonomy, rights, and dignity of participants, and justice, by ensuring that the research makes a positive contribution towards people and that the research does not cause harm to the research participants.

The protocol for this research was submitted and approved by the Makerere University, School of Health Sciences Research Ethics Committee and Uganda National Council of Science and Technology (#REC REF2017-169) and by the Institutional Review Board of University Research Co. LLC in the United States (January 3, 2018).

The participating health care providers/managers (interviewed using Tool #1 and #2) were not informed about the aim of the study until the beginning of the interview to reduce bias; they were at liberty to participate or not to participate in the study. The study staff took steps to ensure each participant's understanding of the protocol and privacy and addressed possible concerns they may have. Informed consent was obtained from each participant prior to interviews. Participating providers/managers were given an information sheet in English and, if they decided to participate and sign the informed consent form, a copy of this as well. It contained contact numbers for the chairperson of Makerere University, College of Health Sciences Research Ethics Committee and for the local Principal Investigator to communicate any questions or concerns about their participation. Participants were not given any monetary or other incentives except for workshop facilitation. The interview lasted between 45 minutes and one hour. The interview was administered during the workday. Fellow staff may be aware if a provider was invited to participate in the study, but the content of the interview was kept confidential. No identifying information from patient records was documented (Tool #3 and #4). Hard copies of completed data collection tools were stored in a locked cabinet within the ASSIST Project office. Electronic files were stored on password-protected computers by ASSIST staff. Only members of the research team had access to the paper and electronic files. All data will be destroyed two years after the completion of the research activity.

III. RESULTS

A. Perceptions and Experiences of Key Informants with Different Intervention Strategies

Respondent demographics: Key informant characteristics between the baseline and endline. More than half (>50%) of the health care providers have been providing maternal and newborn care services for between 3 and 5 years and majority of care providers were female, midwifery professionals. About 22%-56% of respondents had some type of management role (facility in charge, unit in charge or team lead).

Use of QI and clinical Guides: Key informant interviews at the endline of the study revealed that most respondents in the Control group (8 of 9) and Group 1 (6 of 12) had not used either the QI or clinical guides. In Group 2, utilization of the written materials was evenly divided among those who had used only the QI guide, who had used both the QI and clinical guides, and who had not used either (2 each). In Group 3, all respondents had used both clinical and QI guides (8 of 9).

Feedback on QI guide: Key informants of Group 1 identified objectives and key knowledge, as the most useful sections of the QI guide, while group discussion and tools for identifying barriers were most valued by Group 2 and Group 3 key informants. In addition, providers from group 3 identified examples of processes and outcomes very useful for their QI processes (**Table 7**).

Table 7. Experience with materials, meeting and coaching visits (end line only)

Variables	Control (n=9) % (n)	Group 1 (n=12) % (n)	Group 2 (n=6) % (n)	Group 3 (n=9) % (n)
Applied information to improve quality of care				
Only used QI guide	0% (0)	33% (4)	33% (2)	0% (0)
Used QI and clinical guides	0% (0)	17% (2)	33% (2)	100% (9)
Only used clinical guide	11% (1)	0% (0)	0% (0)	0% (0)
Did not use any guide	89% (8)	50% (6)	33% (2)	0% (0)
Attended a 1-day orientation workshop	NA	NA	83% (5)	78% (7)
Received support after workshop			NA	100% (9)
Received 3 or more coaching visits				100% (9)
Had phone communication with coach				56% (5)
Sections of the QI guide that were the most helpful	NA	n=6	n=4	n=9
Objectives		67% (4)	50% (2)	22% (2)
Key knowledge		33% (2)	50% (2)	0% (0)
Practice exercises		17% (1)	50% (2)	11% (1)
Group discussion		17% (1)	75% (3)	22% (2)
Improvement team actions		17% (1)	50% (2)	0% (0)
Tools for identifying barriers		17% (1)	75% (3)	67% (6)
Examples of process and outcome indicators		0% (0)	50% (2)	44% (4)

When asked how they will use the QI guide in their everyday practice, orientation workshop participants from 5 out of 8 facilities (intervention group 2 and group 3) mentioned that the guide will be instrumental to provide step-by-step guidance during the implementation of the improvement interventions, help to explain the simple steps of improvement and guide how to address specific QI problems. One facility also mentioned that the guide will be helpful *"To identify the (quality) gaps, utilize the data and know how we can get there".* Overall, participants provided positive feedback on the guide, highlighting that "The volume is friendly; "The content is straight forward" and "The guide is self -explanatory". They also anticipated that the guide will help them to "perfect the work of health workers" and "Promote teamwork". Key informants at the endline also noted good organization, illustrations and simplicity of language as positive attributes of QI guide. The only negative feedback received on QI guide was the length of the material (Table 8).

The coaching log filled during the coaching visit also contained suggestions on improving QI guide, however, none of the coaching logs provided any further suggestion.

***The feedback on orientation workshop*:** Orientation workshop participants found the workshop interactive and easy to understand, however, they noted distance to the workshop location and tight program as a challenge and suggested to allocate two days for the workshop and a follow-up meeting to help better utilize the content.

The feedback on the coaching visits: key informant interviews at the endline revealed very positive attitude towards coaching visits, _ participants found it as a vanue of corrections, knowledge sharing and skills development. They reported that the coaching helped them to "*change the attitude towards QI*" and keep them motivated. They also suggested to continue coaching visits to promote sustainability, increase frequency and plan the visits "*when no clients to limit interruptions*" (**Table 8**). There was no negative feedback on the coaching visits, but it is possible that it was due to respondent bias if the data collectors and coaches viewed as representatives of the USAID ASSIST Project. However, it is noteworthy to

mention that data collectors were not ASSIST staff and no individually identifiable data were collected during the interviews).

Table 8. Perceived attributes of the guide, meeting, and coaching visits

Intervention Components	Positive Attributes	Negative Attributes	Recommendations for Improvement
Guides	"Has knowledge we need in our daily work" (clinical guide)	Hard to understand (clinical guide)	
	English is easy to read and understand (clinical & QI guides)	A lot of material to get through (QI guide)	
	Well organized (QI guide)		
	Illustrations (clinical & QI Guide)		
	Similar to HIV guide (QI guide)		
Meeting	Friendly & knowledgeable facilitator	"tight program"	Allocate 2 days
	Interactive	Far to travel from home location	Incorporate facility-based practical component
	Content		Follow-up meeting
	Tools & presentations were easy to understand		
Coaching Visits	Mentorship, immediate corrections		Better to come when no clients to limit interruptions
	Motivating		Increase frequency
	Knowledge sharing & skill development		Administer small tests or exercises to ensure understanding
	Improved attitude toward QI		Continue coaching visits to promote sustainability
	Improved documentation & supervision		

B. Change in QI-related Knowledge, Attitudes, and Practices

1. QI-related knowledge and attitudes

Assessment of knowledge of key concepts of QI found universal use of QI guide in intervention group 3 (receiving QI guide, orientation workshop and coaching) facilities at the end line. The knowledge of key QI concepts has also been improved in group 3, compared to other groups (**Appendix 3, Table 27**). The difference in QI-related knowledge in group 3 participants was substantially higher compared to other groups particularly in such practical aspects of QI such as focusing on one or two barriers of quality of care at a time, testing on small scale for feasibility and strategies for prioritizing, measuring and instituting changes. In these areas, the proportion of providers with correct answers substantially improved compared to the baseline, while the knowledge has not changed or worsened in control and intervention group 1. The knowledge and positive attitude to QI was the second highest in intervention group 2, receiving QI guide and orientation workshop. It is also noteworthy to mention that 8% less key informants from intervention group 3 considered key inputs as essential factor to deliver good quality of care at the end line, compared to baseline, while absolute or vast majority of other groups considered key inputs as essential for good quality of care both before and after the intervention (**Appendix 3, Table 27**). This attitude usually comes from the deeper understanding of the QI concepts, realizing that inputs are

necessary but not enough to address gaps in quality of care (e.g., when the gap in quality of care occurs due to incorrect or missing steps in care).

QI experience and activities

Most respondents at both baseline and end line and across groups were aware of ongoing QI activities for MNH in their facilities, however only nearly half of the respondents from control group, intervention group 1 and group 2 and none of the intervention group 3 reported ongoing MNH QI activity last month. While this remained the same at the end line in control and intervention group 1, over 80% of respondents at the end line from intervention group 2 and 3 reported ongoing MNH improvement activity during the last month. Only one third of respondents from all groups reported separate QI team for MNH at baseline. At end line, over 65% of respondents from intervention group 1 and 2 and all respondents of intervention group 3 reported having a separate QI team for MNH in their health facilities (**Table 9**).

Self-reported routine QI processes (review of performance over time, choosing the barriers to overcome, plan and test changes, measuring the progress, adjusting activities based on monitoring results, repeating PDSA cycles) improved in all intervention groups and reached 100% for almost all processes in group 2 and 3. Respondents from control group reported worsened results of routine QI processes in their respective health facilities. Intervention group 3 reported the greatest number of QI team meetings last 6 months (average of 6.2). All respondents from intervention group 3 also reported availability of written QI plan in their health facilities (1 general and 8 MNH-specific QI plan). This was sizable improvement compared to baseline. The availability of QI plans has not been changed dramatically in control and other intervention groups compared to baseline, however group 2 reported higher availability of written QI plans before and after the intervention (around 80%), compared to group 1 and control facilities, where plan availability ranged from 26-44%. Across groups and points of data collection, QI teams were not viewed by respondents as making improvement the norm and average number of hours spent on QI has been reduced at the end line across all intervention and control groups (**Table 9**, and **Appendix 2, Table 24** and **Table 26**.)

Table 9. QI experience and activities

Variables BL=baseline EL=end line	Control				Group 1				Group 2				Group 3			
	BL (n=9)		EL (n=9)		BL (n=8)		EL (n=12)		BL (n-11)		EL (n=6)		BL (n=11)		EL (n=9)	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Have prior experience with QI	89%	8	NA		50%	4	NA		91%	10	NA		73%	8	NA	
Any QI activities in health facility at the moment or near past																
Yes	89%	8	100%	9	88%	7	100%	12	91%	10	100%	6	91%	10	100%	9
When was most recent MNH QI initiative?																
Currently ongoing during last month	44%	4	100%	6	50%	4	58%	7	45%	5	83%	5	0%	0	89%	8
During last 1-3 months	0%	0	0%	0	0%	0	0%	0	18%	2	0%	0	27%	3	11%	1
During last 4-5 months	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
During the last 6-12 months	44%	4	0%	0	13%	1	0%	0	0%	0	0%	0	27%	3	0%	0
More than a year ago	0%		0%	0	0%	0	8%	1	0%	0	0%	0	0%	0	0%	0
I don't know of any MHC improvement initiative	11%	1	0%	0	13%	1	17%	2	27%	3	17%	1	18%	2	0%	0
QI team for MNH in facility																
Yes, separate QI team for MNH	33%	3	33%	2	13%	1	67%	8	36%	4	67%	4	18%	2	100%	9

Variables BL=baseline EL=end line	Control				Group 1				Group 2				Group 3			
	BL (n=9)		EL (n=9)		BL (n=8)		EL (n=12)		BL (n-11)		EL (n=6)		BL (n=11)		EL (n=9)	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Yes, one QI team that works on QI in different clinical areas	33%	3	50%	3	25%	2	17%	2	36%	4	33%	2	64%	7	0%	0
There is no team, only 1 person responsible	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
No	0%	0	0%	0	25%	2	0%	0	9%	1	0%	0	0%	0	0%	0
What does the QI team do?																
Decide what to improve	67%	6	56%	5	38%	3	75%	9	73%	8	100%	6	82%	9	100%	9
Routinely review performance and service delivery standards	67%	6	33%	3	38%	3	67%	8	64%	7	67%	4	73%	8	100%	9
Discuss and choose barriers/gaps to overcome	67%	6	56%	5	38%	3	83%	10	73%	8	100%	6	82%	9	100%	9
Plan and test changes	67%	6	33%	3	38%	3	75%	9	73%	8	100%	6	55%	6	100%	9
Determine if change resulted in improvement by monitoring indicators	67%	6	22%	2	13%	1	75%	9	55%	6	100%	6	55%	6	89%	8
Adjust activities based on monitoring results	67%	6	33%	3	13%	1	50%	6	36%	4	100%	6	45%	5	78%	7
Conduct repeating planning, implementing and monitoring changes over time	67%	6	56%	5	38%	3	58%	7	55%	6	100%	6	73%	8	100%	9
Make improvement the norm	0%	0	0%	0	0%	0	0%	0	9%	1	0%	0	0%	0	0%	0
Average number of QI team meetings on MNH in last 6 months	3 (range 1-6)		3.4 (range 1-6)		4.6 (range 2-6)		1.9 (range 1-5)		1 (range 1-2)		3.3 (range 1-6)		2 (range 0-3)		6.2 (range 1-12)	
Written facility QI plan																
Yes, for MNH only	11%	1	11%	1	13%	1	33%	4	27%	3	50%	3	18%	2	89%	8
Yes, but general	33%	3	22%	2	13%	1	8%	1	55%	6	33%	2	27%	3	11%	1
No	33%	3	0%	0	50%	4	25%	3	0%	0	17%	1	9%	1	0%	0
Don't know	0%	0	22%	2	0%	0	17%	2	9%	1	0%	0	27%	3	0%	0

QI structures and activities in Intervention group 3 facilities*:* Coaching logs, filled during the coaching visits in intervention group 3 provided further details about QI activities and processes in four supported health facilities. Specifically, all facilities formed a QI teams. The QI teams at both HCIIIs were slower to move forward following the orientation meeting, but as with the other two facilities, by the third or fourth coaching visit, there was documentation of the team working together, journal use, and data collection and analysis.

One HCIII team did meet after the orientation meeting but had not used data to determine baseline, documented the meeting, or had a clear understanding of the implementation objectives. By the second

coaching visit, there appeared to be more clarity on the role of the QI team, and they had established their QI team. The team had also begun collecting and analyzing data with graphs. Good teamwork was observed by the third coaching visit.

In the second HCIII, the QI team was formed during the orientation but, unlike the other two facilities, had not been oriented before the first coaching visit. By the second visit, the team members were listed on the wall of the facility, and teamwork was observed by visit 3. However, the coach noted in the third visit that some staff had negative attitudes toward their work (unclear if this was in general, toward clinical work specifically, or toward QI work specifically).

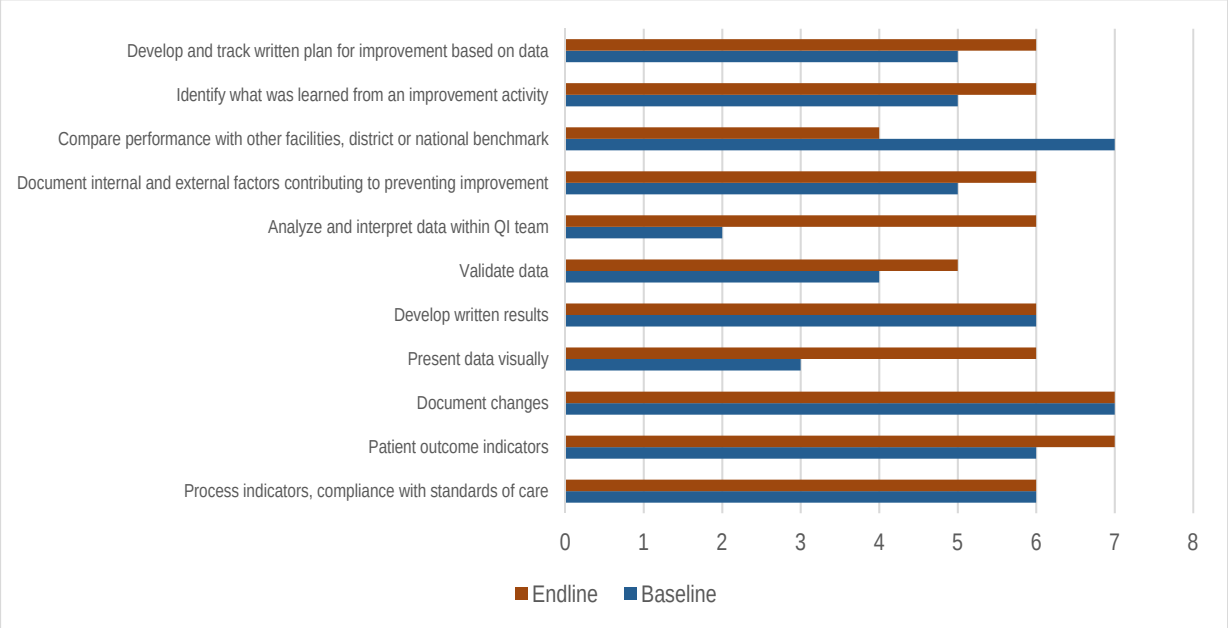
In the third supported health facility (HCIV), at the third coaching visit, the team still faced challenges in specifying their activities.

In fourth supported health facility (hospital), the QI team was established after the orientation workshop and met weekly. By the second visit they were collecting data and implementing changes. The actions planned at the QI meetings were carried out, and improvements were seen in partograph use and stock/cold chain for uterotonics.

2. Data collection and use for continuous improvement

Fewer respondents in the control group at end line reported the facility collecting and reviewing performance data compared to baseline (5 of 9, 9 of 9, respectively). In line with the quality improvement goals, the study determined what data was being collected and what was done with the data. There was a shift in the purpose of data collection between the baseline and end line following the intervention. In group 3, there was a shift in the need to use data to identify what was learned from an improvement activity, analyze and interpret data within the QI team and to document changes, develop written results, and document internal and external factors contributing to changes observed (**Figure 1**). Self-reported data use for continuous improvement has sizably improved at the end line and surpassed over 65%, except data validation (56%) and comparing performance data with other facilities (44%), which may not be under the control of facility teams (**Appendix 2, Table 26**).

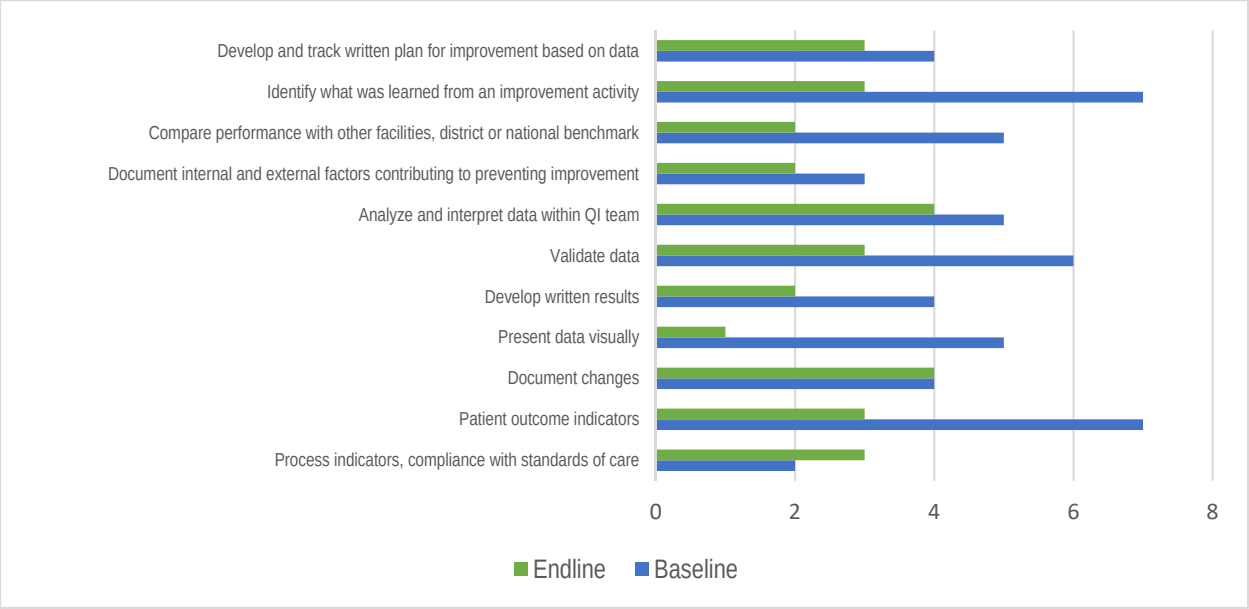
Figure 1. Data collection and use in group 3 (n=20)



In group 2, data was used to identify what had been learned from the improvement activity, analyze and interpret data by the QI team and document changes, however self-reported data collection and use

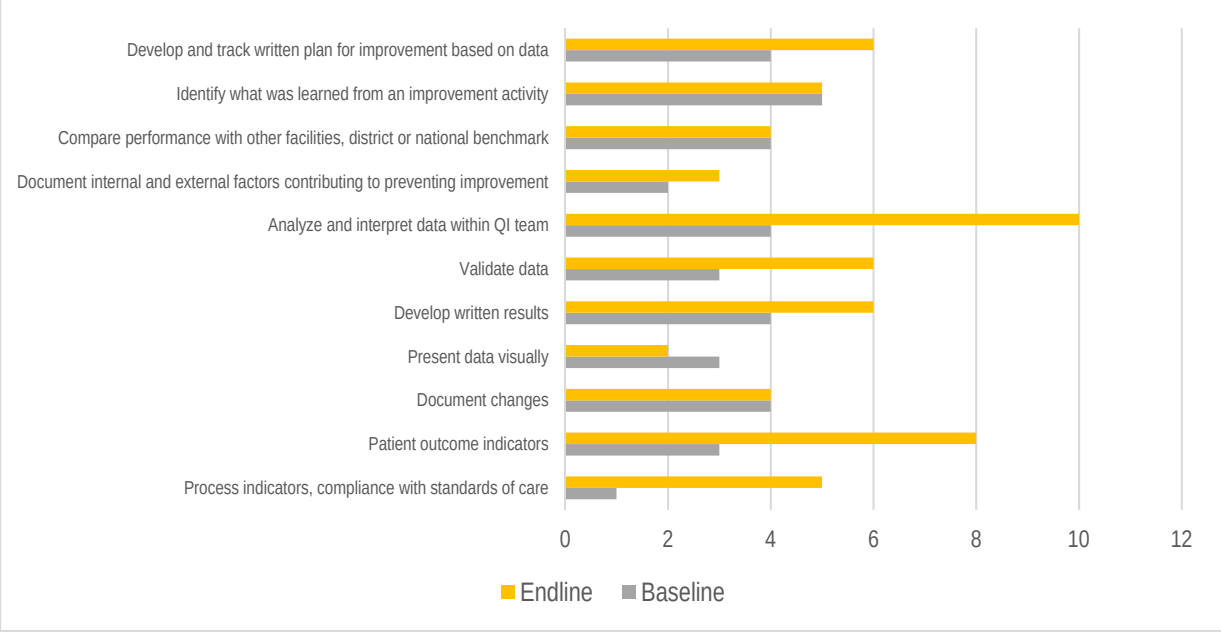
practice worsened compared to the baseline, except measuring process indicators (**Figure 2** and **Appendix 2, Table 26**).

Figure 2. Data collection and use in group 2



The data use patterns were weaker in intervention group 1 and, except improvements in collecting process and outcome indicators and analyzing and interpreting data within QI team, did not change substantially from the baseline (**Figure 3** and **Appendix 2, Table 26**).

Figure 3. Data collection and use in group 1



Supportive supervision and coaching

Across all groups and data collection points, respondents indicated that they had received supportive supervision or coaching in the previous 12 months, mostly from external coach or supervisor. At the

baseline, representatives of the control group and group 3 also reported support from a clinical supervisor or peer within the facility, however, internal coaching support was reduced and external supervision increased at the end line in these study groups. Control group and group 3 also reported improved regularity of coaching and frequency of the visits (at least monthly). Interestingly, almost all respondents of control group and group 3 reported external support from clinical officers of the district health management team; external on-site support in group 1 and 2 facilities were provided by administrative officers of the district team. All respondents from groups 2 and 3 also reported external on-site support from donor-funded projects.

In terms of content of the coaching visits, respondents from intervention group 1 and 2 reported weaker on-site support in almost all aspects of coaching and supportive supervision, including on-the job clinical training, sharing evidence-based clinical materials and guidance for improvement activities. These aspects of the coaching appeared weaker in the control group, particularly at the end line, while all on-site support functions, provided by the external coach improved in intervention group 3 facilities at the end line. Notably, internal on-site support functions improved in group 2 and group 3 facilities at the end line, suggesting possible positive effect of the orientation workshop and the use of the QI guide (**Table 10** and **Appendix 2, Table 23**).

Table 10. Supportive supervision and coaching

Variables	Control				Group 1				Group 2				Group 3			
BL = baseline	BL(n=9)		EL(n=9)		BL (n=8)		EL (n=12)		BL 9 (n=11)		EL (n=6)		BL (n=11)		EL (m=9)	
EL = end line	%	n	%	n	%	n	%	n	%	N	%	n	%	n	%	n
Received supportive supervision or coaching in last 12 months	89%	8	100%	9	75%	6	92%	11	91%	10	100%	6	100%	11	100%	9
Who provides supervision or coaching?																
Clinical supervisor within facility	89%	8	22%	2	25%	2	58%	7	27%	3	50%	3	64%	7	56%	5
Peer within facility	67%	6	0%	0	13%	1	0%	0	9%	1	0%	0	82%	9	11%	1
External coach or supervisor	89%	8	100%	9	63%	5	83%	10	82%	9	100%	6	100%	11	100%	9
Frequency of supportive supervision or coaching (internal or external)																
Every month	44%	4	100%	9	38%	3	8%	1	55%	6	0%	0	36%	4	67%	6
Number of supportive supervisory visits or interactions to support clinical competence or performance improvement in last 3 months																
1	0%	0	33%	3	13%	1	50%	6	36%	4	17%	1	0%	0	0%	0
2	22%	2	0%	0	25%	2	33%	4	9%	1	67%	4	0%	0	22%	2
3	22%	2	11%	1	13%	1	8%	1	9%	1	17%	1	18%	2	22%	2
4	22%	2	11%	1	0%	0	0%	0	9%	1	0%	0	27%	3	33%	3
5+	22%	2	44%	4	13%	1	0%	0	18%	2	0%	0	55%	6	22%	2
Who provided external supervision or support (Any)	n=8	n=8	n=9	n=9	n=5	n=5	n=10	n=10	n=9	n=9	n=6	n=6	n=11	n=11	n=9	n=9
Clinical officers from district/county HMT	100%	8	100%	9	40%	2	0%	0	0%	0	0%	0	91%	10	89%	8
Administrative officer from district/county HMT	25%	2	22%	2	40%	2	75%	9	56%	5	67%	4	36%	4	11%	1
Representative of donor-funded project	100%	8	0%	0	20%	1	50%	6	78%	7	100%	6	64%	7	100%	9
What was conducted during the visits from external coach																

Variables BL = baseline EL = end line	Control				Group 1				Group 2				Group 3			
	BL(n=9)		EL(n=9)		BL (n=8)		EL (n=12)		BL 9 (n=11)		EL (n=6)		BL (n=11)		EL (m=9)	
	%	n	%	n	%	n	%	n	%	N	%	n	%	n	%	n
Observe my performance directly	78%	7	100%	9	38%	3	33%	4	36%	4	83%	5	64%	7	100%	9
Review clinical records	89%	8	100%	9	50%	4	67%	8	64%	7	67%	4	91%	10	100%	9
Review performance toward care outcome or process indicators	89%	8	100%	9	0%	0	58%	7	36%	4	100%	6	55%	6	100%	9
QI capacity building	89%	8	44%	4	25%	2	75%	9	45%	5	67%	4	64%	7	100%	9
On the job clinical trainings	78%	7	33%	3	75%	6	67%	8	55%	6	33%	2	55%	6	67%	6
Distribute/sharing evidence-based guidelines, protocols, etc	89%	8	22%	2	38%	3	17%	2	55%	6	17%	1	36%	4	67%	6
Provide updates on administrative or technical issues	89%	8	89%	8	38%	3	75%	9	45%	5	100%	6	45%	5	67%	6
Provide guidance for improvement activities	89%	8	78%	7	25%	2	83%	10	73%	8	83%	5	73%	8	89%	8

Free responses regarding obstacles to improvement were grouped into three key areas: 1) commodities and infrastructure, 2) human resources, and 3) patient behaviors or challenges. Commodities and infrastructure, which included insufficient equipment, drug stockouts, and small space in the facility, was the leading obstacle across groups and points of data collection. Limited staffing was also an obstacle that persisted across groups and points of data collection. Interestingly, while multiple infrastructure and human resource factors were reported as a challenge in intervention group 3 at the baseline, their attitude had changed at the end of the intervention; none of the care providers identified human-resource related factors as barriers to QI at the end line. This is an important attitude shift on perceived barriers to quality care that may indicate increased confidence of QI teams of intervention group 3 facilities to solve their own problems that are within their control (**Table 11**).

Table 11. Obstacles to improvement (open-ended)

BL = baseline EL = end line	Control		Group 1		Group 2		Group 3	
	BL (n=9)	EL (n=9)	BL (n=8)	EL (n=12)	BL (n=11)	EL (n=6)	BL (n=11)	EL (n=9)
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Commodities and Infrastructure								
Lack of equipment/supplies	89% (8)	89%	75% (6)	100% (12)	91% (10)	83% (5)	100% (11)	33% (3)
Limited space in facility	11% (1)	11% (1)	0% (0)	17% (2)	9% (1)	50% (3)	27% (3)	11% (1)
Drug stock-outs	22% (2)	44%	0% (0)	0% (0)	0% (0)	50% (3)	45% (5)	78% (7)
Facility infrastructure is poor, including no water and inconsistent electricity	0% (0)	22% (2)	50% (4)	50% (6)	9% (1)	17% (1)	9% (1)	0% (0)
Lack of health management information system tools	0% (0)	0% (0)	13% (1)	0% (0)	0% (0)	0% (0)	9% (1)	0% (0)
No blood bank	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	9% (1)	11% (1)

Variable BL = baseline EL = end line	Control		Group 1		Group 2		Group 3	
	BL (n=9)	EL (n=9)	BL (n=8)	EL (n=12)	BL (n=11)	EL (n=6)	BL (n=11)	EL (n=9)
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Lack of transport for emergency cases/referrals	22% (2)	0%	13% (1)	8% (1)	0% (0)	0% (0)	27% (3)	0% (0)
Weak referral system	11% (1)	(0)	0% (0)	0% (0)	0% (0)	0% (0)	9% (1)	0% (0)
Human Resources								
Limited staff	56% (5)	0% (0)	38% (3)	33% (4)	27% (3)	17% (1)	27% (3)	0% (0)
Low provider motivation/poor attitude	0% (0)	0% (0)	25% (2)	8% (1)	36% (4)	0% (0)	0% (0)	0% (0)
No ongoing training to build provider skills (clinical and QI)	0% (0)	0% (0)	25% (2)	0% (0)	36% (4)	0% (0)	9% (1)	0% (0)
Low payment	0% (0)	0% (0)	0% (0)	0% (0)	18% (2)	0% (0)	0% (0)	0% (0)
Workload	0% (0)	0% (0)	0% (0)	0% (0)	27% (3)	0% (0)	9% (1)	0% (0)
Lack of support/mentorship from supervisor	0% (0)	11% (1)	0% (0)	0% (0)	0% (0)	0% (0)	9% (1)	0% (0)
Resistance from staff	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	17% (1)	0% (0)	0% (0)
Patient Behaviors/Challenges								
Mothers delay in seeking care	11% (1)	0% (0)	25% (2)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)
Distance for mothers to access care is too great	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	17% (1)	0% (0)	0% (0)
Lack of awareness in the community	0% (0)	0% (0)	13% (1)	0% (0)	9% (1)	0% (0)	9% (1)	0% (0)
Mothers don't bring supplies for delivery	0% (0)	0% (0)	0% (0)	0% (0)	9% (1)	0% (0)	0% (0)	0% (0)

Coaches reports in intervention group 3 identified stock-outs and not receiving requested drugs as a persistent challenge for QI teams. Some sites experienced challenges with availability of partographs and staff attitudes towards partograph use.

C. Change in MNH Care Processes and Outcomes Based on Medical Documentation Review

Changes in care processes and outcomes have been analyzed in the context of priority improvement areas, reported by key informants and/or in coaching visit logs (in intervention group 3). In intervention groups 1 and 2 and the control group, data collection was limited with predefined list of indicators and variables available in the maternity registries. In intervention group 3 facilities, additional indicators related to improvement aims (that may not be captured by the registries) were routinely monitored and shared by facility QI teams.

Intervention group 1 (receiving QI guide only): According to key informant interviews, over 80% of respondents of intervention group 1 reported care of sick newborn and essential maternal care as priority improvement areas of focus (**Appendix 2**, **Table 24**). However, analysis of maternal and newborn health (MNH) care processes based on medical documentation review by randomly selected registry entries found that the group 1 intervention (distribution of QI guide only) did not improve care processes related

to essential maternal care (e.g., uterotonic administration after birth and counselling on danger signs, infant feeding, and maternal nutrition) except of provision of immediate FP method to the mother before discharge, which improved by 12% from baseline, compared to the control group (p=0.02) (**Table 12** and **Appendix 4, Table 28**).

Table 12. Selected results of pairwise difference-in-difference in MNH processes, in intervention group 1, compared to control facilities; n=1240 randomly selected registry entries of mother and baby pairs

Indicators	Control		Intervention 1		Diff in diff	p-value
	Pre n=560	Post n=560	Pre n=560	Post n=560		
Essential maternal care						
% of all women giving birth in the health facility who received uterotonic after birth	98	92	68	62	0	0.9103
Care of maternal complications						
% of women in labor and childbirth area of the facility who gave birth after 12h of active labor and/or with diagnosis of obstructed labor	1	6	2	10	4	0.1476
Monthly incidence of PPH per 1000 deliveries	10	20	0	10	0	0.9955
% of all birthing or postpartum women in the health facility with following diagnosis (puerperal sepsis, sepsis related to pregnancy or cesarean section, 3-4-degree perineal tear) who received antibiotics	0	11	79	96	6	0.6658
Discharge planning and counselling						
% of mothers counselled on danger signs, home-based care, and when to return to postnatal care	76	87	88	59	-40	<.0001
% of mothers counselled on maternal nutrition	53	86	66	59	-40	<.0001
% of mothers counselled on infant and young child feeding	75	92	67	61	-23	<.0001
% of mothers with family planning method given	97	79	55	48	12	0.0227

Analysis of facility data found statistically significant reductions in the institutional maternal mortality rate (MMR) and incidence of obstructed labor in intervention group 1 facilities (p=0.012 and 0.05, respectively). These results, however, are difficult to attribute to the improvement intervention given that we did not see related improvements in care processes based on the information available in the maternal registries. Furthermore, case fatality among babies with asphyxia, improvement area of focus of the health facilities, also increased by 19% in intervention group 1 (p=0.029) compared to control facilities and the baseline (**Table 13**).

Interestingly, the majority of care processes improved in the control group, however, this did not result in corresponding improvements in care outcomes, which worsened for 12 out of 16 outcome indicators (see **Appendix 4**, **Table 28**, and **Appendix 5**, **Table 29**). Improved documentation in control group 1 may be associated with better supportive supervision practices, focused on review of maternity registries and their completion by external reviewers from district health management teams.

Table 13. Selected results of pairwise difference-in-difference MNH outcomes, comparing intervention group 1 with control group at the baseline and end line, results of review of facility statistics

Indicators	Control		Intervention 1		Diff in diff	p-value
	Pre	Post	Pre	Post		
Maternal outcomes						
Institutional maternal mortality per 100,000 deliveries	0	284.90	100.47	0	-385.37	*0.012*
Incidence of obstructed labor per 1000 deliveries	25.31	46.57	29.58	33.51	-17	*0.0503*
Incidence of PPH per 1000 deliveries	19.17	17.39	20.85	11.32	-7.76	*0.322*
Case fatality from maternal PPH	0%	8%	5%	0%	-13%	*0.099*
Case fatality from eclampsia/pre-eclampsia	0%	0%	0%	0%	0%	-
Case fatality from maternal sepsis	0%	-	0%	0%		-
Perinatal Outcomes						
Institutional neonatal mortality rate (inborn) per 1,000 live birth per months	9.46	4.53	9.34	7.29	2.88	*0.591*
Case fatality among premature babies	2%	7%	25%	36%	6%	*0.526*
Incidence of newborn asphyxia among 1000 total birth	50.16	39.89	45.61	35.71	0.37	*0.975*
Case fatality among babies with asphyxia	5%	11%	10%	34%	19%	*0.029*
Incidence of newborn sepsis among 1000 live birth	0	0	13.30	13.54	0.25	0.961
Case fatality from newborn sepsis	0%	-	19%	12%		-
Fresh stillbirths per 1,000 total birth	10.75	11.40	9.40	11.2	1.18	*0.838*
Macerated stillbirths per 1,000 total birth	16.12	7.12	12.88	13.27	9.38	*0.152*
Stillbirth rate per 1000 total birth	26.87	18.52	22.28	24.49	10.56	*0.223*

Intervention group 2 (receiving QI guide and orientation workshop): All key informants of group 2 reported working on improving newborn resuscitation, prevention and management of PPH, and care of preeclampsia/eclampsia and obstructed labor. Review of medical documentation showed 10% improvement in uterotonic administration immediately after birth to prevent PPH (p=0.005) compared to the control group and baseline (**Table 14**). However, improvements in care outcomes, except institutional MMR, which was reduced by 492 per 100,000 deliveries (p=0.05), were not statistically significant (**Table 15**).

Table 14. Selected results of pairwise difference-in-difference in maternal and newborn care processes and outcomes, comparing intervention group 2 with control group at baseline and end line, results of medical documentation review (n=random sample of 1120 charts/registry entries)

Indicators	Control		Intervention 2		Diff in diff	p-value
	Pre n=560	Post n=560	Pre n=560	Post n=560		
Essential maternal care						
% of all women giving birth in the health facility who received uterotonic after birth	98	92	84	87	10	0.0052
Care of maternal complications						
% of women in labor and childbirth who gave birth after 12h of active labor and/or with diagnosis of obstructed labor	1	6	5	10	0	0.8679
% of mothers who developed PPH per month	1	2	0	0	-1	0.3192

Table 15. Selected results of pairwise difference-in-difference in maternal and newborn care outcomes, comparing intervention group 2 with control group at baseline and end line, results of review of facility statistics

Indicators	Control		Intervention 2		Diff in diff	p-value
	Pre	Post	Pre	Post		
Maternal outcomes						
Institutional maternal mortality (MMR) per 100,000 deliveries	0	284.90	359.91	152.44	-492.37	*0.0495*
Incidence of obstructed labor per 1000 deliveries	25.31	46.57	39.74	73.89	13	*0.199*
Incidence of PPH per 1000 deliveries	19.17	17.39	17.46	7.68	-8.01	*0.25*
Case fatality from maternal PPH	0%	8%	12.73%	0%	-21%	*0.075*
Case fatality from eclampsia/pre-eclampsia	0%	0%	0%	6%	6%	*0.165*
Case fatality from maternal sepsis	0%	-	0%	10%		-
Perinatal outcomes						
Case fatality among babies with asphyxia	5%	11%	9%	8%	-6%	*0.313*
Fresh stillbirths per 1,000 total births	10.75	11.40	25.08	30.60	4.87	*0.525*

Intervention group 3 (receiving QI guide, orientation workshop and 6 coaching visits): According to key informant interviews and coaching reports, the majority of intervention group 3 facilities were focused on improving labor monitoring using the partograph (all 4 facilities), prevention of PPH (all 4 facilities), and newborn resuscitation.

Labor monitoring using the partograph: Each of the facilities also tested changes surrounding the use of the partograph to monitor labor. To address the gap, according to coaching reports, facility QI teams of intervention group 3 facilities implemented various changes throughout the course of implementation (see **Appendix 6 Table 30** for details), including:

- Conducting practical skills building sessions on how to fill out the partograph and one-on-one job mentorship
- Reviewing a sample of a partograph (correctness and completeness) during weekly meetings
- Involving facility in-charge in monitoring use of the partograph, including cesarean section partograph
- Availing partographs within the admission table in the labor suite
- Conducting physical handover of partographs during shifts
- Maintaining availability of partographs through printing partographs or tendered supply of partographs from stationary shop
- Posting and providing continuous reminders on use of partograph by ward in-charges
- Attaching partographs to admission cards or mothers' passports

As the result of tested changes, routine monitoring of improvement interventions across all three sites (where data was available) indicated improved partograph use from 6% at the beginning of February 2018 to 91% at the end of May 2018 (**Figure 4**). Correct partograph use increased from 54% to 93% in the same period (**Figure 5**).

Analysis of medical record review using randomly selected charts did not show any significant differences between group 3 facilities and control facilities with respect to maternal care processes and outcomes (**Table 16**), however, analysis of facility statistics (all registry entries during the study period) did document reduced incidence of obstructed labor by 26% and reduced fresh stillbirth rate by 4 per 1000 total births in intervention group 3 facilities, compared to control facilities and the baseline (**Table 17**), although the results were not statistically significant (p=0.17 and 0.47, respectively).

Figure 4. Percentage of mothers monitored with a partograph in three intervention group 3 facilities, February 1-May 31, 2018

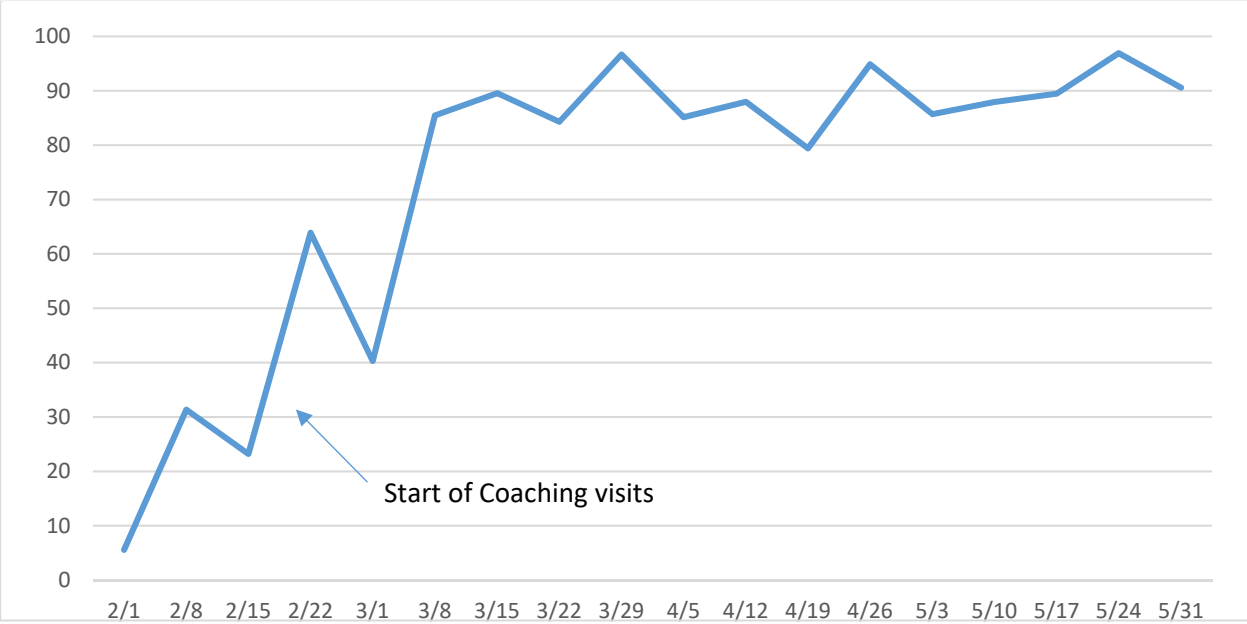


Figure 5. Percentage of mothers correctly monitored on a partograph in intervention group 3 facilities (n=3), February 1-May 31, 2018

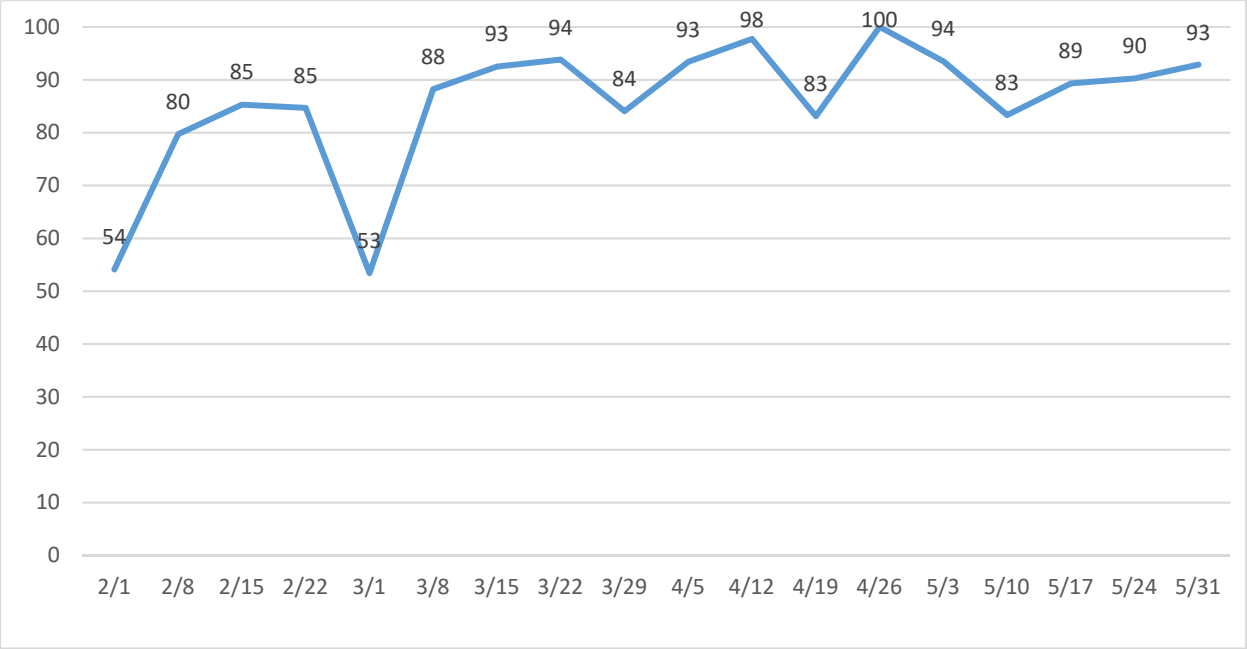


Table 16. Pairwise difference-in-difference in maternal and newborn care processes and outcomes, comparing intervention group 3 with control group at baseline and end line, results of medical documentation review (n=random sample of 2240 charts/registry entries)

Indicators	Control		Intervention 3		Diff in diff	p-value
	Pre n=560	Post n=560	Pre n=560	Post n=560		
Essential maternal care						
% of all women giving birth in the health facility who received uterotonic after birth	98	92	96	88	-2	0.4599
Care of maternal complications						
% of women in labor and childbirth area of the facility who gave birth after 12h of active labor and/or with diagnosis of obstructed labor	1	6	3	6	-1	0.6533
% of mothers who developed PPH per month	1	2	2	1	-2	0.1932
% of all birthing or postpartum women in the health facility with following diagnosis (puerperal sepsis, sepsis related to pregnancy or cesarean section, 3-4-degree perineal tear) who received antibiotics	0	11	71	57	-25	0.1791

Table 17. Selected results of pairwise difference-in-difference in maternal and newborn care outcomes, comparing intervention group 3 with control group at baseline and end line, results of review of facility statistics

Indicators	Control		Intervention 3		Diff in diff	p-value
	Pre	Post	Pre	Post		
Maternal outcomes						
Institutional maternal mortality per 100,000 deliveries	0	284.90	0	0	-284.9	*0.004*
Incidence of obstructed labor per 1000 deliveries	25.31	46.57	19.27	14.05	-26	*0.17*
Incidence of PPH per 1000 deliveries	19.17	17.39	28.62	11.78	-15.07	*0.08*
Case fatality from maternal PPH	0%	8%	0%	0%	-8%	*0.026*
Perinatal outcomes						
Fresh stillbirths per 1,000 total birth	10.75	11.40	10.87	7.41	-4.11	*0.478*

Prevention of postpartum hemorrhage: All four facilities of intervention group 3 also focused on preventing PPH through administration of uterotonic immediately after birth. To address the gap in uterotonic administration and cold-chain practices, facilities tested and implemented changes (see **Appendix 6, Table 30** for details), including:

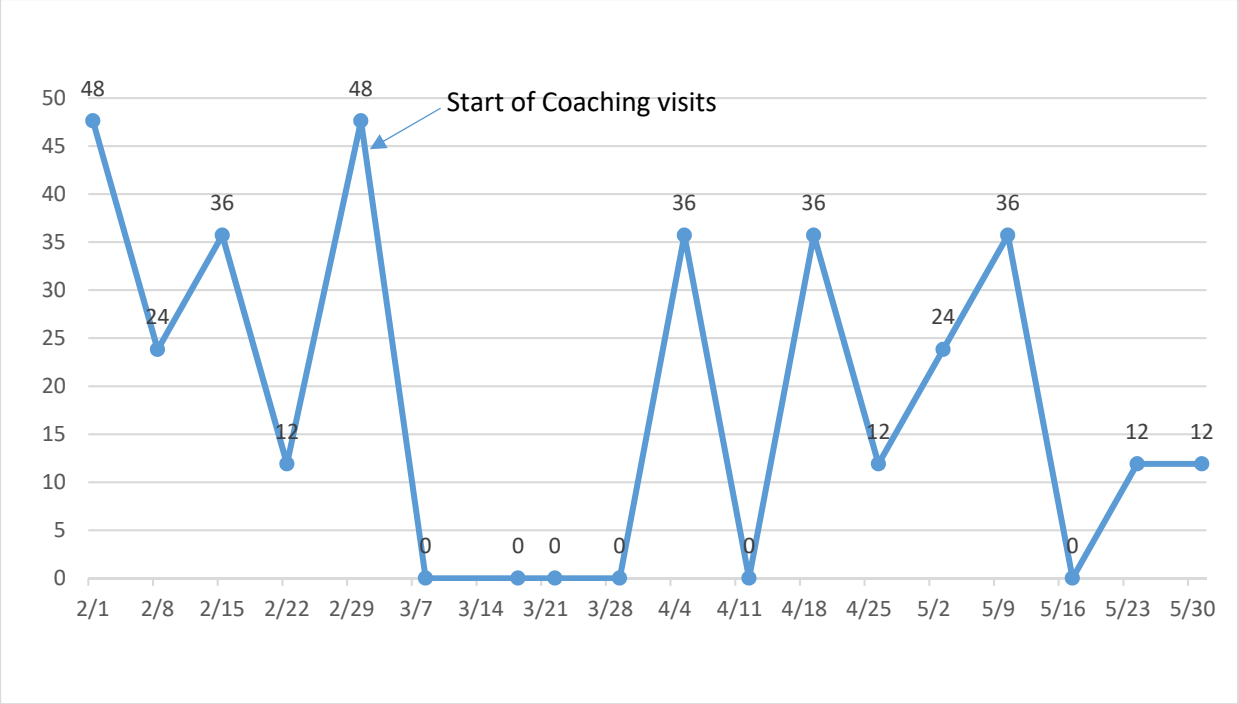
- Moving oxytocin storage from pharmacy to the labor suite using cold boxes
- Preloading oxytocin in syringes before delivery
- Maintaining stock of uterotonics, including redistribution of oxytocin from stocked facilities
- Proper screening of mothers on admission for risks of PPH
- Reviewing PPH cases during QI meetings
- Conducting physical handover to include re-stocking oxytocin and change of ice packs to maintain cold chain

As a result, coaching logs reported improved maintenance of cold chain. It is noteworthy to mention that administration of uterotonics was reduced by 2% compared to control facilities and the baseline, however

the result was not statistically significant (**Table 16**). The reduction in uterotonic use may be associated with repeated challenge of uterotonic availability, reported by intervention group 3 facilities during the coaching visits.

Weekly monitoring of the PPH incidence per 1000 deliveries, reported by all intervention group 3 facilities, showed sizable reduction of PPH cases in group 3 facilities from about 48 to 12 (**Figure 6**).

Figure 6. PPH incidence per 1000 deliveries in intervention group 3 facilities (n=4), February 1-May 31, 2018



This has also been confirmed by review of facility statistics in intervention group 3 facilities where, after two months of improvement intervention (June-July 2018), PPH incidence was reduced by 15 per 1000 deliveries (p=0.08) compared to control facilities and the baseline. A statistically significant reduction was also achieved in the institutional MMR, by 284 per 100,000 deliveries (p=0.004) and reduction of case fatality rate by 8% (p=0.026) in group 3 facilities, compared to control sites (**Table 17**).

Newborn resuscitation: Three out of four facilities of intervention group 3 worked to improve newborn resuscitation and its outcomes. According to coaching reports, facility teams tested and implemented the following changes:

- Setting up a resuscitation corner in the labor suite
- Organizing and equipping the newborn resuscitation area
- Conducting simulation trainings on newborn resuscitation for all maternity staff

As the result of the improvement activities, 65 out of 66 babies born with asphyxia (98%) were successfully resuscitated during the coaching period (see **Appendix 6, Table 30**).

D. Cost Evaluation of the Intervention

This study examined the relative cost-effectiveness of different methods of implementing the QI guide. The cost-effectiveness analysis was conducted from the funder's perspective. Total project cost of the

intervention for group 1 (receiving hard and soft copies of the QI book) was 86.8 USD[3]. The project cost for intervention group 2 was 1931.4 USD. This included the cost of distribution of hard and soft copies of the QI guide and orientation workshop expenses. The project cost of intervention group 3 (including distribution of the QI guide, orientation workshop, and coaching visits) was 8,092 USD (**Table 18)**. The intervention cost included the cost of printing/reproduction of the QI book; cost of labor, venue, and supplies for the orientation workshop and for the coaching visits; cost of transportation for coaching activities; the costs of lodging, per diem, meals, and incidentals of project staff conducting coaching visits and the orientation workshop; and other expenses directly related to the intervention.

Table 18. Summary cost of project interventions by group

Type of expense	Total expense in UGX	Total expense in USD	Intervention group 1 in USD	Intervention group 2 in USD	Intervention group 3 in USD
Printing materials (QI book)[4]	1903000.0	514.5	86.8	86.8	86.8
Orientation workshop	13277008.8	3689.2		1844.6	1844.6
Coaching	22169793.5	6160.2			6160.2
Total cost of the intervention	37349802.3	10363.8	86.8	1931.4	8091.6

Although participating sites did not incur additional costs to implement improvement activities, expenses associated with the time care providers spent on training and coaching visits organized by the project were also considered as part of the cost of the improvement interventions. Specifically, estimation of site expenses was based on the time spent on the improvement interventions at the baseline and end line, self-reported average monthly salary of care providers, and estimated number of working hours per week. Interestingly, average self-reported time spent on QI was reduced at end line, compared to baseline for all study group participants (**Table 19**). Therefore, it has been assumed that facilities of all study groups did not incur any additional expenses related to staff time spent on QI during the intervention period, and thus, these costs were not included in the cost analysis.

Considering multiple internal (changes in price and cost) and external factors (changes in medication prices, financing and reimbursement mechanisms) affecting medical care costs, the analysis did not consider all costs of medical care, including the cost of externalities associated with improved compliance or non-compliance with recommended evidence-based clinical practices. Thus, only incremental cost-effectiveness ratio was analyzed.

Table 19. Average time spent on QI at baseline and end line by study group

	Hours spent on QI	Average # of working hours per week	Average monthly salary in UGX
Baseline			
Control	2	63.9	710000.0
Group 1	1.51	42.0	555142.9
Group 2	1.95	57.5	547545.5
Group 3	2	68.8	671000.0
End line			

[3] Costs were reported in US dollars (USD) using average exchange rate for 2018 (1USD= 3698.9 UGX).
[4] This does not include the cost of distribution of clinical materials, which was received by all study groups, including the control group.

	Hours spent on QI	Average # of working hours per week	Average monthly salary in UGX
Control	1.3	68.4	683922.2
Group 1	0.85	34.3	637500.0
Group 2	1.1	34.8	772833.3
Group 3	1.9	51.2	583000.0
Change in average number of hours spent on QI at end line			
Control	-0.7		
Group 1	-0.66		
Group 2	-0.85		
Group 3	-0.1		

Decision tree analysis was used to model the cost-effectiveness of the improvement intervention for each intervention group, compared to the control group. We considered all outcome indicators measuring quality of care separately as outcomes of interest for incremental cost-effectiveness ratios (ICERs). For calculation of ICERs for a particular outcome indicator, we used the program cost associated with the relevant improvement intervention for each group and divided it by the number of patients with the relevant diagnosis/condition related to the improvement indicator, retrieved from facility statistics to determine a per-patient cost as the denominator. Therefore, the cost-effectiveness assessment results assume that the intervention is implemented as an integrated maternal and newborn improvement activity. This means that the results assume that the MNH improvement intervention is implemented as one whole package, rather than as an improvement intervention to address a single disease or condition.

Table 20 presents the ICER based on the results of difference-in-difference analysis of the medical documentation review two months after the intervention per each intervention group. The ICER results can be read as the additional cost of the intervention for each additional patient to achieve specific maternal and newborn care outcomes. The intervention in group 1 (distribution of QI guide) cost 86.8 USD and was not cost-effective as it reduced institutional MMR, incidence of obstructed labor and case fatality from maternal PPH, however increased the case fatality among babies with Asphyxia. The results in intervention group 1 are also difficult to attribute to improvement intervention given that we did not see related improvements in care processes based on the information available in the maternal registries and only half of the respondents reported the use of QI guide. Similarly, intervention in group 2 (QI guide and orientation workshop), which cost 1931.4 USD, was not cost-effective as, in parallel of reducing institutional MMR, incidence of newborn sepsis and case fatalities from maternal PPH and preterm birth, it increased the incidence of newborn asphyxia and stillbirth rate in intervention group 2 facilities. These results are also difficult to attribute to improvement intervention given as only 67% of respondents reported the use of the QI guide. The intervention 3 was cost-effective as it averted institutional MMR, incidence of PPH and case fatality from maternal PPH. ICER per patient to avert institutional MMR, incidence of PPH and case fatality from PPH was 73.4 USD, 13.9 USD and 215.8 USD respectively. These results were also associated with improvement areas of focus and could be attributed to the intervention as all respondents reported the exposure to the intervention (**Table 20** and **Table 31** in **Appendix 7**).

Table 20. Incremental cost-effectiveness ratio (ICER) per patient by intervention group for specific MNH practices based on difference-in-difference analysis of medical documentation review during March-July 2018

Indicator	Group 1			Group 2			Group 3		
	Diff in diff	p value	ICER USD	Diff in diff	p value	ICER USD	Diff in diff	p value	ICER USD
Institutional maternal mortality per 100,000 deliveries	-385.37	0.012	-0.5	-492	0.0495	-7.5	-284.9	0.004	-73.4
Incidence of obstructed labor per 1000 deliveries	-17	0.0503	-0.1						
Incidence of PPH per 1000 deliveries							-15.07	0.08	-13.9
Incidence of newborn asphyxia among 1000 total births				44.91	0.001	0.8			
Incidence of newborn sepsis among 1000 live births				-9.98	0.007	-3.9			
Stillbirth rate per 1000 total births				22.16	0.031	1.7			
Case fatality from maternal PPH	-13%	0.099	-1.4	-21%	0.075	-18.5	-8%	0.026	-215.8
Case fatality among premature babies				-14%	0.088	-12.6			
Case fatality among babies with asphyxia	19%	0.029	0.3						

Key: Grey area= results are not statistically significant and thus, ICER does not apply.

Despite cost-effectiveness of the intervention in group 3, the ICER per patient, because of the high initial cost of the coaching support, was still high. Considering that the coaching model introduced by the ASSIST team empowered the district coach from the district health management team to provide coaching support, the cost of the intervention after the initial phase could be minimal and very cost-effective.

IV. DISCUSSION

Use of the QI guide and feedback on its different implementation scenarios: The study results clearly demonstrated that distribution of clinical or QI guides alone do not guarantee their use without continuous on-site coaching support; most respondents in the control group (8 of 9) and intervention group 1 (6 of 12) had not used either the QI or clinical guides, while all respondents from intervention group 3 had used both the clinical and QI guide. This is an important finding that speaks against the low-resource-intensive distribution of materials, without follow-up mechanisms to support implementation.

The study also provided valuable qualitative feedback on the QI guide and the orientation workshop. Despite the usefulness and user-friendliness of the QI guide, it became clear that a one-day orientation workshop is not sufficient to induce participants to fully utilize the content of the QI guide; more time and follow-up on-site support are needed to enable participants to apply its key concepts in health care service delivery settings using case scenarios, exercises, and real life problems in quality of care. Implementation of the QI book in other similar settings (e.g., Ghana, Guyana) showed similar findings. It is recommended therefore to extend the length of the orientation workshop for minimum of two days to allow time for practice exercises for each step of improvement and group discussions allow participants to reflect on its practical applications in context-specific settings.

Key informants' feedback on the on-site coaching support was overwhelmingly positive, finding coaching support to be a mechanism for correcting misconceptions, knowledge sharing, skill development, and changing QI attitudes and practices. This has been confirmed by the study results, demonstrating improved ***knowledge of key QI concepts*** in group 3, compared to the other groups, particularly in such practical aspects of QI such as focusing on one or two barriers of quality of care at a time, testing on a small scale for feasibility, and strategies for prioritizing, measuring, and instituting changes. Group 3 also

demonstrated deeper understanding of QI concepts and less dependence on inputs as the most important aspect to improve quality of care. The knowledge and positive attitude toward QI were the second highest in intervention group 2, which also received the orientation workshop. These findings further solidify the argument that dissemination of QI materials alone is not enough for changing knowledge or attitudes of care providers towards QI. With follow-up coaching support, the QI guide was better able to achieve one of its core objectives: to demystify the quality improvement process, making it simple and user-friendly.

In terms of ***QI practices***, on-site coaching support increased the regularity of ongoing MNH improvement activity in intervention group 2 and 3 facilities. Self-reported routine QI processes also improved and reached 100% for almost all processes in groups 2 and 3, while these processes worsened in the control group. Respondents of intervention group 3 facilities also reported a sizeable improvement in the availability of written QI plans in their health facilities compared to baseline, while the availability of QI plans did not change dramatically in control and other intervention groups compared to baseline. Coaching reports provided further evidence of the functionality of QI teams in intervention group 3 facilities, highlighting that all facilities of intervention group 3 formed QI teams and by the third or fourth coaching visit, there was documentation of the team working together, using the documentation journal, and collecting and analyzing data. The coaching reports also found that lower level health facilities required more time to understand QI concepts and engage in continuous QI activities than the hospital QI team. While, this trend was also observed by the USAID ASSIST Project across different low- and middle-income countries and various service delivery settings, further research is needed to explore key attributes of this finding.

Despite clear evidence of improved QI practices in intervention group 3 facilities, the study found that across groups and points of data collection, QI teams were not viewed by respondents as making improvement the norm. This is an important study finding, suggesting that six coaching visits may not be enough to help facility teams to realize their potential for sustaining improvement in care processes and outcomes.

***Data collection and use for continuous improvement*:** The study findings suggest that data use for continuous improvement was the strongest in group 3 and the second strongest in group 2 facilities. In group 3, self-reported use of data for continuous improvement increased at end line and surpassed over 65% for almost all measures. In study group 3, there was also an increase in recognition of the need to use data to identify what was learned from an improvement activity, analyze and interpret data within the QI team, and document changes, develop written results, and document internal and external factors contributing to changes observed. Considering the importance of data use to inform evidence-based improvement decisions, on-site coaching that builds capacity of QI teams to regularly generate, collect, analyze, and use data to inform next steps, can be viewed as effective strategy to build capacity for data analysis and use for continuous improvement.

The study findings also suggest that improving medical documentation and data quality and use should be a critical component of any MNH improvement activity. Because of limited availability of essential MNH data elements in the registries, we were not able to monitor all important maternal and newborn care processes of care and demonstrate the linkages between improved care processes and outcomes. Limited availability of essential clinical data elements and poor standardization and completion of medical records pose significant challenges to MNH improvement activities, limiting the ability of QI teams to review and monitor care performance over time without excessive time spent on observation or interviews.

***Supportive supervision and coaching*:** Across all groups and data collection points, respondents indicated that they had received supportive supervision or coaching in the previous 12 months, mostly from an external coach or supervisor. Group 3 reported improvements in all internal and external on-site support functions and increased frequency of on-site visits (at least monthly). The coaching also helped

teams to change their attitude towards perceived barriers to quality care and increased the confidence of QI teams to solve local problems that are within their control.

Change in MNH care processes and outcomes: Assessment of effectiveness of different implementation scenarios of the QI guide demonstrated comparative effectiveness of the third intervention (QI guide distribution, orientation workshop, and coaching support) to improve MNH care processes and outcomes, compared to control facilities and other intervention groups. In **intervention group 1,** the intervention did not improve care processes related to priority improvement areas, such as essential maternal care (e.g., uterotonic administration after birth and counselling on danger signs, infant feeding, and maternal nutrition) except of provision of a family planning method to the mother before discharge, which improved by 12% from baseline, compared to the control group (p=0.02) (**Table 12** and **Appendix 4, Table 28**). Analysis of facility data found a statistically significant reduction in the institutional maternal mortality rate and decreased incidence of obstructed labor in intervention group 1 facilities (p=0.012 and 0.05, respectively). These results are, however, difficult to attribute to the improvement intervention given that we did not see related improvements in care processes. The case fatality among babies with asphyxia, the outcome of priority improvement area reported by group 1 facilities, demonstrated statistically significant increase and thus, ineffectiveness of the intervention implemented in study group 1 facilities.

In **intervention group 2** facilities, uterotonic administration immediately after birth to prevent PPH improved by 10% (p=0.005) compared to the control group and baseline (**Table 14**). However, improvements in care outcomes were not statistically significant (**Table 15**), except for the decrease in the institutional maternal mortality rate, which was reduced by 492 per 100,000 deliveries (p=0.05).

The **intervention group 3** facilities were focused on labor monitoring using partograph (all 4 facilities), PPH (all 4 facilities), and newborn resuscitation (3 of the 4 facilities). Routine monitoring of improvement interventions by facility teams indicated improved successful resuscitation. The facilities with coaching support also improved the use and correct completion of the partograph and reached an associated reduction in the incidence of obstructed labor and fresh stillbirth rate, compared to control facilities and the baseline (**Table 17**). Also, weekly monitoring of PPH incidence per 1000 deliveries showed a sizable reduction of PPH cases in group 3 facilities, also confirmed by facility statistics according to which, PPH incidence two months after the intervention was reduced by 15 per 1000 deliveries (p=0.08) compared to control facilities and the baseline. A statistically significant reduction was also achieved in the institutional maternal mortality rate by 284 per 100,000 deliveries (p=0.004) and the PPH case fatality rate by 8% (p=0.026) in group 3 facilities, compared to control sites (**Table 17**).

To improve care processes and outcomes, evidence-based interventions or global practice guidelines first need to be translated and contextualized to the needs of local settings and then a support system consisting of technical assistance and coaching needs to be put in place to ensure that these adapted practices are successfully embedded into the organizational culture (Ramaswamy et al. 2015). Our study found improvement in maternal and newborn care processes and associated outcomes in group 3 facilities even though across all groups and data collection points, respondents indicated that they had received supportive supervision or coaching in the previous 12 months. Our study confirms findings of other studies providing a strong argument for coaching (Rowe et al. 2018), however, our study also suggests that the content of on-site support matters. Given that care providers did not learn QI concepts during pre-service, in-service, or continuing medical education trainings, teams needed to be guided to prioritize what to improve, identify gaps and root causes of the gaps in quality of care, and select, test, implement, routinely monitor, and refine changes to address the gaps through local, feasible solutions. From this perspective, our study findings confirm recent evidence from Lancet Global Commission on High Quality Health Systems on effectiveness of team-based problem solving to improve quality of care (Rowe et al. 2018).

Cost-evaluation of the intervention: The intervention 1 (distribution of QI guide) and 2 (distribution of QI guide and follow-up orientation workshop) were not cost-effective; in parallel of improving care outcomes, intervention 1 and 2 increased the incidence of complications and case fatalities. The results in intervention group 1 and group 2 facilities are also difficult to attribute to respective interventions given that not all respondents reported exposure to these interventions (e.g. the use of QI guide). The intervention 3 was cost-effective as it averted institutional MMR, incidence of PPH and case fatality from maternal PPH. ICER per patient to avert institutional MMR, incidence of PPH and case fatality from PPH was 73.4 USD, 13.9 USD and 215.8 USD respectively. These results were also associated with improvement areas of focus and could be attributed to the intervention as all respondents reported the exposure to the intervention.

Despite cost-effectiveness of the intervention in group 3, the ICER per patient, because of the high initial cost of the coaching support, was still high. Considering that the coaching model implemented by the ASSIST team, which empowered coaches from the district health management team with a supportive supervision function to perform coaching support, the cost of the intervention after the initial phase could be minimal and very cost-effective in the long run. Also, considering that the cost of the demonstration phase of the QI intervention is typically higher than the cost of its spread in the same number of facilities (due to higher costs associated with assessment of quality gaps, preparation of QI implementation, and development of evaluation tools and materials), the scale-up of QI interventions has the potential to reach substantial cost-savings per patient.

Lastly, the study results suggest that many of the problems related to supporting key inputs in health facilities remain unsolved. Insufficient infrastructure and commodities, together with staff shortages and turnover, pose challenges to continuously improving and sustaining the quality of maternal and newborn care. Considering the critical role of the district health system in sustaining MNH improvement efforts, resources for district health offices must be mobilized to address resource availability issues within and across health facilities (e.g., key inputs such as infrastructure, human resources, commodities, and ambulance services) and to provide continuous coaching to health facility teams (e.g., transportation to health facility) (WHO 2016b).

A. Strength and Limitations of the Study

The strength of the study was the sufficiently large sample size for medical documentation review and inclusion of a control group; The study sample for medical documentation review was sufficiently large and representative (randomly selected) to allow assessment of the effects of the intervention on maternal care processes and outcomes. While inclusion of the control group also allowed us to assess to what extent the results demonstrated were attributable to the interventions, our study had limitations.

First, the sample size may not be large enough for rare outcomes. Similarly, we had relatively small number of key informants and health facilities included in the study. Lacking random assignment of intervention and control facilities limits generalizability of our results beyond Uganda because of unmeasured confounding variables. However, medical documentation results did come from randomly selected register reviews, and our findings are consistent with other study findings on the effectiveness of coaching and team-based problem solving (Ramaswamy et al. 2015; WHO 2016a).

While the study aimed to assess the use of QI guide, as part of the impact, the assessment of the impact on related QI and clinical processes and outcomes assumed that the QI guide was used. However, because of limited use of QI guide in intervention arm 1 (50%) and partly in intervention arm 2 (67%), the study results in intervention arm 1 and 2 are difficult to fully attribute to respective interventions.

Assessment of QI knowledge, attitudes, and practices and MNH care processes and outcomes at baseline and end line in both intervention and control facilities strengthened our case for arguing that the improvements are attributable to the intervention. To strengthen the argument, we also triangulated and presented data from different sources (medical documentation, provider questionnaires, and routine

weekly monitoring of selected MNH indicators measured by facility QI teams). The fact that the analysis of data from different sources showed largely similar results and trends suggests that the data collected was reliable and gives us confidence in the results.

While qualitative interviews provided in-depth understanding of the opportunities and challenges related to QI knowledge, attitudes, and practices of key informants, many questions were free response, meaning that options were not read to the respondent, and respondents spontaneously listed, for example, who provided supportive supervision or mentorship. It is possible that respondents did not provide comprehensive responses due to recall or other biases.

Lastly, cost-effectiveness analysis did not consider costs associated with improved compliance or non-compliance, including economic effects of poor MNH practices. Considering these long-term effects would make a stronger case for the cost-effectiveness of the third implementation strategy (distribution of QI guide, orientation workshop, and coaching support).

V. CONCLUSIONS AND RECOMMENDATIONS

The study results demonstrate that dissemination of the QI guide with an orientation workshop and coaching support is the most effective implementation strategy in Uganda and other similar settings, compared to control group and changes in other groups in terms of improving:

- The use of the QI guide
- Knowledge of key QI concepts, positive attitudes, and QI practices, including data use for improvement, and
- MNH care processes and outcomes in priority focus areas, reported by QI teams

The intervention 3 was also cost-effective as it averted institutional MMR, incidence of PPH, and case fatality from PPH. Considering long-term cost of the coaching model, with the district coach from the district health management team performing coaching support, the intervention 3 could be very cost-effective. Also, considering that the cost of the demonstration phase of the QI intervention is typically higher than the cost of its spread in the same number of facilities, the scale-up of the 3rd QI guide implementation strategy has the potential to reach substantial cost-savings per patient.

To effectively scale up the implementation of the QI guide in Uganda and other similar settings, the following measures need to be considered:

- It is recommended to extend the length of the orientation workshop to a minimum of two days to allow time for practice exercises for each step of the improvement process and for group discussions to reflect upon its practical applications in context-specific settings.
- The role of district health teams in Uganda is crucial to build and sustain QI capacity and on-site coaching support in an efficient manner. To this end, the clinical and QI capacity of district health teams needs to be strengthened and district-level resources mobilized to address resource availability issues within and across health facilities and provide continuous coaching to health facility teams.
- Improving medical documentation and data quality and use should be a critical component of any MNH improvement activity. Improving maternal and newborn care would not be possible or documented without standardization and generation of essential MNH clinical data to routinely monitor performance and use data for continuous improvement.

Scale-up of the proven implementation strategy of the QI guide, orientation workshop, and on-site coaching support, stimulating team-based problem solving across Uganda and other similar settings would likely contribute to health and economic benefits for patients and society. One such opportunity is

to scale up the implementation of the QI guide across the WHO Global Network for Quality of Care for MNCH, implemented in 11 countries. The QI guide has been introduced in three network countries, Ghana, Uganda, and Ethiopia (by American Academy of Pediatrics) and has shown promising initial results in all three countries. Strong leadership and commitment from the Ministry of Health of Uganda and other network countries to improve quality of care for mothers, newborns, and children, create favorable conditions to spread effective QI guide implementation strategies and sustainably improve the health of mothers and babies at large scale.

REFERENCES

Ramaswamy R, Iracane S, Srofenyoh E, Bryce F, Floyd L, Kallam B, Olufolabi A, Romeck VZ, Medge O. 2015. Transforming Maternal and Neonatal Outcomes in Tertiary Hospitals in Ghana: An Integrated Approach for Systems Change. *J Obstet Gynaecol Can* 2015;37(10):905–914.

Rowe AK, Rowe SY, Peters DH, Holloway KA, Chalker J, Ross-Degnan D. 2018. Effectiveness of strategies to improve health-care provider practices in low-income and middle-income countries: a systematic review. *Lancet Glob Health* 2018; 6: e1163–75. http://dx.doi.org/10.1016/.

Uganda Bureau of Statistics (UBOS) and ICF. 2018. Uganda Demographic and Health Survey 2016. Kampala, Uganda and Rockville, Maryland, USA: UBOS and ICF.

WHO. 2015. Guide for Essential Practice for Pregnancy, Childbirth, Postpartum and Newborn Care (3rd edition): Available at: https://apps.who.int/iris/bitstream/handle/10665/249580/9789241549356-eng.pdf;jsessionid=21264AA969B6D2A3225DCBC90351C96C?sequence=1

WHO. 2016a. Standards for improving quality of maternal and newborn care in health facilities. Geneva, Switzerland: WHO. Available at : https://www.who.int/maternal_child_adolescent/documents/improving-maternal-newborn-care-quality/en/

WHO. 2016b. Towards a grand convergence for child survival and health: a strategic review of options for the future building on lessons learnt from IMNCI. Geneva: World Health Organization (WHO). http://www.who.int/maternal_child_adolescent/documents/strategic-review-child-health-imnci/en/.

APPENDICES

Appendix 1: Sample Distribution for Medical Documentation Review

Table 21. Sample distribution for medical documentation review per facility

Health facility	Study Group	District	Baseline	Endline	Total
1	Control	District 1	70	70	140
2			70	70	140
3			70	70	140
4			70	70	140
5	Intervention group 1	District 2	70	70	140
6			70	70	140
7			70	70	140
8			70	70	140
9	Intervention group 2	District 3	70	70	140
10			70	70	140
11			70	70	140
12			70	70	140
13	Intervention group 3	District 4	70	70	140
14			70	70	140
15			70	70	140
16			70	70	140
Total: 16	4 study groups	4 districts	1120	1120	2240

Appendix 2: Detailed Results of Key Informant Interview (Tool 1A and 1B)

Table 22. Key informant respondent demographics

Variables BL = baseline; EL = end line	Control		Arm 1		Arm 2		Arm 3	
	BL (n=9)	EL (n=9)	BL (n=8)	EL (n=12)	BL (n=11)	EL (n=6)	BL (n=11)	EL (n=9)
Facility Type								
Referral Hospital	0%	0%	0%	0%	27%	50%	0%	0%
General Hospitals	33%	33%	25%	25%	0%	0%	27%	33%
HC IV	0%	0%	25%	0%	27%	0%	27%	33%
HC III	67%	67%	50%	75%	45%	50%	45%	33%
Sex			1 (no data)					
Male	11%	11%	0%	17%	18%	17%	18%	89%
Female	89%	89%	88%	83%	82%	83%	82%	11%
Years working at facility								
6-11 months	11%	11%	0%	0%	27%	0%	9%	0%
1-2 years	11%	11%	25%	17%	27%	17%	9%	11%
3-5 years	22%	11%	25%	17%	9%	17%	9%	11%
5-10 years	0%	22%	50%	58%	18%	50%	27%	33%
>10 years	56%	44%	0%	8%	18%	17%	36%	44%
Cadre								
Generalist Medical Doctor	0%	0%	0%	0%	0%	0%	0%	0%
Specialist Medical Doctor	0%	0%	0%	8%	0%	0%	0%	0%
Non-physician Clinician	22%	0%	0%	8%	9%	0%	18%	11%
Nursing Professional	11%	22%	13%	8%	18%	33%	0%	0%
Midwifery Professional	44%	67%	88%	75%	73%	50%	73%	89%
Other	22%	11%	0%	0%	0%	17%	9%	0%
Have a management role	56%	22%	25%	50%	45%	33%	45%	33%

Table 23. Supportive supervision and coaching

Variables	Control				Group 1				Group 2				Group 3			
	BL (n=9)		EL (n=9)		BL (n=8)		EL (n=12)		BL 9 (n=11)		EL (n=6)		BL (n=11)		EL (n=9)	
BL = baseline; EL = end line	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Received supportive supervision or coaching in last 12 months	89%	8	100%	9	75%	6	92%	11	91%	10	100%	6	100%	11	100%	9
Who provides supervision or coaching																
Clinical supervisor within facility	89%	8	22%	2	25%	2	58%	7	27%	3	50%	3	64%	7	56%	5
Peer within facility	67%	6	0%	0	13%	1	0%	0	9%	1	0%	0	82%	9	11%	1
Manager	22%	2	67%	6	13%	1	0%	0	0%	0	0%	0	27%	3	11%	1
Other staff in facility	22%	2	22%	2	0%	0	0%	0	9%	1	0%	0	0%	0	33%	3
External coach or supervisor	89%	8	100%	9	63%	5	83%	10	82%	9	100%	6	100%	11	100%	9
Frequency of supportive supervision or coaching (internal or external)																
Every month	44%	4	100%	9	38%	3	8%	1	55%	6	0%	0	36%	4	67%	6
Every 2-3 months	33%	3	0%	0	25%	2	17%	2	0%	0	17%	1	55%	6	22%	2
Every 4-6 months	11%	1	0%	0	0%	0	67%	8	18%	2	67%	4	9%	1	11%	1
Every year	0%	0	0%	0	13%	1	0%	0	18%	2	17%	1	0%	0	0%	0
Number of supportive supervisory visits or interactions to support clinical competence or performance improvement in last 3 months																
1	0%	0	33%	3	13%	1	50%	6	36%	4	17%	1	0%	0	0%	0
2	22%	2	0%	0	25%	2	33%	4	9%	1	67%	4	0%	0	22%	2
3	22%	2	11%	1	13%	1	8%	1	9%	1	17%	1	18%	2	22%	2
4	22%	2	11%	1	0%	0	0%	0	9%	1	0%	0	27%	3	33%	3
5+	22%	2	44%	4	13%	1	0%	0	18%	2	0%	0	55%	6	22%	2
Who provided external supervision or support	n=8	n=8	n=9	n=9	n=5	n=5	n=10	n=10	n=9	n=9	n=6	n=6	n=11	n=11	n=9	n=9
Clinical officers from district/county HMT	100%	8	100%	9	40%	2	0%	0	0%	0	0%	0	91%	10	89%	8

Variables	Control				Group 1				Group 2				Group 3			
	BL (n=9)		EL (n=9)		BL (n=8)		EL (n=12)		BL 9 (n=11)		EL (n=6)		BL (n=11)		EL (n=9)	
BL = baseline; EL = end line	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Administrative officer from district/county HMT	25%	2	22%	2	40%	2	75%	9	56%	5	67%	4	36%	4	11%	1
Central MOH	13%	1	67%	6	80%	4	0%	0	67%	6	0%	0	55%	6	44%	4
Member of professional association	0%	0	11%	1	0%	0	0%	0	11%	1	0%	0	0%	0	0%	0
Representative of donor-funded project	100%	8	0%	0	20%	1	50%	6	78%	7	100%	6	64%	7	100%	9
What was conducted during the visits from external coach																
Observe my performance directly	78%	7	100%	9	38%	3	33%	4	36%	4	83%	5	64%	7	100%	9
Review clinical records	89%	8	100%	9	50%	4	67%	8	64%	7	67%	4	91%	10	100%	9
Review performance toward care outcome or process indicators	89%	8	100%	9	0%	0	58%	7	36%	4	100%	6	55%	6	100%	9
QI capacity building	89%	8	44%	4	25%	2	75%	9	45%	5	67%	4	64%	7	100%	9
On the job clinical trainings	78%	7	33%	3	75%	6	67%	8	55%	6	33%	2	55%	6	67%	6
Distribute/sharing evidence-based guidelines, protocols, etc	89%	8	22%	2	38%	3	17%	2	55%	6	17%	1	36%	4	67%	6
Provide updates on administrative or technical issues	89%	8	89%	8	38%	3	75%	9	45%	5	100%	6	45%	5	67%	6
Provide guidance for improvement activities	89%	8	78%	7	25%	2	83%	10	73%	8	83%	5	73%	8	89%	8
What was conducted during the visits from internal coach																
Observe my performance directly	78%	7	100%	9	38%	3	58%	7	27%	3	83%	5	82%	9	89%	8
Review clinical records	89%	8	100%	9	63%	5	50%	6	27%	3	83%	5	64%	7	89%	8
Review performance toward care outcome or process indicators	89%	8	100%	9	25%	2	42%	5	55%	6	67%	4	73%	8	78%	7

Variables	Control				Group 1				Group 2				Group 3			
	BL (n=9)		EL (n=9)		BL (n=8)		EL (n=12)		BL 9 (n=11)		EL (n=6)		BL (n=11)		EL (n=9)	
BL = baseline; EL = end line	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
QI capacity building	89%	8	44%	4	25%	2	50%	6	27%	3	83%	5	55%	6	67%	6
On the job clinical trainings	78%	7	78%	7	38%	3	58%	7	36%	4	17%	1	73%	8	67%	6
Distribute/sharing evidence-based guidelines, protocols, etc	56%	5	11%	1	38%	3	8%	1	45%	5	33%	2	18%	2	11%	1
Provide updates on administrative or technical issues	89%	8	100%	9	38%	3	58%	7	36%	4	83%	5	82%	9	89%	8
Provide guidance for improvement activities	89%	8	100%	9	25%	2	50%	6	55%	6	83%	5	82%	9	67%	6

Table 24. QI experience and activities

Variables BL = baseline; EL = end line	Control				Group 1				Group 2				Group 3			
	BL (n=9)		EL (n=9)		BL (n=8)		EL (n=12)		BL (n-11)		EL (n=6)		BL (n=11)		EL (n=9)	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Have experience with QI	89%	8	no data	-	50%	4		-	91%	10		-	73%	8		-
Any QI activities in health facility at the moment or near past																
Yes	89%	8	100%	9	88%	7	100%	12	91%	10	100%	6	91%	10	100%	9
No	11%	1	0%	0	13%	1	0%		9%	1	0%	0	0%	0	0%	0
Don't know	0%	0	0%	0	0%	0	0%		0%	0	0%	0	9%	1	0%	0
Facility QI focus on following clinical areas																
Essential/routine newborn care	78%	7	56%	5	75%	6	67%	8	73%	8	83%	5	45%	5	78%	7
Newborn resuscitation	44%	4	33%	3	63%	5	75%	9	91%	10	100%	6	45%	5	100%	9
Care of premature newborns	44%	4	33%	3	25%	2	33%	4	55%	6	67%	4	27%	3	11%	1
Care of the small newborn	33%	3	22%	2	13%	1	67%	8	55%	6	67%	4	36%	4	33%	3
Care of the sick newborn	44%	4	22%	2	38%	3	83%	10	55%	6	83%	5	64%	7	44%	4
Care of babies with/at risk of sepsis	56%	5	44%	4	50%	4	67%	8	73%	8	83%	5	73%	8	22%	2
Essential maternal care	67%	6	33%	3	50%	4	92%	11	64%	7	83%	5	64%	7	67%	6
Prevention and management of PPH	67%	6	56%	5	63%	5	75%	9	91%	10	100%	6	73%	8	100%	9
Care of eclampsia/pre-eclampsia	56%	5	22%	2	25%	2	58%	7	55%	6	100%	6	55%	6	44%	4
Care of mothers with/at risk of sepsis	56%	5	33%	3	38%	3	83%	10	73%	8	83%	5	45%	5	33%	3
Obstructed labor	44%	4	33%	3	38%	3	50%	6	55%	6	100%	6	36%	4	33%	3
Discharge planning and counseling	44%	4	22%	2	75%	6	58%	7	82%	9	83%	5	64%	7	33%	3
When was the most recent MNH QI initiative																

Variables BL = baseline; EL = end line	Control				Group 1				Group 2				Group 3			
	BL (n=9)		EL (n=9)		BL (n=8)		EL (n=12)		BL (n-11)		EL (n=6)		BL (n=11)		EL (n=9)	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Currently ongoing during last month	44%	4	6(n=6)	6(n=6)	50%	4	58%	7	45%	5	83%	5	0%	0	89%	8
During last 1-3 months	0%	0	0%	0	0%	0	0%	0	18%	2	0%	0	27%	3	11%	1
During last 4-5 months	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
During the last 6-12 months	44%	4	0%	0	13%	1	0%	0	0%	0	0%	0	27%	3	0%	0
More than a year ago	0%		0%	0	0%	0	8%	1	0%	0	0%	0	0%	0	0%	0
I don't know of any MNH improvement initiative	11%	1	0%	0	13%	1	17%	2	27%	3	17%	1	18%	2	0%	0
Role in MNH QI process																
I participate but don't lead	56%	5	50%	3	63%	5	75%	9	73%	8	67%	4	73%	8	78%	7
I am leading	11%	1	33%	2	0%	0	8%	1	9%	1	33%	2	0%	0	22%	2
I am not involved	11%	1	17%	1	13%	1	8%	1	9%	1	0%	0	0%	0	0%	0
If you lead improvement process, describe your leadership and support to QI efforts in your facility.	(n=1)		(n=2)		NA		(n=1)		(n=1)		(n=2)		NA		(N=2)	
Facilitate enabling environment	100%	1	100%	2	NA	NA	0%	0	Data for this question in group 2 wasn't available		100%	2	NA	NA	100%	2
Develop coaching strategies to support implementation	100%	1	50%	1	NA	NA	100%	1	0%		100%	2	NA	NA	100%	2
Support team members to undertake, manage and sustain QI activities	100%	1	100%	2	NA	NA	100%	1	0%		100%	2	NA	NA	100%	2
Monitor and evaluate QI team functionality and performance	100%	1	100%	2	NA	NA	100%	1	0%		100%	2	NA	NA	100%	2
QI team for MNH in facility																
Yes, separate QI team for MNH	33%	3	33%	2	13%	1	67%	8	36%	4	67%	4	18%	2	100%	9

Variables BL = baseline; EL = end line	Control				Group 1				Group 2				Group 3			
	BL (n=9)		EL (n=9)		BL (n=8)		EL (n=12)		BL (n-11)		EL (n=6)		BL (n=11)		EL (n=9)	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Yes, one QI team that works on QI in different clinical areas	33%	3	50%	3	25%	2	17%	2	36%	4	33%	2	64%	7	0%	0
There is no team, only 1 person responsible	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
No	0%	0	0%	0	25%	2	0%	0	9%	1	0%	0	0%	0	0%	0
Don't know	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
What does the QI team do?																
Decide what to improve	67%	6	56%	5	38%	3	75%	9	73%	8	100%	6	82%	9	100%	9
Routinely review performance and service delivery standards	67%	6	33%	3	38%	3	67%	8	64%	7	67%	4	73%	8	100%	9
Discuss and choose barriers/gaps to overcome	67%	6	56%	5	38%	3	83%	10	73%	8	100%	6	82%	9	100%	9
Plan and test changes	67%	6	33%	3	38%	3	75%	9	73%	8	100%	6	55%	6	100%	9
Determine if change resulted in improvement by monitoring indicators	67%	6	22%	2	13%	1	75%	9	55%	6	100%	6	55%	6	89%	8
Adjust activities based on monitoring results	67%	6	33%	3	13%	1	50%	6	36%	4	100%	6	45%	5	78%	7
Conduct repeating planning, implementing and monitoring changes over time	67%	6	56%	5	38%	3	58%	7	55%	6	100%	6	73%	8	100%	9
Make improvement the norm	0%	0	0%	0	0%	0	0%	0	9%	1	0%	0	0%	0	0%	0
Average number of QI team meetings on MNH in last 6 months	3 (range 1-6)		3.4 (range 1-6)		4.6 (range 2-6)		1.9 (range 1-5)		1 (range 1-2)		3.3 (range 1-6)		2 (range 0-3)		6.2 (range 1-12)	
Written facility QI plan																
Yes, for MNH only	11%	1	11%	1	13%	1	33%	4	27%	3	50%	3	18%	2	89%	8
Yes but general	33%	3	22%	2	13%	1	8%	1	55%	6	33%	2	27%	3	11%	1
No	33%	3	0%	0	50%	4	25%	3	0%	0	17%	1	9%	1	0%	0
Don't know	0%	0	22%	2	0%	0	17%	2	9%	1	0%	0	27%	3	0%	0

Table 25. Perceived attributes of the QI guide, orientation workshop, and coaching visits

Intervention Components	Positive Attributes	Negative Attributes	Recommendations for Improvement
Guides	"Has knowledge we need in our daily work" (clinical guide)	Hard to understand (clinical guide)	
	English is easy to read and understand (clinical & QI guides)	A lot of material to get through (QI guide)	
	Well organized (QI guide)		
	Illustrations (clinical & QI Guide)		
	Similar to HIV Guide (QI guide)		
Meeting	Friendly & knowledgeable facilitator	"tight program"	Allocate 2 days
	Interactive	Far to travel from home location	Incorporate facility-based practical component
	Content		Follow-up meeting
	Tools & presentations were easy to understand		
Coaching Visits	Mentorship, immediate corrections		Better to come when no clients to limit interruptions
	Motivating		Increase frequency
	Knowledge sharing & skill development		Administer small tests or exercises to ensure understanding
	Improved attitude toward QI		Continue coaching visits to promote sustainability
	Improved documentation & supervision		

Table 26. Performance data to inform QI

Variables	Control		Group 1		Group 2		Group 3	
	BL (n=9)	EL (n=9)	BL (n=8)	EL (n=12)	BL (n=11)	EL (n=6)	BL (n=11)	EL (n=9)
Facility collects and reviews performance data	100%	56%	75%	83%	91%	67%	91%	78%
Data collected and use								
Process indicators, compliance with standards of care	78%	67%	13%	42%	18%	50%	55%	67%
Patient outcome indicators	78%	67%	38%	67%	64%	50%	55%	78%
Document changes	67%	89%	50%	33%	36%	67%	64%	78%
Present data visually	78%	67%	38%	17%	45%	17%	27%	67%
Develop written results	44%	44%	50%	50%	36%	33%	55%	67%
Validate data	44%	33%	38%	50%	55%	50%	36%	56%
Analyze and interpret data within QI team	44%	22%	50%	83%	45%	67%	18%	67%
Document internal and external factors contributing to preventing improvement	44%	78%	25%	25%	27%	33%	45%	67%
Compare performance with other facilities, district or national benchmark	67%	33%	50%	33%	45%	33%	64%	44%
Identify what was learned from an improvement activity	56%	33%	63%	42%	64%	50%	45%	67%
Develop and track written plan for improvement based on data	67%	67%	50%	50%	36%	50%	45%	67%
Documentation of active and completed QI initiatives	78%	67%	50%	92%	91%	100%	27%	89%
Heard of “Improving Care of Mothers and Babies: A Guide for Improvement Teams”	22%	78%	13%	42%	36%	83%	9%	89%
Exposure to the QI guide								
I have heard about it but not seen it	22%	22%	13%	8%	27%	17%	9%	11%
I have heard and seen it in a QI team meeting	0%	0%	0%	33%	9%	50%	0%	78%
I have my own guide	0%	0%	0%	0%	0%	17%		0%
Other	0%	4 (heard and read)	0%	0%				0%
Facility provided MNH guidelines/standards of care	33%		25%	25%	18%			
Average hours spent on QI in a month	2	1.3	1.51	0.85	1.95	1.1	2	1.9
Average hours per work week	63.9	68.4	42.0	34.3	57.5	34.8	68.8	51.2
Average monthly salary in UGX	710000.0	683922.2	555142.9	637500.0	547545.5	772833.3	671000.0	583000.0

Appendix 3: Detailed Results of Provider Knowledge Assessment Questionnaire (Tool #2)

Table 27. Changes in provider knowledge of basic QI concepts & tools between study periods and groups, n=85

Variable	Pre (n=40)	Post (n=45)	% Change from baseline	p-value
Provider characteristics				
Sex of health provider is female (%)				
Group 3	83.3	66.7	-16.6	0.64
Group 2	81.8	91.7	9.9	0.59
Group1	100	77.8	-22.2	0.471
Control	88.9	91.7	2.8	1
Health provider has been providing maternal and/or newborn care services for at least 3 to 5 years (%)				
Group 3	91.7	100	8.3	1
Group 2	63.6	91.7	28.1	0.155
Group1	75	77.8	2.8	1
Control	66.7	91.7	25	0.272
Is involved in improvement activities in their facility (%)				
Group 3	83.3	100	16.7	0.478
Group 2	90	91.7	1.7	1
Group1	100	88.9	-11.1	1
Control	77.8	91.7	13.9	0.553
Uses the QI guide "Improving Care of Mothers and Babies: A Guide for Improvement Teams" (%)				
Group 3	25	75	50	*0.02*
Group 2	27.3	41.7	14.4	0.389
Group1	12.5	22.2	9.7	0.547
Control	0	16.7	16.7	0.314
Part 1. Setting up improvement teams				
Does not believe that teams have less power to make change than a single, enthusiastic person (%)				
Group 3	83.3	91.7	8.4	1
Group 2	45.5	83.3	37.8	0.089
Group1	62.5	88.9	26.4	0.294
Control	77.8	75	-2.8	1
Believes teams that want to improve newborn care should represent each type of provider who cares for newborns (%)				
Group 3	75	83.3	8.3	1
Group 2	81.8	91.7	9.9	0.59
Group1	87.5	100	12.5	0.471
Control	77.8	100	22.2	0.171
Believes facility managers should be involved in QI throughout the improvement process (%)				
Group 3	91.7	91.7	0	1
Group 2	100	91.7	-8.3	1
Group1	87.5	77.8	-9.7	1

Variable	Pre (n=40)	Post (n=45)	% Change from baseline	p-value
Control	100	100	0	-
Part II. Deciding what to improve				
Believes that good health outcomes depend upon resources for health care and correct performance of processes (%)				
Group 3	100	100	0	-
Group 2	100	91.7	-8.3	1
Group1	87.5	88.9	1.4	1
Control	100	100	0	-
Part III. Understanding the barriers to overcome				
Believes that inputs are the resources needed for delivery of health care (%)				
Group 3	91.7	100	8.3	1
Group 2	100	100	0	-
Group1	87.5	100	12.5	0.471
Control	100	100	0	-
Consider the following inputs as necessary to deliver quality health care: adequate staffing, providers with adequate knowledge and skills, leadership and management, and necessary supplies (%)				
Group 3	91.7	83.3	-8.4	1
Group 2	72.7	91.7	19	0.317
Group1	75	100	25	0.206
Control	100	100	0	-
Agrees that one should choose barriers to overcome by selecting 1 or 2 that mainly contribute to the problem (%)				
Group 3	41.7	83.3	41.6	0.089
Group 2	45.5	41.7	-3.8	1
Group1	62.5	33.3	-29.2	0.347
Control	88.9	66.7	-22.2	0.338
Part IV. Testing and implementing changes				
Believes it is best to test the change on small scale to see feasibility and then test large scale when testing changes (%)				
Group 3	75	91.7	16.7	0.59
Group 2	63.6	83.3	19.7	0.371
Group1	75	44.4	-30.6	0.335
Control	100	83.3	-16.7	0.486
Thinks changes to be tested to overcome the barrier of quality of care can be prioritized by the (1) feasibility of the change, (2) cost of the change, and (3) expected effect of the change (%)				
Group 3	75	83.3	8.3	1
Group 2	72.7	66.7	-6	1
Group1	62.5	33.3	-29.2	0.347
Control	88.9	41.7	-47.2	0.067
Part V. Measuring quality improvement				
Knows that the best tool to follow the progress of an outcome over time is a run chart (%)				
Group 3	58.3	83.3	25	0.371
Group 2	18.2	58.3	40.1	0.089
Group1	12.5	44.4	31.9	0.294

Variable	Pre (n=40)	Post (n=45)	% Change from baseline	p-value
Control	66.7	75	8.3	1
Part VI. Making improvement the norm				
Thinks tasks to make QI permanent include: (1) communicating recommendations to facility and health system management, (2) incorporating successful change into policies and training manuals, among others, (3) training new staff in the improved process, and (4) including funds in the operating budget for needed staff and supplies (%)				
Group 3	58.3	83.3	25	0.371
Group 2	54.5	66.7	12.2	0.68
Group1	50	33.3	-16.7	0.637
Control	77.8	83.3	5.5	1

Appendix 4: Detailed Results of Maternal and newborn Care Medical Documentation Review (Tool 3)

Table 28. Pairwise difference-in-difference in maternal and newborn care processes and outcomes, comparing intervention groups with control group at baseline and end line, results of medical documentation review (n=random sample of 2240 charts/registry entries)

Indicators	Control		Intervention 1		Diff in diff	p-value	Intervention 2		Diff in diff	p-value	Intervention 3		Diff in diff	p-value
	Pre	Post	Pre	Post			Pre	Post			Pre	Post		
Essential maternal care														
% of all women giving birth in the health facility who received uterotonic after birth	98	92	68	62	0	0.9103	84	87	10	0.0052	96	88	-2	0.4599
Care of maternal complications														
% of women in labor and childbirth area of the facility who gave birth after 12h of active labor and/or with diagnosis of obstructed labor	1	6	2	10	4	0.1476	5	10	0	0.8679	3	6	-1	0.6533
% of mothers who developed PPH per month	1	2	0	1	0	0.9955	0	0	-1	0.3192	2	1	-2	0.1932
% of all birthing or postpartum women in the health facility with following diagnosis (puerperal sepsis, sepsis related to pregnancy or cesarean section, 3-4-degree perineal tear) who received antibiotics	0	11	79	96	6	0.6658	21	6	-26	0.0516	71	57	-25	0.1791
Essential newborn care														
% of newborns breast fed within 1 hour after birth	99	92	95	71	-17	<.0001	82	80	4	0.3402	97	88	-2	0.4201
% of all newborns with documented exclusive breast feeding as infant feeding option	94	92	95	74	-20	<.0001	86	86	2	0.6007	98	89	-7	0.0153
% of newborns with immediate skin-to-skin contact	99	92	93	61	-25	<.0001	82	80	4	0.2512	96	87	-3	0.3604
% of newborns with BCG and polio vaccination at birth	73	87	93	80	-26	<.0001	50	61	-3	0.5182	81	74	-21	<.0001
% of newborns to whom tetracycline eye ointment given for eye care	73	90	70	62	-24	<.0001	56	85	13	0.0108	94	87	-24	<.0001

Indicators	Control		Intervention 1		Diff in diff	p-value	Intervention 2		Diff in diff	p-value	Intervention 3		Diff in diff	p-value
	Pre	Post	Pre	Post			Pre	Post			Pre	Post		
% of newborns to whom Vitamin K is administered	48	82	46	40	-40	<.0001	50	72	-13	0.0226	94	87	-41	<.0001
% of newborns to whom normal saline is provided for cord care	0	0	0	0	0	0.3197	0	0	0	0.3237	15	0	-15	<.0001
% of newborns who received at least one dose of chlorhexidine for cord care	11	45	1	0	-35	<.0001	0	16	-18	<.0001	0	1	-33	<.0001
Care of newborn complications														
% of newborns who were not breathing spontaneously / crying at birth for whom resuscitation actions (stimulation and/or bag and mask) were initiated	0/0	7/7	13/13	3/4	NA	NA	4/4	9/9	NA	NA	2/2	2/2	NA	NA
% of asphyxiated babies who were successfully resuscitated	0/0	6/7	13/13	2/4	NA	NA	4/4	9/9	NA	NA	2/2	1/2	NA	NA
% of neonates surviving to 24 hours after resuscitation or at discharge)	0/0	4/7	12/13	3/4	NA	NA	4/4	8/9	NA	NA	2/2	1/2	NA	NA
Discharge planning and counselling														
% of mothers counselled on danger signs, home-based care, and when to return to postnatal care	76	87	88	59	-40	<.0001	91	86	-16	0.0003	92	75	-28	<.0001
% of mothers counselled on maternal nutrition	53	86	66	59	-40	<.0001	91	87	-38	<.0001	92	73	-53	<.0001
% of mothers counselled on infant and young child feeding	75	92	67	61	-23	<.0001	90	87	-20	<.0001	94	85	-26	<.0001
% of mothers given family planning method	97	79	55	48	12	0.0227	93	87	13	0.0006	95	67	-10	0.016

Appendix 5: Detailed Results of Maternal and Newborn Care Outcomes (Tool 4)

Table 29. Pairwise difference-in-difference in maternal and newborn care outcomes, comparing intervention groups with control group at the baseline and end line, results of review of facility statistics

Indicators	Control		Intervention 1		Diff in diff	p-value	Intervention 2		Diff in diff	p-value	Intervention 3		Diff in diff	p-value
	Pre	Post	Pre	Post			Pre	Post			Pre	Post		
Maternal outcomes														
Institutional maternal mortality per 100,000 deliveries	0	284.90	100.47	0	-385.37	*0.012*	359.91	152.44	-492.37	*0.0495*	0	0	-284.9	*0.004*
Incidence of obstructed labor per 1000 deliveries	25.31	46.57	29.58	33.51	-17	*0.0503*	39.74	73.89	13	*0.199*	19.27	14.05	-26	*0.17*
Incidence of PPH per 1000 deliveries	19.17	17.39	20.85	11.32	-7.76	*0.322*	17.46	7.68	-8.01	*0.25*	28.62	11.78	-15.07	*0.08*
Case fatality from maternal PPH	0%	8%	5%	0%	-13%	*0.099*	12.73%	0%	-21%	*0.075*	0%	0%	-8%	*0.026*
Case fatality from eclampsia/pre-eclampsia	0%	0%	0%	0%	0%	-	0%	6%	6%	*0.165*	0%	0%	0%	-
Case fatality from maternal sepsis	0%	-	0%	0%		-	0%	10%		-	-	0%		-
Perinatal outcomes														
Institutional neonatal mortality rate (inborn) per 1,000 live births per month	9.46	4.53	9.34	7.29	2.88	*0.591*	18.25	8.68	-4.64	*0.456*	0.79	1.07	5.21	*0.133*
Case fatality among premature babies	2%	7%	25%	36%	6%	*0.526*	19%	10%	-14%	*0.088*	0%	0	-5%	*0.335*
Incidence of newborn asphyxia among 1000 total births	50.16	39.89	45.61	35.71	0.37	*0.975*	73.57	108.21	44.91	*0.001*	30.05	23.28	3.50	*0.743*
Case fatality among babies with asphyxia	5%	11%	10%	34%	19%	*0.029*	9%	8%	-6%	*0.313*	0%	9%	4%	*0.559*
Incidence of newborn sepsis among 1000 live births	0	0	13.30	13.54	0.25	0.961	9.98	0	-9.98	0.007	0	0	0.00	-
Case fatality from newborn sepsis	0%	-	19%	12%		-	0%	-		-	-	-		-
Fresh stillbirths per 1,000 total births	10.75	11.40	9.40	11.2	1.18	*0.838*	25.08	30.60	4.87	*0.525*	10.87	7.41	-4.11	*0.478*
Stillbirth rate per 1000 total births	26.87	18.52	22.28	24.49	10.56	*0.223*	42.16	55.97	22.16	*0.031*	20.78	19.05	6.62	*0.431*

Appendix 6. Detailed Results of Coaching

Table 30. Changes implemented and results achieved in priority areas of focus by intervention group 3 facilities according to coaching logs

Improvement area	# of facilities with this area of focus	List of changes being implemented	Key results achieved
Labor monitoring using partograph	4	• Review a sample of a partograph during weekly meetings • Assign staff follow up on charts and cesarean section partograph • Involve facility in-charge in monitoring use of partograph • Each midwife to follow up caesarean section partographs on the ward as routine care • Avail partographs within the admission table in labor suit • Physical handover of partographs • Practical continuing medical education (CME) on how to fill the partograph • Put staff with negative attitude towards partographs under the supervision of the facility in-charge • One to one job mentorship • Maintain availability of partographs/ Printing partographs, tendered supply of partograph from stationary shop • Use partograph in routine care • Continuous reminders on use of partograph by ward in-charges • Continue attaching partographs on admission cards/ Attaching partographs into mothers' passports • Staff assigned to follow up incomplete partographs • Monitoring how well partographs are completed	• Partograph use across the 4 sites went from 6% at the beginning of February to 91% at the end of May. Correct partograph use went from 54% to 93% in the same period of time. • CME done on partograph use • Partographs were available

Improvement area	# of facilities with this area of focus	List of changes being implemented	Key results achieved
Prevention of postpartum hemorrhage	4	• Move oxytocin storage from pharmacy to the labor suit using cold boxes • Preloading oxytocin in syringes/ administering it within a minute after delivery • Redistribution of oxytocin from stocked facilities • Maintain stock of uterotonics • Empty bladder before and after delivery for all mothers • Proper screening of mothers on admission for risks of PPH • Review PPH cases during QI meetings • CME on emergency drugs and equipment • Health education for mothers/community on dangers of natural herbs when in labor • Physical handover to include re-stocking oxytocin and change of ice packs (maintain cold chain) • Classifying maternity admissions in labor into low and high risk for PPH	• Oxytocin was preloaded and adopted as part of routine • Cold chain was maintained (ice-packs changed) • In All facilities it was reported that all mothers received uterotonic within 1 minute after birth • Oxytocin storage moved from the pharmacy to the labor unit
Prevention of sepsis among newborns with maternal risk of infection	1	• Pre-operative antibiotics for every mother before cesarean section	• The team administered antibiotics preoperatively
Newborn resuscitation	3	• Set up resuscitation corner in the labor suite • Conducted a CME on neonatal resuscitation (simulations) • Conducted a CME on neonatal resuscitation (simulations) • Organize and equip newborn resuscitation area • Simulation session on Helping Babies Breathe with maternity staff	• All but 65 out of 66 babies born with asphyxia were successfully resuscitated during the study period

Appendix 7: Detailed Results of Cost-effectiveness Analysis

Table 31. Results of cost-effectiveness of QI interventions in different intervention groups

Indicator	Group 1					Group 2					Group 3				
	Diff-in-diff	p-value	Cost of interven-tion, USD	# of patients	ICER in USD	Diff-in-diff	p-value	Cost of interven-tion, USD	# of patients	ICER in USD	Diff-in-diff	p-value	Cost of inter-vention USD	Est. # of patients[5]	ICER in USD
Institutional maternal mortality per 100,000 deliveries	-385	*0.012*	*5.8*	2881	*-0.5*	-492	*0.0495*	*128.8*	3488	*-7.5*	-285	0.004	539.4	2580	-73.4
Incidence of obstructed labor per 1000 deliveries	-17	*0.0503*	*5.8*	2881	*-0.1*										
Incidence of PPH per 1000 deliveries											-15.1	0.08	539.4	2580	-13.9
Incidence of newborn asphyxia among 1000 total births						44.91	*0.001*	*128.8*	3491	*0.8*					
Incidence of newborn sepsis among 1000 live births						-9.98	*0.007*	*128.8*	3286	*-3.9*					
Stillbirth rate per 1000 total births						22.16	*0.031*	*128.8*	3491	*1.7*					
Case fatality from maternal PPH	-13%	*0.099*	*5.8*	32	*-1.4*	-21%	*0.075*	*128.8*	33	*-18.5*	-8%	0.026	539.4	30	-215.8
Case fatality among premature babies						-14%	*0.088*	*128.8*	72	*-12.6*					
Case fatality among babies with asphyxia	19%	*0.029*	*5.8*	98	*0.3*										

Key: Grey area = *results are not statistically significant*

[5] Estimated # of patient is calculated from average monthly # of patients seen during June and July 2018.

USAID APPLYING SCIENCE TO STRENGTHEN AND IMPROVE SYSTEMS PROJECT

University Research Co., LLC
5404 Wisconsin Avenue, Suite 800
Chevy Chase, MD 20815

Tel: (301) 654-8338
Fax: (301) 941-8427
www.usaidassist.org