DOPPLER TO IMPROVE FETAL HEART RATE ASSESSMENT IN INTRAPARTUM CARE IN TANZANIA: DOES IT SAVE NEWBORN LIVES, AND WHAT ARE IMPLICATIONS FOR SCALE-UP?

Marya Karen Plotkin

A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Public Health in the Health Policy and Management Department in the Gillings School of Global Public Health.

Chapel Hill
2019

Approved by:

Stephanie B. Wheeler

Linda A. Fogarty

Rohit Ramaswamy

Jim Ricca

Kavita Singh-Ongechi

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ABSTRACT

Marya Karen Plotkin: Doppler to Improve Fetal Heart Rate Assessment in Intrapartum Care in Tanzania: Does It Save Newborn Lives, and What Are the Implications for Scale-up?
(Under the direction of Stephanie B. Wheeler)

In low and middle income countries (LMIC), intrapartum stillbirth and newborn death, associated with lack of or poor quality obstetric care, cause staggering levels of perinatal and neonatal death. Globally, over 2.7 million neonates die annually, including roughly 700,000 intrapartum stillbirths. In Tanzania, an estimated 46,000 infants died in the neonatal period in 2017. Intermittent fetal heart rate (FHR) monitoring is a key intrapartum intervention recommended by WHO. The standard of care for FHR monitoring in most LMIC is the Pinard stethoscope, but studies in Uganda, Zimbabwe and Tanzania have shown that using a hand-held Doppler can be more effective in detecting abnormal FHR.

This mixed methods study used qualitative and quantitative methods to assess outcomes of Doppler use in health facilities and attitudes around scale up of Doppler in Tanzania. In a qualitative assessment, nine high-level experts/policymakers were interviewed based on theoretical domains drawn from Proctor's implementation outcomes. Findings included high alignment between national priorities and improving intrapartum FHR monitoring using Doppler, and a need to learn lessons from Helping Babies Breathe (HBB) program experience, including effective training, clinical mentoring, and a system for monitoring outcomes.

A quantitative study assessed changes in cesarean delivery and perinatal mortality in 10 health facilities in Kagera region, Tanzania before and after a six-month intervention (Doppler to assess FHR upon admission to maternity ward). Costs ranged from $2.13 - $0.20 (average $0.46) per woman assessed. Cesarean delivery increased and perinatal mortality decreased in one out of the ten

intervention sites in Kagera, but perinatal mortality also decreased in the comparison (Mara region) site in the same period. Cesarean delivery did not significantly increase in any sites other than Kagera regional hospital. These largely negative findings indicate that the proposed pathway between Doppler use and reduced perinatal death may be less directly related than assumed. Further research should address contextual factors and be designed to capture implementation outcomes.

My Plan for Change includes disseminating the findings through professional associations including Association of Gynecologists and Obstetricians of Tanzania (AGOTA) and educating health care providers and district administrators on measurement of intrapartum mortality in health facilities.

To the nurse/midwives who opened my eyes to the world of maternal and newborn care in Tanzania: Gaudiosa Tibaijuka, Asma Ramadhan Khamis, Scholastica Chibehe, and Ukende Shalla, among others. Your service to the women of Tanzania inspires me. I hope the findings presented here will help in a small way to assist in the work you do every day improving maternal and newborn care in Tanzania.

ACKNOWLEDGMENTS

I could not have completed this massive effort without the generous support of friends and family. First and foremost, I acknowledge my boys, Janusz Fundikira Kumpuni and Tadzio Giryn Kumpuni, for helping their Mama become a doctor. You boys are the center of my world – you motivate me to do my best.

I also acknowledge the unwavering support of my parents, Gretchen and Joel Plotkin. You put me in a position to be intellectually curious, thoughtful and open to new experiences in a way that has served me so well in life. Without your nurturing and support all the years of my life, I would not be publishing this dissertation today.

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LIST OF ABBREVIATIONS

ECSACOG	East, Central and Southern Africa College of Obstetrics and Gynaecology
FHR	Fetal Heart Rate
FPM	Facility Perinatal Mortality
FSB	Fresh Stillbirth
HBB	Helping Babies Breathe
GoT	Government of Tanzania
KII	Key Informant Interview
LBW	Low birthweight
LMIC	Low and Middle Income Countries
LDHF	Low Dose / High Frequency
MSB	Macerated SB
MOHCDGEC	Ministry of Health, Community Development, Gender, the Elderly and Children
PO-RALG	President's Office, Regional and Local Government
SMTWG	Safe Motherhood Working Technical Group
SB	Stillbirth
SSA	Sub-Saharan Africa
VEND	Very Early Newborn Death
USAID	United States Agency for International Development

CHAPTER 1: INTRODUCTION

The Problem: Perinatal death, which is often preventable, occurs too often within the facility setting in Tanzania

Perinatal deaths which occur in the facility setting (both stillbirths and newborn deaths) are both a devastating reality for millions of families and a public health problem of massive proportions. Globally, it is estimated that over 2.7 million babies die in the neonatal period annually: of these deaths over half a million (roughly 700,000) are attributable to intrapartum-related events[1] and almost all (98%) of these occur in low and middle income countries (LMIC).[2] In Tanzania, like in other LMICs, stillbirths are not only many times more numerous, but also occur proportionally much more frequently in the intrapartum period, directly related to lack of or poor quality of obstetric care.[3] It is estimated that 47% of the 47,550 stillbirths which occur annually in Tanzania are intrapartum stillbirths,[4] and many of these deaths could be averted with improved intrapartum care.[5]

Tanzania is a major contributor to the global burden of perinatal mortality.[6] Newborn and intrapartum death is particularly persistent and high in Tanzania: 66% of neonatal deaths in Tanzania occur in the first 24 hours (65.5%), one of the highest rates among LMICs.[7] When these deaths occur after a woman is admitted to maternity services, a high proportion of the deaths are preventable. For example, in Tanzania's Muhimbili national referral hospital, suboptimal care factors were associated with 80% of perinatal deaths. Specifically, poor fetal heart monitoring in labor was associated with nearly half (47%) of the deaths.[8]

WHO describes main causes of neonatal deaths and intrapartum stillbirths as poor maternal health, inadequate care during pregnancy, poor or inappropriate management of complications during

pregnancy and delivery, poor hygiene during delivery and immediately following birth, and lack of newborn care.[9] UNICEF has declared that the key to reducing neonatal death is building stronger health services, ensuring attendance by skilled personnel and making emergency obstetric services available.[10] In summary, many major causes of intrapartum stillbirth and very early newborn death are preventable with better obstetric care in the intrapartum period – globally, and in Tanzania.

The intervention: Doppler for improving fetal heart monitoring in intrapartum care

Fetal heart monitoring is an important and WHO-recommended part of intrapartum care.[11] The Pinard fetoscope has been widely used in sub-Saharan Africa as the standard of care for auscultation of fetal heart rates (FHR),[12] but studies have shown that a hand-held Doppler device may be more effective at detecting abnormal FHR.[13–15] WHO guidance specifies intermittent FHR monitoring and charting FHR on the partograph,[11] as does guidance from the Ministry of Health, Community Development, Gender, the Elderly and Children (MOHCDGEC) of Tanzania.[16] However, WHO does not recommend which tool is preferred for intrapartum FHR auscultation (Pinard stethoscope or Doppler). However, expert consensus arising from a recent Delphi review of intrapartum management recommends use of a hand-held Doppler device for intermittent fetal heart auscultation in health facilities in LMIC.[17] This leaves countries with high levels of intrapartum stillbirth and very early newborn death, including Tanzania, in a position of considering which tool may best improve intrapartum fetal monitoring and contribute to improved intrapartum care, with the goal of fewer perinatal deaths.

Cost information is an important consideration in bringing public health programs to scale.[18] The cost of developing training curricula and national trainers, training health care providers and the cost of the Doppler and related commodities will be needed to take steps towards scale up. Finally, an assessment of the environment for scale up is needed. How does use of Doppler align with national

priorities as detailed in vision statements such as the National Roadmap for Improving Maternal and Newborn care in Tanzania?

The study: actionable information to guide program planners to scale up improvements to intrapartum fetal heart rate monitoring in Tanzania

This mixed methods, sequential exploratory study set out to provide the MOHCDGEC of Tanzania and other key stakeholders, policy-makers and program implementers in Tanzania with useful information on using Doppler to assess FHR upon admission to labor and delivery services, costs associated with use of the Doppler, and an assessment of the environment for scale up of Doppler to improve intrapartum care in Tanzania. The study used qualitative and quantitative methods, with the goal of providing actionable information to make changes to improve intrapartum fetal heart monitoring in Tanzania. My final chapter, the Plan for Change, outlines key actions taken and plans for further action to move forward with improving intrapartum fetal heart monitoring in Tanzania using Doppler.

Study Questions

The study answered the following questions:

1. Was an intervention to improve FHR assessment (women admitted to labor and delivery services had FHR assessed using Doppler) associated with a change in perinatal death and cesarean delivery rates in health facilities in Kagera region, Tanzania?
2. What were the costs associated with revising training materials, preparing Master Trainers, training health care providers and operational costs of using Doppler for intrapartum FHR assessment in the study facilities?
3. How does Doppler align with national priorities in Tanzania, what are the facilitators and barriers to scaling up use of Doppler, and how will Doppler be financed, according to national policy-makers and subject matter experts?

4. What is my Plan for Change in introducing Doppler for improved intrapartum care in Tanzania?

The structure of the Dissertation is as follows: Chapter 1 is an Introduction; Chapter 2 presents the Systematic Literature Review; Chapter 3 presents findings from the qualitative assessment of the environment for scale up of Doppler in intrapartum care in Tanzania; Chapter 4 presents findings from the quantitative assessment of perinatal mortality in facilities using Doppler for admission to labor and delivery services, and Chapter 5 is my Plan for Change focusing on how to move improvements to intrapartum FHR monitoring forward in Tanzania.

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CHAPTER 2: SYSTEMATIC REVIEW

Background: Using Doppler to improve detection of intrapartum fetal heart rate (FHR) abnormalities linked to appropriate, timely intrapartum care in low- and middle-income countries (LMIC) can save lives.

Objective: To review the literature on using Doppler to improve detection of intrapartum FHR abnormalities and intrapartum care quality in LMIC health facilities.

Search Strategy: PubMed, Web of Science, Embase, Global Health, and Scopus databases were searched from inception to October 2018, by combining terms for Doppler, perinatal outcomes, and FHR monitoring.

Selection Criteria: Selected studies compared Doppler to Pinard stethoscope for detecting/monitoring intrapartum FHR or described provider and client preferences for FHR monitoring in LMIC settings.

Data Collection and Analysis: Two team members independently screened and collected data. Risk of bias was assessed using EPOC criteria.

Results: Eleven studies from eight countries were included. Doppler was superior at detecting abnormal intrapartum FHR compared to Pinard stethoscope, but was not associated with improved perinatal outcomes. Using Doppler on admission helped accurately measure perinatal deaths occurring after facility admission.

Conclusion: Studies and program learning in LMICs are needed to translate improved detection of FHR abnormalities to improved case management. Doppler should be used to calculate a facility indicator on intrapartum care quality.

PROSPERO registration: CRD42019121924

2.1 Introduction

Globally, an estimated 2 million early neonatal deaths occur in low- to middle-income countries (LMIC) annually: 904,000 intrapartum-related neonatal deaths and 1.02 million fresh stillbirths.[1-2] Nearly all intrapartum stillbirths and newborn deaths that occur in health facilities could be prevented by good obstetric care,[3] essential newborn care, and prompt identification and resuscitation of asphyxiated neonates.[4]

Interruption of placental blood flow during labor can result in fetal heart rate (FHR) accelerations, decelerations, bradycardia (under 120 beats per minute) and/or tachycardia (over 160 bpm). Such FHR abnormalities have been associated with low Apgar scores, intrapartum stillbirths, and neonatal deaths.[5-6] Early detection of FHR abnormalities linked to timely and appropriate obstetric case management practices can potentially reduce adverse perinatal outcomes.

A 2017 Cochrane review found that *continuous* monitoring of FHR using cardiotocography, the standard of care in high-income countries, was associated with increased cesarean sections and assisted births, without a corresponding decrease in adverse newborn outcomes.[7] This may have contributed to WHO's recommendation of intermittent FHR monitoring.[8-9] The guidance, however, contains no recommendation of which device (Pinard stethoscope or Doppler) should be used for auscultation,[9] and multiple studies have arisen examining effectiveness of Doppler for intrapartum FHR monitoring in LMIC settings.

The usefulness of Doppler in the intrapartum care setting is not limited to diagnosis of abnormalities of fetal heart. The importance of tracking an indicator for intrapartum deaths in health facilities was noted in a call to action in the *Lancet* in 2007.[10] Additional studies have used Doppler to confirm timing of fetal demise so as to measure stillbirths and newborn deaths which occur after admission to the health facility.

Mothers' preferences may increasingly influence which method is used for FHR monitoring in LMIC settings.[8] Some laboring women have noted that hearing the fetal heart beat amplified by Doppler is a positive experience, and some have noted that the Pinard fetoscope causes discomfort.[11-12] However, client preferences for method of FHR monitoring in the LMIC health facility setting has not been systematically described in the literature.

This systematic review synthesized evidence on whether Doppler for intrapartum FHR monitoring was associated with a decrease in adverse perinatal outcomes; whether Doppler could be effectively used in calculation of a facility-based indicator on perinatal mortality; and whether clients and health care providers expressed preferences for Doppler over Pinard stethoscope for intrapartum FHR monitoring in LMIC settings.

2.2 Methods

This review sought to answer the following research questions:

1. What is the available evidence that using Doppler to intermittently or continuously to monitor intrapartum FHR is associated with a reduction in adverse perinatal outcomes?
2. What is the available evidence that using Doppler upon admission to labour and delivery services can be used to improve measurement of perinatal mortality?
3. What is the available evidence on provider and client preference for Doppler vs. Pinard for intrapartum FHR monitoring?

Search Strategy and Search Terms

This review was registered with PROSPERO (Reference: CRD42019121924). We followed guidelines detailed in the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).[13] We searched up to October 2018 in the following databases: PubMed, Web of Science, Embase, Global Health, and Scopus. Searches were limited to English and had no date restriction. Both American and UK English spelling was considered in the search terms.

The following search terms were used: (Doppler OR fetoscope OR Pinard) AND (newborn* OR labor OR labour OR delivery OR perinatal OR intrapartum OR stillbirth OR still birth OR fetal OR foetal OR fetus OR neonatal OR "intermittent fetal heart rate monitoring" OR "fetal heart").

Records received through the searches were imported into Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia)—deduplication was conducted automatically by Covidence. Additional studies were identified using backward searches (snowballing) from references in relevant articles.

Inclusion Criteria

Included studies must have been conducted in a LMIC; assessed an intervention which included Doppler in the intrapartum (not pregnancy) period; have been conducted in a health facility or with health facility staff; have tested use of Doppler to improve the detection of FHR abnormalities to inform intrapartum interventions; address client or health care provider preference for tools of FHR monitoring during the intrapartum period; or have tested the validity or application of an indicator in which Doppler is used to assess timing of fetal demise. Systematic reviews, case reports, abstracts and unpublished reports were excluded.

Data Collection and Analysis

Title and abstract screening

We conducted a title and abstract screening using inclusion and exclusion criteria. In this stage, the abstract was perused to assess fit given the criteria. Studies were selected for inclusion by two authors (MP,BK), working independently. Disagreements between the two authors were resolved by discussion and review by another author (SW).

Full text review

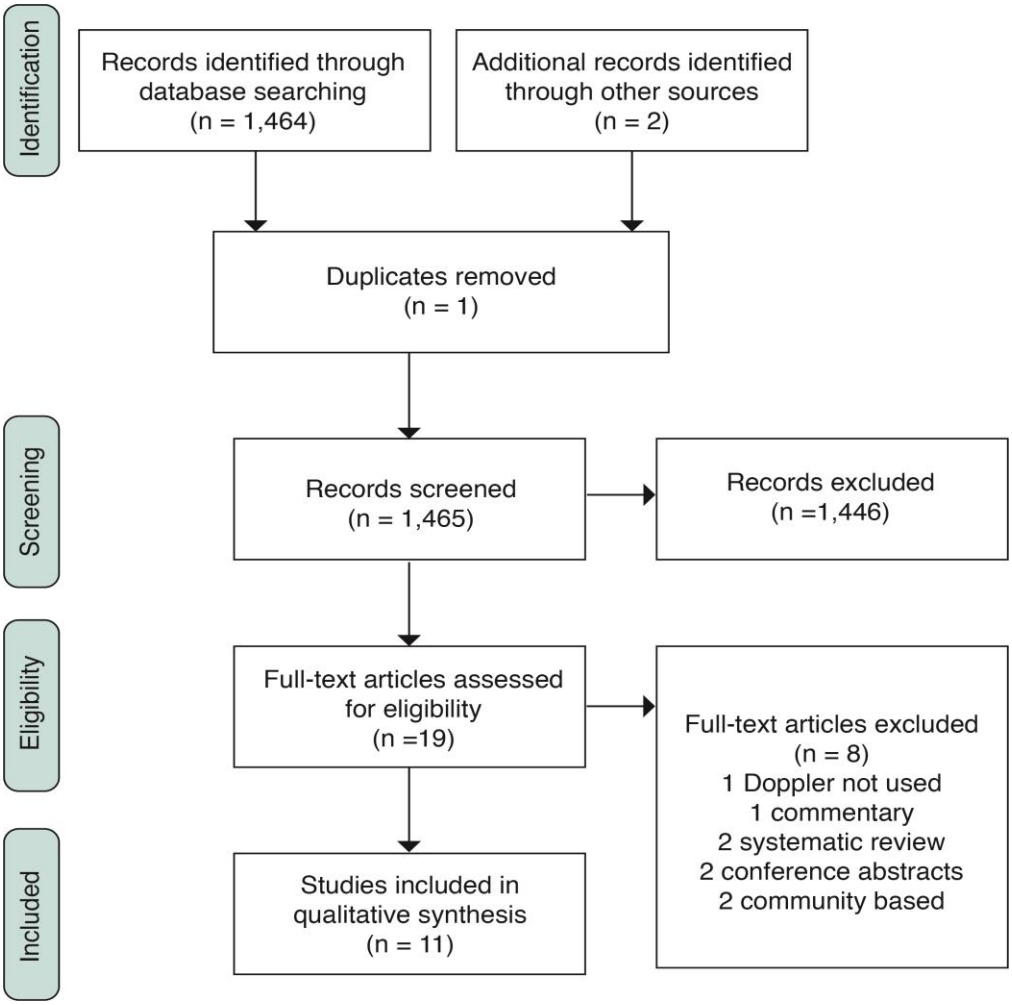
Following screening, full text versions of eligible citations were examined fully. We extracted data from included studies using a pre-defined data extraction form. Abstracted data included: study setting and design, study outcome measures, key findings, summary of limitations, type and characteristics of the intervention, outcome measures, and effect of the intervention on the outcome measures. Qualitative data were described using textual narrative synthesis as recommended for systematic reviews. To assess risk of bias and quality of evidence, we used the Cochrane criteria detailed in "Suggested risk of bias criteria for EPOC reviews."[14]

2.3 Results

Search results

The search initially yielded 1464 records. After deduplication, a total of 1463 articles remained. Of these, 1446 articles did not meet the inclusion criteria, and the remaining 19 studies were reviewed in full text. Of these, 11 studies from Tanzania, Uganda, South Africa, India, Pakistan, Democratic Republic of Congo, Kenya, and Zimbabwe met inclusion criteria and were included in the review (Figure 2.1).

Figure 2.1. Search results



Included studies

Of the 11 included studies, all but one[15] were published in the last 10 years. Six studies assessed the effectiveness of Doppler to detect abnormal FHR during intrapartum care, two studies assessed verification of FHR upon admission using Doppler for calculation of an indicator on perinatal mortality, and three studies assessed client or health care provider preferences for method of intrapartum FHR monitoring.

Studies on FHR Abnormalities and Adverse Perinatal Outcomes

Six studies addressed effectiveness of Doppler compared to Pinard stethoscope for detection of abnormal FHR during intermittent or continuous FHR monitoring in the intrapartum period [15-20] (Table 2.1). All of these studies had secondary outcome measures of adverse perinatal outcomes. Two studies compared continuous fetal monitoring using a Doppler to intermittent monitoring with the Pinard stethoscope. Types of Doppler used in the studies included the PowerFree Education Technology Wind-up Fetal Doppler;[16] Freeplay (wind up) Doppler;[17] Moyo strap-on Doppler using the continuous or intermittent monitoring function;[18-19] and the Huntleigh pocket Doppler.[15]

Findings on detection of abnormal fetal heart rate

All but one study[17] comparing FHR monitoring showed that Doppler significantly increased detection of abnormal FHR as compared to Pinard [33] (Table 2.1), whether continuous Doppler monitoring (adjusted odds ratio [AOR] 6.90, 95% confidence interval [CI] 3.89–12.24)[19] (risk ratio [RR] 2.64, 95% CI 1.8–3.7)[20] or with intermittent monitoring (incidence rate ratio=1.61, 95% CI 1.13–2.30) (AOR 1.59, 95% CI: 1.13–2.26, p=0.008)[16] (RR 3.6, 95% CI 2.4–5.3).[15] The one study that showed no difference in detection of abnormal FHR was thought to be due to a Type 2 error.[17]

Findings on adverse perinatal outcomes

Adverse perinatal outcomes were defined as intrapartum stillbirth, newborn death within 24 hours, neonatal seizures, hypoxic ischaemic encephalopathy, bag and mask ventilation, or admission to the neonatal intensive care unit (NICU). Two studies[15,18] documented a reduction in perinatal adverse events associated with intermittent Doppler monitoring of intrapartum FHR as compared to intermittent monitoring with the Pinard fetoscope. In the oldest study, Mahomed et al. reported a reduction of perinatal mortality in the arms using Doppler for intermittent monitoring, with neonatal death rates of

0.6% in the Doppler arm compared to 2–3% in the two Pinard arms.[15] No statistics were presented to demonstrate significance of the finding. In a more recent study in Tanzania, among newborns with abnormal intrapartum FHR who were delivered vaginally, lower rates of adverse outcomes (composite of fresh stillbirth, perinatal death and admission to NICU) were seen in the Doppler compared to the Pinard arm (16.3% in Doppler versus 45.3% in Pinard arm, *P*=0.021) (16.3% in in Doppler arm versus 45.3% in the Pinard arm, *P*=0.021).[18] However, in the same study, there was no decline in adverse perinatal outcomes if all newborns included in the study were considered. In the other four studies no difference in adverse perinatal outcomes was seen between Doppler for FHR monitoring and Pinard fetoscope (Table 2.1).[15,17,19]

Multiple studies looked at intrapartum clinical management procedures that would be expected to increase after detection of an abnormal FHR and potentially be associated with a reduction in perinatal mortality. These measures included cesarean delivery;[15-18,20] shortening the length of time from abnormal FHR detection to delivery,[15-18,20] vacuum delivery, admission to the NICU and intrauterine resuscitations.[20]

Findings on clinical management associated with abnormal FHR

Two studies showed a higher rate of cesarean sections with use of Doppler: in a randomized controlled trial (RCT) in Zimbabwe, the relative risk of cesarean section compared to routine monitoring with the Pinard was 1.6 (95% CI 1.2 -2.0).[15] In an observational study in Tanzania, cesarean section rates increased from 2.6 – 5.4% (p<0.001) with continuous monitoring with Doppler compared to intermittent monitoring with Pinard.[19] Studies in Uganda[16] and in Tanzania[17-18] showed no difference in cesarean section rates between Doppler and Pinard arms.

In another RCT in Tanzania, an increase in intrauterine resuscitations was seen in the group of women continuously monitored using Doppler compared to those intermittently monitored using Pinard

(RR 2.07, 95% CI 1.4–2.9) – as described above, there was no difference in adverse perinatal outcomes between the arms.[20]

In Tanzania, two RCTs of intermittent monitoring using Doppler compared to intermittent monitoring using Pinard did not find a difference in time from abnormal FHR detection to delivery between the Doppler and the Pinard arms.[17-18] In Zimbabwe, there was no difference in mean duration of labor between the four study groups.[15] An observational study conducted in Tanzania found that continuous FHR monitoring with Doppler was associated with a shorter time from last FHR assessment to delivery (45 minutes median time compared to 60 minutes, $p<0.001$), as were vacuum deliveries (from 2.2 to 5.8%).[19] The RCT in Uganda did not report any measure of time associated with clinical management of the client.[16]

Risk of bias and quality of evidence

For these six studies, risk of bias and quality of evidence was assessed using the Cochrane Effective Practice and Organisation of Care (EPOC) criteria.[14] The most pervasive risk in all of the RCTs was the lack of blinding regarding which device participants and study staff used (Table 2.2). All studies had unclear or undescribed generation of randomization sequence, with the exception of an RCT at Muhimbili Hospital in Tanzania, in which a computer-generated sequence was created by an independent researcher.[18] All studies were at low risk of incomplete outcome data reporting and were free of selective reporting (all stated outcomes were reported upon). All studies were deemed to be at low risk of contamination as arms adhered to allocated interventions. Finally, all studies demonstrated no important differences across study groups and thus were at low risk of bias associated with having different baseline characteristics except two studies whose similar baseline characteristics were adjusted for in the analysis.[18-19]

Doppler as a Tool for Improving Measurement of Perinatal Deaths Occurring in Health Facilities

Two studies assessed feasibility and validity of measurements of perinatal mortality in facilities based on the use of Doppler to verify the presence or absence of a FHR upon admission to labor and delivery services (Table 2.3).[21-22] A multi-country study was conducted to determine the level of potentially preventable perinatal deaths occurring in study facilities and to describe feasibility of the measure. The study found that 40–45% of intrapartum deaths occurring in the facility were potentially preventable (based on the presence of positive fetal heart sounds on admission) and deemed measurement of the indicator to be feasible.[21]

A study in Tanzania had health care providers use Doppler to check FHR upon admission to the facility and record the findings in the national facility register. Perinatal deaths recorded in the register in the study period were verified through use of perinatal death audit. The aim of the study was to create an indicator of facility perinatal mortality, tracked through national health information systems. The study authors recommended that the indicator be used to track perinatal deaths occurring following after admission to the facility and link the results of the indicator tracking to quality improvement initiatives.[22]

Health Care Provider or Client Preferences for Doppler Versus Pinard Stethoscope

Three studies examined client or health care provider preferences for Pinard fetoscope compared to Doppler for intrapartum FHR monitoring (Table 2.4).[11,23-24] In a South Africa study which compared client preferences for Doppler, Pinard, and cardiotocography, 74% of women noted Doppler as their first choice.[23] In a qualitative assessment of women who had been continuously monitored using a strap-on Doppler device in Tanzania, women were reassured by the sound of their baby's heartbeat, and felt that the Doppler made health care providers more attentive. The authors concluded that while

using Doppler for intrapartum FHR monitoring was appreciated by clients, further use of this device should be accompanied by educating women on its functions.[11] In a Tanzania RCT among nurses and nurse-midwives who had used either Doppler or Pinard fetoscope for intermittent FHR monitoring, the nurses and midwives tended to prefer the device with which they were most familiar. The arising recommendation was to include adequate education on Doppler for health care providers when introducing the device and in preservice/professional training.[24]

All three of these studies had notable limitations that lessen the generalizability of results. The Tanzanian study was conducted with relatively few midwives, only reflected views from one health facility, and reflected experiences in which the device used was based on random assignment rather than provider preference. The South Africa study, which compared client preferences between Doppler, Pinard and cardiotocography, did not test FHR monitoring throughout labor, but rather at a single point during the first stage of labor. Additionally, authors did not address potential effects of being in active labor while giving feedback, nor did the authors describe what information they provided to participants about efficacy of the devices for FHR monitoring. Finally, this study did not provide statistics to test significance of the findings. The qualitative study from Tanzania, which assessed women's perceptions on Doppler for continuous monitoring of FHR during labor, reflected views from women who attended services at one facility, and only women who had healthy babies were included in the study. Interviews were conducted before discharge from the facility, which may have affected the women's openness to answer questions frankly.

2.4 Discussion

An estimated 1 million newborn deaths and half of all maternal deaths could be prevented with higher quality maternal and newborn care.[25] Lack of intrapartum monitoring of FHR according to standards contributes to persistently high levels of perinatal and newborn death in LMIC.[2,26] Although

assessment of the fetus at time of admission to labor and delivery services is supposed to be routine,[27] in practice, there is evidence to suggest that FHR is often not assessed[17] and/or not recorded[21] in LMIC health facilities. A study of perinatal death audits in Tanzania showed that poor FHR monitoring was associated with over 40% of the deaths.[27] In Zanzibar, poor quality of intrapartum care was a determinant in virtually all stillbirths that occurred in the hospital, with median time from last fetal heart assessment to fetal death or delivery being 210 minutes.[28] These persistent gaps in quality of intrapartum FHR monitoring have consequences for the survival of newborns; new means to close the gaps are needed. To contribute to filling this gap, our study reviewed the literature for the ways Doppler has been used in intrapartum care in LMIC health facilities: to improve detection of intrapartum FHR abnormalities; respond to client and provider preferences or improve measurements for quality of intrapartum care.

Doppler and Perinatal Mortality

Except in one instance,[19] none of the reviewed studies demonstrated a reduction of perinatal mortality associated with the use of Doppler for FHR monitoring compared to Pinard fetoscope. This finding echoed that of a broader systematic review of intrapartum fetal surveillance in LMIC.[29] In multiple studies where Doppler was used for FHR monitoring,[15-18,20] while detection of abnormal FHR increased, proxy measures of clinical management following this (cesarean births, shortened time to delivery) did not. The implication of this finding is that introduction of Doppler to improve early detection of intrapartum fetal hear abnormalities needs stronger support for what follows after the detection of the abnormality. This may include job aides, such as decision-trees as developed by UK's NICE,[30] protocols addressing case management or referral processes, or other structural support to improve quality of intrapartum care around detection of abnormal FHR.

Continuous monitoring of fetal heart has been associated with an increase of caesarean sections which may not benefit the client.[8] Given WHO guidance cautioning about potential overuse of caesarean sections in LMIC,[31] any quality improvement work which introduces Doppler, particularly continuous monitoring, should also monitor potential overuse of caesarean section.

Doppler to Improve Measurement of Facility Perinatal Mortality

WHO has called for a metric for perinatal mortality occurring after admission to a health facility that can be used to monitor quality of intrapartum care.[11,32] In two studies in five countries, Doppler was used to detect FHR in women upon admission, allowing for the verification of whether fetal deaths occurred before or after facility admission. This information is useful to calculate an indicator of perinatal mortality that occurs in a health facility (i.e., mother was admitted to the facility with a documented FHR and was discharged with a stillborn or deceased newborn). It can be presumed that many of these cases represent poor quality of care. Both of these studies concluded that such a facility perinatal mortality indicator is a feasible and useful measurement[21-22] – one study also noted the feasibility of integrating the indicator into the national health information system.[22] Despite the small number of studies, the findings support increased use of Doppler to accurately measure preventable perinatal deaths (intrapartum stillbirths and early newborn deaths) occurring after admission to labor and delivery services LMIC health facilities. Further studies might address the feasibility of integrating the indicator into health information management systems, provider acceptance of the indicator, cost associated with scaling up Doppler use, and national policy makers' understanding of the need for the indicator.

Health Care Provider and Client Preference for Doppler as a Means of FHR Monitoring

WHO considers client and health care provider preferences key elements for a positive childbirth experience,[9] and the importance of the woman having informed choices regarding interventions in labor.[27] A strong client or health care provider preference for Doppler over Pinard may be sufficient to justify integrating the device into LMIC intrapartum care protocols. Three reviewed studies addressed health care provider and client preference for Doppler compared to other devices for monitoring FHR. All three had substantial limitations to generalizability which limit their usefulness in drawing programmatic or policy conclusions. The current evidence on client and provider preferences should be bolstered with studies that have greater generalizability and that include perspectives of women who experienced deliveries with fetal distress.

Limitations

There are some limitations that should be noted. First, the findings rely on the quality of included studies. All studies that examined adverse perinatal outcomes were designed with perinatal outcomes as a secondary outcome measure, and hence had relatively low power to detect these differences. Second, two studies indicated that, although FHR monitoring protocols were properly followed due to study oversight, there were delays in proper case management, impacting perinatal death rates.[16-17] This study did not include a meta-analysis due to dissimilarity of interventions and outcome measures in the studies. None of the included studies addressed feasibility of scale-up of Doppler, which would require an assessment of infrastructure-related needs such as power, ultrasound gel, and maintenance, which will eventually be important considerations for Doppler scale-up.

2.5 Conclusion

Based on the reviewed studies, it is reasonable to conclude that Doppler may be a better diagnostic tool compared to Pinard fetoscope for monitoring FHR in the LMIC facility setting. In all but a few cases, the studies that assessed interim measures of clinical management—i.e., cesarean sections, intrauterine resuscitation, time from detection of abnormal FHR to delivery—showed that these interventions were the same in Doppler arms compared to other arms, indicating a gap in clinical management following detection of fetal heart abnormalities. Further research and programming should link intrapartum FHR monitoring using Doppler with improved clinical decision-making, case management and referral protocols in case an abnormal FHR is detected.

Table 2.1. Studies on effectiveness of fetal heart rate monitoring using Doppler at reducing perinatal mortality

Study	Study country	Study objective	Intermittent or continuous FHR monitoring	Study design	N of study population (per arm or overall)	Difference in clinical management	Difference in perinatal outcome or abnormal FHR detection
Byaruhanga R, et al. BMJ Open (2017)	Uganda	To compare intermittent fetal heart monitoring using Doppler vs. Pinard for detection of FHR abnormalities (primary outcome measure), and intrapartum stillbirth and death within first 24 hours of life (secondary outcome measures)	Intermittent	Two-arm randomized controlled trial	Overall 1,987 women admitted to one peri-urban hospital Doppler arm = 1,000 Pinard arm = 987	No differences in rates of cesarean deliveries.	Significantly higher detection of FHR abnormalities in the Doppler arm (incidence rate ratio=1.61, 95% CI 1.13–2.30 p=0.008). No differences in rates of intrapartum stillbirths, neonatal deaths, Apgar score <7 at 5 min, or admission to NICU.
Kamala B, et al. IJWH (2018)	Tanzania	To compare intermittent fetal heart monitoring using Doppler vs. Pinard on detection of FHR abnormalities (primary outcome measure), and intrapartum stillbirth and newborn death, time to delivery, mode of delivery (secondary outcome measures)	Intermittent	Two-arm randomized controlled trial	Overall, 2,844 women admitted to Tanzania's national referral hospital Doppler arm = 1,421 Pinard arm = 1,423	No difference in time between detection of an abnormal FHR to delivery.	Significantly higher detection of FHR abnormalities in the Doppler arm (6%) compared to Pinard arm (3.9%) (aOR=1.59, *P*=0.008). Overall, no difference in perinatal death. Among newborns with abnormal FHR delivered vaginally, fewer adverse outcomes in Doppler (16.3%) compared to Pinard arm (43.5%), *P*=0.021. No significant differences Apgar score <7, bag and mask ventilation, mode of delivery, perinatal admissions to the NICU, and perinatal deaths.

Mahomed K, et al. BMJ (1994)	Zimbabwe	To compare effectiveness of cardiotocography, intermittent monitoring with Doppler; intermittent monitoring with Pinard by a research midwife and intermittent monitoring with a Pinard by facility midwife on detection of abnormal FHR (primary outcome) and cesarean section, neonatal mortality, and admission to NICU (secondary outcomes)	Intermittent	Four-arm randomized controlled trial Doppler for intermittent monitoring; cardiotocography; Pinard with research midwife (gold standard); Pinard with facility midwife (routine monitoring)	Overall, 1,255 women admitted to one urban referral hospital Doppler arm = 312 Pinard with research midwife arm = 310 Pinard with facility midwife arm = 315 Cardiotocography arm = 318	No difference in time between detection of FHR abnormality and delivery in the 4 groups. Cesarean section more common in the cardiotocography (28%) and Doppler arms (24%) than in the Pinard arms with research midwife (10%) and with facility midwife (15%). Fetal distress was indication for cesarean section for 63% of those from cardiotocography arm and 67% of Doppler arm— each significantly higher than Pinard stethoscope arms (41%).	Compared with routine monitoring, relative risk of detecting abnormal FHR was 6.1 (95% CI 4.2–8.8) with cardiotocography, 3.6 (95% CI 2.4–5.3) with Doppler, and 1.7 (95% CI 1.1–2.7) with the Pinard stethoscope with research midwife. Stillbirth or newborn death was 3% in cardiotocography arm; 0.6% in Doppler arm; 2% in Pinard with research midwife and 3% in routine monitoring group. Significantly fewer babies in the Doppler arm were admitted to the NICU compared to the other groups.
Mdoe P, et al. BMC Preg Childbrth (2018)	Tanzania	To compare intermittent fetal heart monitoring using Doppler vs. Pinard for detection of FHR abnormalities (primary outcome measure) and intrapartum stillbirth and newborn death and infants admitted in the neonatal unit after 24 hours (secondary outcome measures)	Intermittent	Two-arm randomized controlled trial	Overall, 2,684 women admitted to one rural referral hospital Doppler = 1,309 Pinard = 1,375	No difference in time between detection of an abnormal FHR to delivery and no difference in cesarean delivery rates.	Abnormal FHR detected in 4.2% of Doppler arm vs 3.1% in the Pinard arm—the difference was not significant (RR=1.38; 95% CI: 0.93–2.04) No difference in adverse perinatal outcomes or bag and mask ventilation between Pinard and Doppler arms.

Kamala B, et al. PLoS One (2018)	Tanzania	To assess the association between introduction of continuous FHR monitoring on detection of abnormal FHR (primary outcome measure); time to delivery, time from detection of abnormal FHR to delivery, and intrauterine resuscitations (secondary outcome measures)	Continuous	Observational pre- and post-intervention study	At one urban referral hospital, 1,640 women were enrolled in the pre-implementation stage and 2,442 were enrolled in the implementation stage.	A higher rate of cesarean sections was seen post-intervention (5.4%) compared to pre-intervention (2.6%) (*P* <0.001). Post-intervention, the cause of cesarean section was fetal distress in 48% of cases compared to 35% pre-intervention. Median time from last FHR assessment to delivery was 60 min pre-intervention vs 45 min post-intervention (p<0.001).	Continuous FHR monitoring using Doppler (post-intervention) was associated with 6.9-fold increased detection of abnormal FHR compared to routing FHR monitoring using Pinard (pre-intervention).
Mdoe P, et al. Int J Gynecol Obstet (2018)	Tanzania	To compare continuous fetal heart monitoring using Doppler vs. intermittent monitoring using Pinard on detection of FHR abnormalities (primary outcome measure) and intrapartum stillbirth and newborn death, mode of delivery, 5-minute Apgar score, bag-mask ventilation, time from abnormal FHR detection to delivery, adverse fresh stillbirth, newborn death within 24 hours, and admission to the NICU (secondary outcome measures)	Continuous	Two-arm randomized controlled trial	Overall, 2652 women enrolled at one rural referral hospital Doppler with continuous monitoring arm: 1,340 Doppler with intermittent monitoring arm: 1,312	Increased rate of intrauterine resuscitations in continuous vs intermittent monitoring groups (6.6% vs 3.2%; RR 2.07, 95% CI 1.4–2.9; *P*<0.001). Fetal heart distress was the cause of 20.2% of cesareans in the continuous vs 7.4% in intermittent monitoring group (2.79, 95% CI 1.7–4.6, *P*<0.001). Median time interval between detection of abnormal FHR to birth was shorter in continuous monitoring group (52 minutes versus 75 minutes) (*P*<0.04).	Continuous FHR monitoring with Doppler detected abnormal FHR in 8.1% vs 3.0% of women in intermittent monitoring group (RR 2.64, 95% CI 1.8–3.7; *P*<0.001). No significant differences in adverse outcomes between groups.

FHR, fetal heart rate; CI, confidence interval; NICU, neonatal intensive care unit; aOR, adjusted odds ratio; RR, risk ratio

Table 2.2. Risk of bias and strength of evidence using Cochrane criteria for assessment of bias in Effective Practice and Organization of Care (EPOC) studies

Study	Domain	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Incomplete outcome data	Free of selective reporting	Blinding of outcome assessment	Baseline outcomes similar	Free of contamination	Baseline similar characteristics
Mahomed K. et al. BMJ (1994)	**Judgement**	Unclear risk	Low risk	High risk	Low risk	Low risk	High risk	Low risk	Low risk	Low Risk
	Description	Randomization sequence generation not described	Sequentially numbered opaque sealed envelopes	Blinding of both clinicians and patients not possible	The proportion of missing data was unlikely to overturn the study result	All out-comes reported	Assessors of the outcomes were not blinded	No outcomes at the beginning of the study	All arms received allocated interventions. No crossing over	No important differences were present across study groups *P*<0.05
Byaruhanga R, et al. BMJ Open (2017)	**Judgement**	Unclear risk	Low risk	High risk	Low risk	Low risk	High risk	Low risk	Low risk	Low risk
	Description	Randomization sequence generation not described	Sequentially numbered opaque sealed envelopes	Blinding of both clinicians and patients not possible	The proportion of missing data was unlikely to overturn the study result	All out-comes reported	Assessors of the outcomes were not blinded	No outcomes at the beginning of the study	All arms received allocated interventions. No crossing over	Baseline characteristics were similar *P*<0.05
Mdoe P, et al. BMC Preg Childbrth (2018)	**Judgement**	Unclear risk	Low risk	High risk	Low risk	Low risk	High risk	Low risk	Low risk	Low risk
	Description	Randomization sequence generation not described	Sequentially numbered opaque sealed envelopes	Blinding of both clinicians and patients not possible	Completed follow-up per protocol	All primary and secondary outcomes reported	Not possible to blind outcomes assessors	No outcomes at the beginning of the study	Allocated interventions adhered to	Baseline characteristics were similar *P*<0.05
Mdoe P, et al. Int J Gynecol Obstet (2018)	**Judgement**	Unclear risk	Low risk	High risk	Low risk	Low risk	High risk	Low risk	Low risk	Low risk

	Description	Randomization sequence generation not described	Sequentially numbered opaque sealed envelopes	Blinding of both clinicians and patients not possible	Completed follow-up per protocol	All primary and secondary outcomes reported	Not possible to blind outcomes assessors	No outcomes at the beginning of the study	Allocated interventions adhered to	Baseline characteristics were similar *P*<0.05
Kamala B, et al. PLoS One (2018)	**Judgement**	Unclear risk	Low risk	High risk	Low risk	Low risk	High risk	Low risk	Low risk	Low risk
	Description	No randomization; controlled before-after study	Controlled before-after studies	Blinding of both clinicians and patients not possible	Completed follow-up per protocol	All primary and second-ary out-comes reported	Not possible to blind outcomes assessors	All mothers had normal FHR on admission	Unlikely since the 2 interventions took place in different times	Imbalances were adjusted in the regression models
Kamala B. et al. IJWH (2018)	**Judgement**	Low risk	Low risk	High risk	Low risk	Low risk	High risk	Low risk	Low risk	Low risk
	Description	A randomization sequence was computer-generated by an indepen-dent statistician	Sequentially numbered opaque sealed envelopes	Blinding of both clinicians and patients not possible	Completed follow-up per protocol	All primary and secondary out-comes reported	Not possible to blind outcomes assessors	All mothers had normal FHR on admission	Allocated interventions adhered to	Adjusted for baseline imbalances using logistic regression, multinomial regression, and linear regression
Mangesi L, et al. S Afr J Obstet Gynaecol (2009)	**Judgement**	High risk	High risk	High risk	Low risk	Low risk	High risk	Unclear risk	Unclear risk	Unclear risk
	Description	No randomization; cross-sectional study	No randomization; cross-sectional study	No blinding; cross-sectional study	All data obtained	All out-comes reported	No blinding because of the study design	Not described	Not described	Not described

Table 2.3. Studies on measurement of health facility-occurring perinatal mortality using Doppler

Author and year	Study country(ies)	Study objective	Study design	Perinatal mortality indicator studied	Definition	Source of data for calculating indicator	Population size / sample size for calculating indicator	Key findings
Goldenberg R, et al. IJGO (2013)	Pakistan, India, Democratic Republic of Congo, Kenya	To quantify the proportion of perinatal deaths that occurred in the facility setting and were potentially preventable, as a demonstration for potential scale-up to assess quality of intrapartum care	A prospective study in which FHR was assessed using Doppler and basic information recorded from women admitted to labor	Perinatal mortality rate per 1,000 deliveries	Stillbirths and newborn deaths before discharge per 1,000 deliveries (stratified by whether occurring hospital, whether neonate was less than 2,500 grams at birth)	Individual client record	3,555 women and 3,593 neonates in 6 hospitals in 5 countries	Approximately 40% of the perinatal mortality occurred in-hospital, and was potentially preventable with better care. The perinatal mortality rate was 34 deaths per 1,000 deliveries overall and 13 per 1,000 deliveries in-facility. Restricted to neonates weighing 2,500 g or more, perinatal mortality rate was 22 per 1,000 deliveries overall and 9.4 per 1,000 deliveries in-facility.
Plotkin M, et al. PLoS One (2018)	Tanzania	To validate an indicator of facility perinatal mortality by 1) comparing perinatal outcomes (macerated stillbirths, fresh stillbirths newborn death) as recorded in the facility register to gold-standard audits and 2) calculating the indicator for the study sites	A validation study in which audits were conducted on 128 perinatal deaths recorded in the health facility's national health information system register over 6 months	Facility perinatal mortality indicator	Fresh stillbirth + very early newborn deaths divided by all women admitted to the facility with a fetal heart rate detected	National health information system maternity register	Indicator calculated on 9,687 women admitted to labor and delivery services in 10 health facilities in Kagera region of Tanzania; 128 perinatal deaths were audited to assess validity of register-recorded classification.	The sensitivity and specificity of register outcomes to predict audit outcomes ranged from 95.7–100%, validating the accuracy of register data for calculation of the indicator. Rates of perinatal mortality occurring within the facility ranged from 4.2% at regional hospital; 1.5–2.7% at district hospitals; 0.3–0.5% at health centers. Use of Doppler upon admission and the recording of the FHR in the register produced a more specific measure as compared to crude perinatal death rate, which included macerated stillbirths and was thus less reflective of quality of intrapartum care.

Table 2.4. Studies related to health care provider or client preference for Doppler versus Pinard

Author	Study country	Primary research question	Study design	Population studied	Number of interviews/ FGDs	Key findings	Recommendations
Lafontan S, et al. Int J Environ Res Public Health. (2018)	Tanzania	To describe attitudes and perceptions of women in labor continuously monitored with a strap-on Doppler device and their perceptions of quality of intrapartum care	A cross-sectional qualitative study; conducted in-depth interviews with women who had delivered in an urban hospital within 12–24 hours of delivery	Multiparous women monitored using a continuous Doppler monitoring system during their delivery; only women with positive birth outcome interviewed	20 interviews	Use of the monitor positively affected the women's birth experience by providing reassurance about the wellbeing of the child. Women believed that use of the device improved care received by the health facility staff through increased communication and attention from birth attendants. Participants were given little to no information about the purpose or functions of the device, thus did not fully understand and often overestimated its capabilities.	Upon introduction of the Doppler for intrapartum care, information should be included in counseling during antenatal care and/or in the early stages of labor. Information should include limitations of the technological device to avoid overestimation of its capabilities.
Mdoe P et al. BMC Preg Childbirth (2018)	Tanzania	To explore midwives' perceptions on using either Doppler, Pinard fetoscope, or Freeplay wind-up for intermittent FHR monitoring in a rural hospital	Cross-sectional qualitative assessment using focus group discussions (FGDs)	Midwives employed at the study hospital for at least 6 months; trained in use of both Doppler and Pinard fetoscope	5 FGDs held with 25 participants	The study did not reveal a common and clear preference for Doppler versus fetoscope for FHR assessment. Three themes emerged: 1) sufficient training and experience in using a device, 2) perceived ability of devices to produce reliable measurements, and 3) convenience of use and comfort of the device.	Regular trainings to make the use of Doppler easier, and equal availability of fetoscopes and Doppler in labor wards. More research needed to address practitioners' preferences on best ways to conduct FHR monitoring.
Mangesi L, et al. S Afr J Obstet Gynaecol (2009)	South Africa	To document preferences on 3 different methods of FHR assessment (Doppler, Pinard fetoscope, and cardiotocography) by laboring women	Cross-sectional based on interview with women in labor	Women in the first stage of labor. In the course of 30 minutes, women were assessed using the wind-up Doppler, the Pinard fetoscope and the cardiotocograph in succession. Women were then asked to rank their first and second choice.	97 women were interviewed	72 out of 97 women preferred the Doppler for assessing FHR in the first stage of labor.	The authors concluded that fetal heart rate monitoring using the Doppler was more acceptable to laboring women than monitoring with a Pinard stethoscope or cardiotocography.

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CHAPTER 3: SCALE-UP OF DOPPLER TO IMPROVE INTRAPARTUM FETAL HEART RATE MONITORING IN TANZANIA: A QUALITATIVE ASSESSMENT OF NATIONAL AND SUBNATIONAL IMPLEMENTATION FACTORS

3.1 Introduction

Globally, an estimated 2.1 million early neonatal deaths and 2.6 million stillbirths occurred in 2015, including 1.3 million intrapartum stillbirths.[1] Almost all of these (98%) occurred in low- and middle-income countries (LMICs).[1–2] Skilled birth attendance, where intrapartum and newborn care comply with globally recommended quality standards, could prevent a substantial portion of these deaths.[3]

Abnormal fetal heart rate (FHR) in the intrapartum period can indicate a hypoxic state in a fetus resulting from interruption of placental blood flow.[4] Due to this connection between fetal heart abnormalities and adverse outcomes, poor quality intrapartum FHR monitoring contributes to intrapartum stillbirths.[5] In Tanzania, studies have provided strong evidence of fetal heart abnormalities as a predictor of fresh stillbirth, birth asphyxia, and newborn death. Improvements to intrapartum monitoring have had demonstrated results, as in a 1989 study in southwest Tanzania where an intervention related to intrapartum monitoring was associated with a reduction of perinatal mortality from 71 to 39 deaths per 1,000 births.[6] Despite this evidence, quality of intrapartum FHR monitoring, both upon admission to labor and delivery services and intermittently throughout labor, is often poor in Tanzania.[5]

The World Health Organization (WHO) recommends intermittent FHR monitoring during labor in the LMIC setting, but does not endorse a particular tool.[7] In LMIC health facilities, the Pinard

stethoscope is widely used to assess FHR in the intrapartum period, rather than cardiotocography (the standard of care in high resource countries) or handheld Doppler device.[8] However, multiple randomized controlled trials in sub-Saharan Africa have demonstrated that Doppler is superior to Pinard stethoscope at detecting abnormal FHR. [9–13] And although evidence on client preference for Doppler over Pinard is not strong, a small study in South Africa showed that laboring women preferred Doppler over Pinard for FHR monitoring.[14] In a qualitative study in Tanzania, women in labor showed a strong liking for Doppler for continuous FHR monitoring.[15] Although further evidence is needed, a growing base of findings suggests that using Doppler to monitor FHR during labor in the LMIC facility setting may improve both quality of clinical care and women's experience of intrapartum care.

In 2008, following a call for a single plan to address reproductive, maternal, newborn, and child health strategies, the Tanzanian Ministry of Health (now the Ministry of Health, Community Development, Gender, the Elderly and Children) developed "The National Road Map Strategic Plan to Accelerate Reduction of Maternal, Newborn, and Child Deaths in Tanzania 2008–2015," referred to as the One Plan.[16] The One Plan included basic emergency obstetric and newborn care (BEmONC) targets, such as intermittent FHR monitoring through use of the partograph. The Sharpened One Plan, created in 2013, emphasized obstetrics and family planning and focused on the Western and Lake Zones of Tanzania.[17] An evaluation of the Sharpened One Plan found that achievements fell far short of targets; for example, the proportion of public health facilities offering BEmONC services was 45% in 2015 against a target of 70%.[17] Currently, the policy framework for improving maternal and newborn care is governed by the One Plan II, the country's second national strategic plan, which covers 2016–2020.

Tanzania's National Service Quality Improvement Tool of 2013 recommends FHR monitoring every 5 minutes when a woman is in the second stage of labor.[18] Similar to WHO guidance, the tool says nothing about whether Doppler or Pinard stethoscope should be used to monitor FHR.

The Helping Babies Breathe (HBB) training approach and set of materials are designed to boost health care providers' newborn resuscitation skills in the low-resource health facility setting. HBB has been used in many LMICs to improve the quality of immediate newborn care.[19] As an intrapartum capacity-building intervention, HBB sets a precedent for scale-up that intrapartum FHR monitoring can use as a model. The Tanzanian national HBB program, which started in 2013, was scaled up to 15 of Tanzania's (then) 25 regions with a 1-day, onsite training for health care providers, provision of supplies and equipment, and post-training mentoring to health care providers. HBB rollout has been evaluated in Tanzania in terms of programmatic approach to scale-up,[19] validation of tools and approaches for training,[20-21] and cost-effectiveness.[22-23]

This analysis presents views from high-level Tanzanian policymakers and subject matter experts (SMEs) about the potential use of Doppler for FHR monitoring in health facilities at large scale. The interviews centered on the following research questions:

- What are the facilitators and barriers to scale-up of Doppler to be used for intermittent fetal heart monitoring?
- What lessons can be learned from Tanzania's experience of scale-up of the HBB program?
- Who needs to do what to scale up Doppler in Tanzania?

The analysis uses a social ecological framework to contextualize findings. The study will be useful to policymakers and program implementers developing policies, protocols, guidelines, and standards to improve intrapartum care in Tanzania and similar settings.

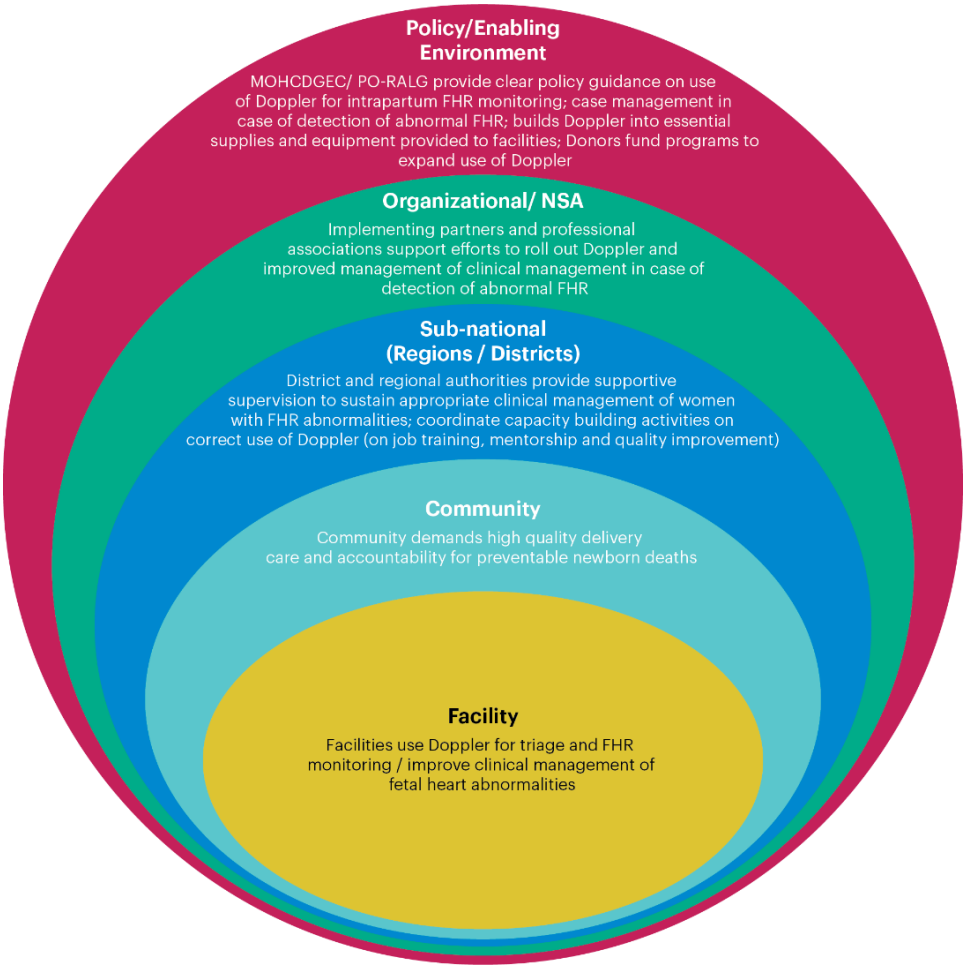
3.2 Methods

This qualitative study used in-depth interviews to elicit views and opinions of policymakers and SMEs from the maternal and newborn health fields on the environment and precedents for scale-up of Doppler for FHR monitoring during intrapartum care in Tanzania.

Social Ecological Framework for Scaling Up Doppler in Intrapartum Care

The social ecological model has proven useful for exploring potential barriers and facilitators to health service use.[24] The current study uses this model to examine national, subnational, and organizational factors associated with the research question, What are the barriers and facilitators to scale-up of Doppler in Tanzania? Figure 3.1 presents the adapted social ecological model, with the health facility at the individual level. The study focus is the two outermost levels (policy and organizational levels).

Figure 3.1. Social ecological framework for environmental factors surrounding scale-up of Doppler



We used a stakeholder analysis framework to examine the research question, Who needs to do what to scale up Doppler in Tanzania? To assign roles to each key stakeholder in the framework, we took suggestions made by interviewees or deduced by the study team and plotted using a diagram.

Participants

A total of nine interviewees were selected. The number of interviews was not predetermined; rather, we designed the interviews to balance input from different branches of the GoT and agencies. Interviewees included high-level Government of Tanzania (GoT) policymakers and national maternal and newborn SMEs at professional organizations, universities, and donor agencies. Regional health authorities from Mara region of Tanzania were also included. Mara is part of an ongoing study examining perinatal mortality rates in facilities using Doppler. Mara region is supported by the Maternal and Child Survival Program (MCSP), a global 5-year cooperative agreement funded by the United States Agency for International Development (USAID) to introduce and support scale-up of high-impact health interventions. Table 3.1 lists the interviewees' positions and organizations.

Table 3.1. Study participants

Number of interviewees and roles	**Organization**
(2) Senior advisors	Reproductive Maternal, Newborn, Child, and Adolescent Health Department, the President's Office, Regional and Local Government (PO-RALG)
(2) Senior advisors	Reproductive and Child Health Section, Ministry of Health, Community Development, Gender, the Elderly, and Children (MOHCDGEC)
(1) Registrar	Tanzania Nursing and Midwifery Council
(1) Reproductive and child health services coordinator	Regional Health Management Team, Mara
(1) Research scientist, subject matter expert	Haydom Lutheran Hospital
(1) Subject matter expert	Aga Khan Medical University
(1) Program specialist, Maternal, Newborn and Child Health	U.S. Agency for International Development

Data Collection Procedures and Study Tool

We selected three themes from Proctor's classification of implementation outcomes [25] to correspond to the early stage of implementation of Doppler in Tanzania. The selected themes (costs, appropriateness, and acceptability) are a subset of a larger group of implementation outcomes (acceptability, adoption, appropriateness, costs, feasibility, fidelity, penetration, and sustainability). These themes are most relevant to the early stage of introduction of the technology as compared to outcomes such as penetration, sustainability and adoption which would be presumed to be assessed later in scale-up. These themes led to specific questions and prompts in the questionnaire (Table 3.2).

Table 3.2. Domains for scale-up of Doppler for intermittent fetal heart rate monitoring in Tanzania

Domain	**Questions**
Costs	• What is the current resource availability for improving intrapartum care? • What financial and other resources were needed from external donors for rollout of the Helping Babies Breather initiative from the Ministry of Health, Community Development, Gender, the Elderly, and Children (MOHCDGEC)? • What affordability barriers do you anticipate if Doppler were to be scaled up to all facilities providing maternity services? • What facilitators do you anticipate?
Appropriateness	• What are current priorities for improving intrapartum care in public health facilities in Tanzania? • What resources would be needed to scale up use of Doppler in intrapartum care in Tanzania? from the MOHCDGEC? from nongovernmental organizations? from external donors? • What human resources and systems barriers do you anticipate if Doppler were to be scaled up to all facilities providing maternity services? • What facilitators do you anticipate?
Acceptability	• How well does use of Doppler in intrapartum care align with current national priorities for maternal and newborn care? Are there competing priorities? synergistic factors? • Is it likely that using Doppler for intrapartum care will be acceptable to the district medical authorities? facility managers? health care providers providing intrapartum care?

Interviews took place between November 2018 and August 2019. Members of the research team conducted the interviews using the standardized interview guide (available in the supplemental materials) after obtaining interviewees' written consent to participate in the study. Interviews were audio recorded and interviewers took notes, which were cross-referenced during the analysis. Interviews were conducted in English (n = 8) or Swahili (n = 1), depending on the interviewee's preference. Transcripts were produced from audio recordings for analysis, and translated into English when needed.

Data Analysis

Because of the small number of interviews, analysts (MP, JG) used manual coding to identify themes and codes. We created a codebook delineating themes drawn from the feasibility domains (Table 3.2), and used color schemes to highlight and annotate text and relate themes and codes in the transcripts. The coding process followed the grounded theory tradition,[26] allowing additional themes and codes to arise during analysis. After the initial pass through the transcripts, the two analysts agreed upon a consolidated list of codes. Using the expanded group of codes, they reviewed the transcripts again, and created a summary of findings and quotes by theme and code.

3.3 Results

Costs

Purchasing Dopplers for Health Facilities

Although several interviewees felt that the local government (through facility and district funds) and the central government and implementing partners (Tanzanian and international civil society organizations) should share responsibility for purchasing Dopplers, most stressed that Dopplers should be purchased with district or facility funds. The specific mechanisms identified were direct health facility

financing, internally generated revenue from health insurance schemes (Interviewee 3), government funds (in the form of district-allocated health budgets) (all participants), nongovernmental organizations (NGOs), and private companies, such as in a corporate social responsibility initiative in Geita where companies donated ultrasound machines (Table 3.3).

To work around this, one participant stressed the importance of priority building so that facilities can plan, budget, and procure Dopplers, indicating that without any one of these steps the device would not reach facilities.

Several participants mentioned including Doppler in facility budgets as a necessary step:

> *If there is anything that is not in the budget, that would be a barrier for the facility to buy. It doesn't matter how much it costs, it's the issue of entering it into the normal yearly budget of every facility.*

One participant raised the cost of a Doppler compared to a Pinard, along with other factors that might eventually be evaluated as part of a cost/benefit analysis:

> *For example, a Pinard stethoscope costs about 5 US dollars compared to the Doppler, which costs about 200 US dollars. If you compare in terms of the prices, the Doppler looks to be expensive. But in terms of functionalities, we find that Doppler saves a lot of time, and it's easier to use.*

Procurement Processes

Although all participants felt that Dopplers were affordable and within the means of health facility budgets, several raised concerns about delays or roadblocks associated with facilities procuring equipment. One participant cited an example of a health facility that did not have a refrigerator or consistent power but could not navigate the system to procure one:

> *I proposed, why don't you buy a fridge powered by solar? They said they can do that, but after 6 months it was still on procurement. That year the budget closed with 6 million shillings still in the budget (and no refrigerator).*

Appropriateness

Training

Several interviewees stressed the importance of workplace-based training on the use of Doppler and the need for subsequent mentoring:

> *Updates should focus on how to give high-quality care, on an on-job training basis.*

> *The training should be mentorship, not classroom learning… We can now see vividly that this helps someone to acquire that skill.*

Two interviewees recommended a low-dose, high-frequency (LDHF) approach to training. One interviewee thought that adding a day to existing BEmONC in-service training would be the best way to scale up the program nationally, unless an external donor was willing to fund a HBB-like standalone training. Additionally, clinical management following detection of abnormal FHR was described as critical:

> *The issue is not just to put the Doppler at the bed of a pregnant woman, but also to know the concept behind the Doppler. Otherwise it can be there, but the interpretation of that data? The midwife may not think that the woman is in danger and take action.*

Two interviewees stressed the need to incorporate facility-level competence into existing supervision systems:

> *Use the Regional and Council Health Management Teams (RHMT and CHMT) to train the providers at the level of the facility. I think that will really cut the cost, because we know that the CHMT and RHMT have regular supportive supervision at the facility … while they are going for that regular supervision, they go with the plan of training people.*

> *We as regional supervisors, progressively need to supervise and sensitize … We must make sure we work together with Councils as they have the capacity to reach all facilities. Emphasis must go on the facility in-charges who ensure that intended women get the service.*

One interviewee stressed the need to develop or incorporate Doppler into clinical guidelines:

I think first and foremost, we need to develop guidelines—guidelines for use of Doppler, specifically.

Two participants mentioned a lack of available evidence on cost and cost-effectiveness needed for the government to make a decision on Doppler scale-up.

Levels of Care

One participant was concerned with whether Doppler would be equally useful at lower and higher level facilities, pointing out that many regional and some district hospitals already use Doppler.

Practicability Barriers

Multiple interviewees mentioned lack of a reliable power source at health facilities as a potential barrier to scale-up. Recommendations included looking into manual, battery-powered, or solar-powered Doppler devices to accommodate this challenge. One participant noted the need for integrated solutions to improve quality of intrapartum care:

The other note I want to make is that Doppler alone is not going to improve intrapartum care…. Areas like training of the personnel and staffing should come together.

Lessons Learned from HBB Scale-Up

Multiple respondents noted the link between HBB as an approach to improve newborn outcomes and use of Doppler for FHR monitoring. Others recognized that HBB scale-up significantly improved newborn care in Tanzania:

HBB has contributed a lot to improve the newborn's conditions … It has rescued a lot of babies who had nearly died but were saved due to availability of these services in health facilities.

HBB is among the very successful programs that has been taken up here in Tanzania.

One participant was particularly concerned about availability of equipment (bag and mask in newborn size) as a barrier to HBB scale-up:

> *The barrier, or can I say challenge, to HBB was the availability of equipment … In most of the government facilities, you find that there are so many clients … even when the equipment is there to help the baby survive, it is inadequate in quantity.*

This concern may be of note in looking at needs for assessing Doppler quantities available for provision of care. One concern raised about HBB scale-up in Tanzania was a perception that HBB (implementation, programmatic outcomes) has not been monitored closely. As one interviewee described:

> *HBB in most parts of this country is not monitored—even at the regional level. It has been scaled up and nobody is concerned with monitoring—this is bad. You should monitor everything to see its effectiveness, see its applicability, to see the challenges.*

Acceptability and Alignment with National Priorities

At least one participant stressed the link between the current national strategy (One Plan II) and improving intrapartum care. The participant noted that the emphasis on delivering babies in the health facility setting had not translated to improved perinatal mortality:

> *Over the past 15 years … we have seen a lot of emphasis on getting women to deliver at the health facilities. And we've done very well on that. We've moved from less than 40% hospital delivery to almost 63%, but we have not seen a significant reduction in infant mortality. And we ask why? Because it looks like we have moved these deaths from the community to the health facility ... These facilities are not prepared to receive that influx of mothers. You see? So currently the government putting a lot of emphasis on improving the quality of intrapartum care.*

The same participant was highly positive about use of the Doppler in Tanzanian health facilities for improved FHR monitoring, arising from recent studies in Tanzania:

> *Our data supports that if you use Doppler… any Doppler, the quality of intrapartum care becomes better and the outcomes are better. I think that's the most important driver because we all want to reduce perinatal mortality… So, if somebody's asking you, why do you want this? We have the evidence.*

Acceptability to Health Care Providers

Almost all interviewees viewed Doppler positively in terms of how they believed health care providers would like Doppler and its utility in intrapartum care. Several interviewees were midwives and saw the benefit to clinical management. One interviewee was certain that Doppler would make birth attendants' jobs in crowded health facilities easier and lead to better care for women:

> *If we have the room to get a device which can assist the midwife to monitor fetal heart rate, I think we should be very positive. We are always telling our people to shout for help, and if this device really assists them to shout for help, why should we wait? We need it right now. I'm not the one budgeting, but as a midwife, I think we need this device. We need to advocate to the management to see the importance of this one.*

One interviewee cautioned against expecting an enthusiastic reception of Doppler for FHR monitoring, citing experience from a recent study in Tanzania in which midwives did not prefer Doppler over the Pinard stethoscope; rather, they preferred the device with which they were most familiar.

Another interviewee stressed the need for both health care providers and women entering maternity services to buy in to use of Doppler for FHR monitoring (Doppler makes the fetal heartbeat audible to both the health care provider and the woman in labor).

> *One of the key issues which needs to change is attitude (of the health care provider). Change your attitude, and then we will make sure that the new technology will improve intrapartum care … and not only the health care provider, mothers too. Because some of them don't like to hear the fetal heartbeat. We need to get the mother and health care providers aware the advantage of using the Doppler.*

Another mentioned that Doppler would simplify FHR monitoring for health care providers, who currently use their watches to time heartbeats when using a Pinard stethoscope:

> *Availability of Doppler actually simplifies work for the provider in reducing the need for counting and using a watch (associated with use of Pinard fetoscope).*

However, one interviewee cautioned against being overly optimistic about Doppler's acceptability among health care providers, citing Rogers' Diffusion of Innovation theory:[27]

Any innovation which comes in, you don't expect to be accepted right away.… Because people want to stay in their comfort zone. So, if a person is used to having a Pinard stethoscope, it's maybe comfortable to continue using the Pinard stethoscope because he has been doing that over years and years.… So, you have those kinds of people who will take the innovation when they get it, but you have those people who will not take it from the beginning.… We should be aware of that. That even though this innovation may be good, we should not expect immediate acceptance by all.

Alignment with National Priorities

Overall, there was general agreement that Doppler aligned with national priorities:

When we read the Road Map you see that it aims at certain goals, one of them being the reduction of maternal death as well as newborn and perinatal death. So, proper monitoring during labor will definitely help to identify babies in distress and respective intervention can be performed, timely.

However, participants' listing of priorities for improving intrapartum care varied in terms of how closely Doppler aligned with perceived national priorities. As Table 3.3 shows, some respondents mentioned bigger picture issues, such as human resource shortage/increasing the number of skilled birth attendants, and provision on the government's ability to provide comprehensive emergency obstetric and newborn care (CEmONC).

Table 3.3. Summary of national priorities mentioned by interviewees and alignment to scale-up of Doppler

Summary of responses to: "What are national priorities for improving intrapartum care in Tanzania?"	**Alignment with Doppler scale-up**	
	Description	**Level***
Ensure competent, high-quality labor and delivery care, including respectful maternity care, to reduce the number of deaths in prenatal and intrapartum care.	Improved fetal heart rate (FHR) monitoring could potentially reduce perinatal death in the intrapartum period.	High
Ensure high-quality newborn care.	Use of Doppler may improve FHR monitoring and thus newborn care.	
During intrapartum care, monitor and document the FHR in the partograph.	Doppler can improve FHR monitoring for better use of partograph.	
Record labor, delivery, and post-delivery client management so the facility can review care.	Doppler can help improve FHR information for quality of care review or for perinatal death audit.	
Increase the number of skilled birth attendants; ensure sufficient supply of lifesaving commodities, equipment, and medicines; and build health care provider capacity.	Having a sufficient supply of Doppler devices may help save newborn lives.	Medium
Manage preterm babies in regional hospitals.	Use of Doppler for FHR monitoring may save lives of preterm babies for treatment in newborn intensive care units.	
Ensure that every mother delivers at a facility with a skilled provider.	Clients may prefer Doppler, which may contribute to better experience and thus higher attendance at care.	Low
Upgrade facilities to provide comprehensive emergency obstetric and newborn care (CEmONC), i.e., cesarean services; promote facility deliveries, early booking, and regular antenatal care (ANC) attendance.	Use of Doppler to monitor FHR may result in more referral to cesarean services. However, use of Doppler is not necessarily associated with the upgrade from BEmONC to CEmONC.	
Book ANC appointments early.	Use of Doppler for intrapartum FHR monitoring is not connected to ANC.	None
Build new health facilities.	Use of Doppler for intrapartum FHR monitoring is not connected to building new health facilities	

*"Levels" (high, medium, low, none) were assigned by authors, not participants.

Three respondents linked use of Doppler with the One Plan II, and one stated the importance of describing Doppler in national plans and clinical guidance:

> *I think the best way (to scale up Doppler) is to make sure that the intervention is clearly shown in the One Plan II. From the One Plan II, you can get all of these interventions focusing on the Doppler, where we can plan to train all of these providers, make sure the Dopplers are available, and the distribution is good.*

Although not all interviewees specifically noted FHR monitoring as a high priority for intrapartum care, they all acknowledged that using Doppler to improve FHR monitoring aligns with government priorities. One respondent tied use of Doppler for FHR monitoring to the importance of reducing newborn deaths in health facilities:

> *One of the issues, which is alarming, is the number of newborns dying in our health facilities. If you go through our statistics, the number of newborns reported dead, one of the leading causes is birth asphyxia … so if you are in a position to establish that at the time the woman is delivering, that baby survives, that will be good!*

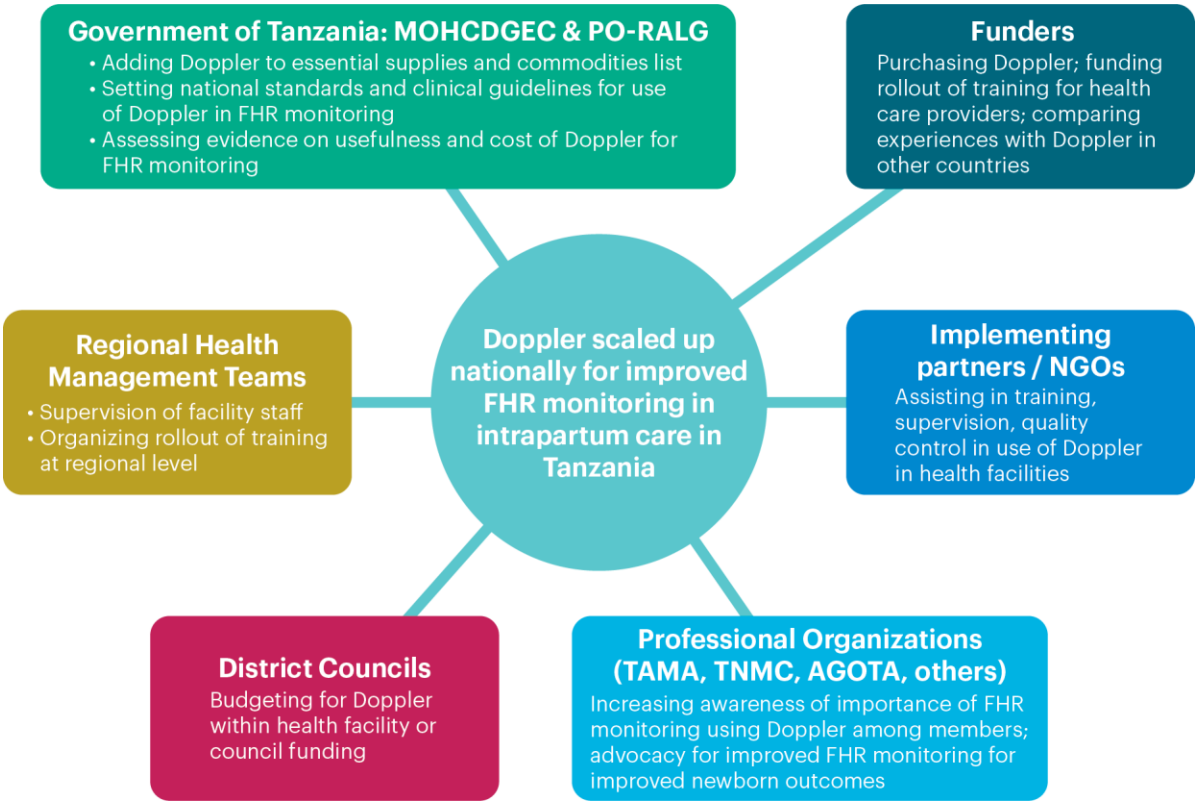
Another participant mentioned that to link Doppler with national priorities outlined in the One Plan II, data will need to be made available to show the outcomes of using Doppler for FHR monitoring:

> *We need to keep the data to see how this will help our people so that the government has a clear reason and a clear vision for using it to reduce death.*

Stakeholders' Roles and Responsibilities

Respondents mentioned roles and responsibilities consistent with the outer two levels of the social ecological framework (policy level and organizational/nonstate actor level), and commented on the roles of the government (national, regional, and district level), funding agencies, NGOs, and professional associations (Figure 3.2).

Figure 3.2. Roles and responsibilities at policy, organizational, and subnational level for scale-up of Doppler



Interviewees described the role of the GoT (MOHCDGEC and PO-RALG) as setting national standards (in line with national priorities elucidated in the One Plan II) (Interviewee 5, PO-RALG) and synthesizing current evidence on Doppler to make informed decisions.

At the subnational level, virtually all interviewees mentioned the need for district councils and health facilities to include Doppler in their budgets.

One interviewee stressed that implementing partners/NGOs could best help with capacity-building (training, supervision, quality control) for health care providers:

> *There are so many updates sometimes, it is not easy for the government facilities to get it … the implementing partners have updates and can build capacity of the health care providers.*

Several interviewees mentioned that professional associations have a role to play in scale-up of Doppler, "since it is the role of the professional organization to help the government." This included capacity-building of health care professionals. Another respondent mentioned that the Tanzanian Midwifery Association (TAMA) could play an important role in advocating for nurses and midwives (who constitute the majority of skilled birth attendants in Tanzania) to use Doppler, stating, "If TAMA advocates, health care providers will listen."

One respondent cautioned about the need for the GoT to take a lead role, particularly in financing scale-up of Doppler:

> *As far as I know, the Government of Tanzania has not really budgeted, or adopted the use of the Moyo (Doppler) throughout the country, hopefully they would be able to do that. Without that, a scale-up of Moyo (Doppler) will suffer from the same disease: donor dependence and lack of buy-in from the local resources.*

3.4 Discussion

This qualitative assessment of views of high-level policymakers and SMEs found that most were optimistic about Doppler's potential to improve intrapartum FHR monitoring in Tanzania and its potential scale-up. Respondents provided specific feedback on what might be needed at the GoT/international donor level (guidance on clinical management and supervision and funding of training and Dopplers); and at the nonstate actor level (guidance for training, supervision, and quality assurance and assistance in using monitoring system). Table 5 summarizes the study findings relevant to national- and organizational-level factors.

Table 3.4. Policy and organizational-level factors affecting scale-up of Doppler in Tanzania

Level	Key finding/needs for scale-up	Lessons learned from HBB scale-up
Policy-enabling environment (Government of Tanzania and international donors)	• Develop guidelines for health care providers to improve case management upon detection of abnormal FHR in intrapartum care. • Fund purchase of Dopplers/training for health care providers. • Provide national monitoring system to track results of scale-up of Doppler. • Provide guidance on supervision to subnational-level government (supervision or quality checklists).	Use both costing and program monitoring data to track program results.
Nonstate actors/organizational environment (national and international civil society organizations and professional associations)	• Support rollout of Doppler through training and quality assurance activities. • Support documentation of use of Doppler in facilities (challenges and benefits).	Training approaches should be evidence-based, and include onsite, low-dose, high-frequency training and clinical mentoring.
Subnational level (regions and districts)	• Scale-up should be accompanied with monitoring system. • Onsite training should be used; low-dose, high-frequency training preferred; provide clinical mentorship following training.	Sufficient supervisory and technical skills must be available at the district level.

Lessons from the scale-up of HBB include the need for a monitoring system as well as effective training and follow-up methodologies.

Respondents saw links to national priorities laid out in the One Plan II, as well as the potential for competing priorities for improving intrapartum care. Several interviewees noted that the ultimate goal was not scale-up of Doppler, but improved FHR monitoring and action to prevent perinatal mortality. This echoes recent experience with scale-up of kangaroo mother care (KMC), where rather

than change case management for newborns, an area is simply set aside for KMC.[28] To avoid "empty" scale-up of Doppler, GoT policymakers may consider substantive ways to support good case management practices, such as tools and clinical mentoring for health care providers. The UK's National Institute for Health and Care Excellence job aide "Fetal Monitoring during Labour"[29] is an excellent resource.

Several studies have compared Doppler's efficacy to Pinard in detecting FHR abnormalities.[9,10,13,30,31] These studies inform policy through evidence, but provide little insight on district-, regional-, and facility-level scale-up. A few publications shed some light on the wider context for scale-up. For example, one study in Tanzania found that midwives who used both Doppler and Pinard to monitor FHR in the context of a randomized controlled trial in a rural hospital tended to prefer the device they were most familiar with.[32] Recommendations included incorporating familiarization with the newer Doppler technology into both pre-service and in-service education.[32] In another study in Kagera, Tanzania, authors noted that incorporating Doppler into the admissions workflow was feasible and did not greatly add to the time needed to admit women to labor and delivery services.[33] These two studies present contextual, environmental evidence at the health facility level to help policymakers address needs and rationale for scale-up of Doppler for FHR monitoring, but the evidence is limited. Further studies, or documentation of program learning, that contribute to the evidence base around contextual factors for successful scale-up of Doppler are needed.

A number of useful resources are available to assist GoT policymakers develop better guidelines for case management of abnormal FHR, including recent WHO guidance on how countries can best assess evidence from systematic reviews or program evaluations to synthesize national policy[34] and on factors to address when taking interventions to scale.[35] In line with the WHO recommendations, if the GoT decides to scale up Doppler, a scale-up framework that includes planning, costing, financing, implementation, and monitoring and sharpens goals and strategies will be important to both facilitate

engagement and serve as a coordinating mechanism. Several frameworks provide guidance on monitoring implementation outcomes, including Proctor and colleagues' implementation outcomes, which ties outcomes to stage of implementation.[25] Additionally, teams have used the consolidated framework on implementation research[36] to support health service improvements, including a study on improving hospital service quality in Kenya.[37]

Interviewee's recommendations on improved training methodologies, such as LDHF and onsite training, are well grounded in the literature. A systematic review of in-service training showed that targeted, repeated interventions lead to better training outcomes.[38] A recent study in Mozambique found that LDHF training on newborn resuscitation helped improve midwife performance, [39] and in Tanzania a supportive intervention to HBB resulted in higher retention of newborn resuscitation skills.[21] A cluster randomized trial in Ghana found that in health facilities using an onsite, LDHF approach to training on intrapartum care, the relative risk of newborn mortality and intrapartum stillbirth significantly declined up to a year following training, leading the authors to recommend use of this training approach.[40]

Publications on taking HBB to scale in Tanzania reinforce the correlations between HBB scale-up and Doppler scale-up noted by participants. The length of training for HBB was 1 day;[20] similar to the 1-day training on Doppler. [41] Participants in the current study stressed the need for clinical mentorship and follow-up to retain health care providers' skills. This was noted in HBB scale-up as well, as 87% of health care providers passed a competency exam immediately following training, but only 56% passed 4–6 months following training. This drop-off in skills caused a programmatic shift to improve training of health care providers.[42] The original 1-day HBB training was expanded by a half-day following development and implementation of a structured on-the-job training guide to standardize LDHF practice, review of service delivery data, and mentorship on clinical practice and data recording.[21] Scale-up of Doppler would do well to incorporate these lessons from HBB programs.

Policy and clinical guidance for improved intrapartum care is not the only important element of scale-up: as several respondents noted, government and donor funding must also support scale-up of Doppler. Although newborn deaths account for 39% of deaths of children under age 5 years in Tanzania[43] only a tiny proportion of funding is allocated to address this issue. In 2010, for example, $1.5 million was allocated to programs benefiting neonates, whereas in the same year, $208 million was allocated to reproductive health (family planning and sexually transmitted infections, including HIV).[16] An assessment of cost for scaling up HBB in Tanzania estimated that national scale-up of HBB training and equipment would cost roughly $4 million (range 2.9–4.3), or an average of $600 per health facility.[44] Similarly, studies have evaluated the effectiveness of the LDHF training approach. In Ghana, for example, a study found that LDHF training for improved intrapartum care had a cost-effectiveness of $53 per disability-adjusted life year (DALY) averted, using intrapartum stillbirth and newborn death as the measure from which DALY was calculated.[45] Cost and cost-effectiveness analyses of use of Doppler for intrapartum FHR monitoring, currently missing from the literature, would be useful to the GoT and other governments as they consider scale-up of Doppler. To fill this gap, more studies and well-documented program learning that look at operational aspects of incorporating Doppler into health services are needed.

Limitations

This study interviewed a small number of respondents. However, not many people are working at the national policymaking level on intrapartum care provision as provided by the GoT health services. Additionally, we noted a high level of agreement in the responses, which leads us to believe that the number of respondents may have been sufficient to reach saturation.

This analysis of use of Doppler for FHR monitoring did not provide discussion around types of Doppler best suited for Tanzania's needs. We acknowledge that there are multiple types of Doppler

devices and further investigation will be needed into which devices are most suitable for the Tanzanian health care setting. Although this study analyzed environmental factors associated with scale-up of Doppler for FHR monitoring in Tanzania, community-, facility-, and individual-level factors are equally important. More studies are needed in these areas.

3.5. Conclusion

Experts and policymakers consider scale-up of Doppler for improving intrapartum FHR monitoring as aligning with national priorities in Tanzania. Linkages and lessons learned from the scale-up of the national HBB program include implementing a structured LDHF approach that includes clinical mentoring and builds monitoring into national systems. It will be useful for the GoT to assess evidence on benefits of Doppler using WHO guidance for synthesis of policy, and if Doppler is adopted at scale, to create a scale-up framework from early phases to enhance coordination of stakeholders in the scale up of Doppler for intrapartum fetal heart monitoring. If benefits are clarified and scale-up pursued more systematically, the resources, training and infrastructure to support improvements to intrapartum monitoring using Doppler and case management in case of abnormal FHR must be in place to overcome barriers described by participants.

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CHAPTER 4: DOPPLER UPON ADMISSION TO LABOR AND DELIVERY SERVICES IN TANZANIA: AN OBSERVATIONAL STUDY OF PERINATAL OUTCOMES WITH MICROCOSTING

4.1 Background

An estimated 2.6 million neonatal deaths and 2.6 million stillbirths occurred in 2015,[1] 98% of which occurred in low- and middle-income countries (LMIC).[2] Improvement of health care quality in LMIC is thought to be able to avert up to 8 million deaths per year, including 1 million newborn deaths.[3] Unlike in high-income countries, where most stillbirths occur in the antenatal period, close to half of stillbirths in LMIC occur in the intrapartum period, linked to poor quality or unavailability of obstetric care.[4] Intrapartum stillbirths[5] and newborn deaths[3] have been pointed to as indicators of poor-quality health systems.

Improving the quality of intrapartum care to prevent intrapartum stillbirths and very early newborn deaths is a high priority in many sub-Saharan African countries, including Tanzania.[6] Intermittent fetal heart rate (FHR) monitoring has been recognized as an important part of intrapartum care's clinical management by the World Health Organization (WHO).[7] Although specific estimates of coverage are not available, the Pinard fetoscope has been widely used in sub-Saharan Africa as the standard of care for auscultation of FHR. WHO guidance does not recommend any particular tool for intrapartum FHR auscultation; the recommendation is for intermittent FHR monitoring and charting on the partograph to assess for abnormalities needing clinical interventions.[7] However, a recent Delphi review focusing on intrapartum management found that expert consensus recommends use of a hand-held Doppler device for intermittent fetal heart auscultation in health facilities in LMIC.[8]

A number of studies conducted in Zimbabwe, Tanzania, and Uganda have shown that using Doppler to assess FHR as part of intrapartum management is more effective at detecting abnormal FHR compared to a Pinard stethoscope.[9,10–12] As secondary outcomes, these studies also examined both cesarean delivery rates and adverse perinatal outcomes, including intrapartum stillbirth and newborn death, in Doppler versus Pinard arms. With the exception of one observational study, which showed more favorable outcomes for newborns with abnormal FHR who were delivered vaginally,[10] and an early study which reported a reduction in perinatal deaths but did not present any statistical analysis of these,[9] none of these studies demonstrated significant reductions in adverse perinatal outcomes associated with use of Doppler for FHR monitoring.[10–14] A study in Zimbabwe[9] and an observational study in Tanzania[10] showed an increase in cesarean delivery rates associated with Doppler for FHR monitoring, and studies in Tanzania[12–14] and Uganda[11] did not.

The current study is a secondary data analysis of outcomes in facilities where Doppler was used upon admission to labor and delivery services. The intervention differs from the studies described above, where intermittent or continuous monitoring of FHR was conducted, and instead looks at a more limited application of Doppler in the intrapartum setting. Despite the difference in use of Doppler for triage as compared to for monitoring throughout labor, the study builds upon what has been demonstrated on efficacy of Doppler as a diagnostic tool in controlled research settings. It provides important quantification of outcomes related to use of Doppler for FHR auscultation in multiple facilities. The study is important to verify what is known about whether use of Doppler to improve intrapartum FHR assessment can produce better perinatal outcomes in the real world setting.

Cost analyses are an important part of evaluating the feasibility of taking an intervention to scale.[15] A micro-costing analysis was conducted to evaluate the use of a handheld Doppler for screening upon triage at facility admission to labor and delivery services in Kagera region, Tanzania, and to inform decision-making about potential scale-up. The costs associated with adapting materials for training,

training health care providers, and recurrent costs of use associated with the study are presented. The analysis is meant to inform budgetary considerations of decision-makers who are looking into scaling up Doppler to improve intrapartum FHR monitoring in the LMIC setting.

The objectives of this section are to:

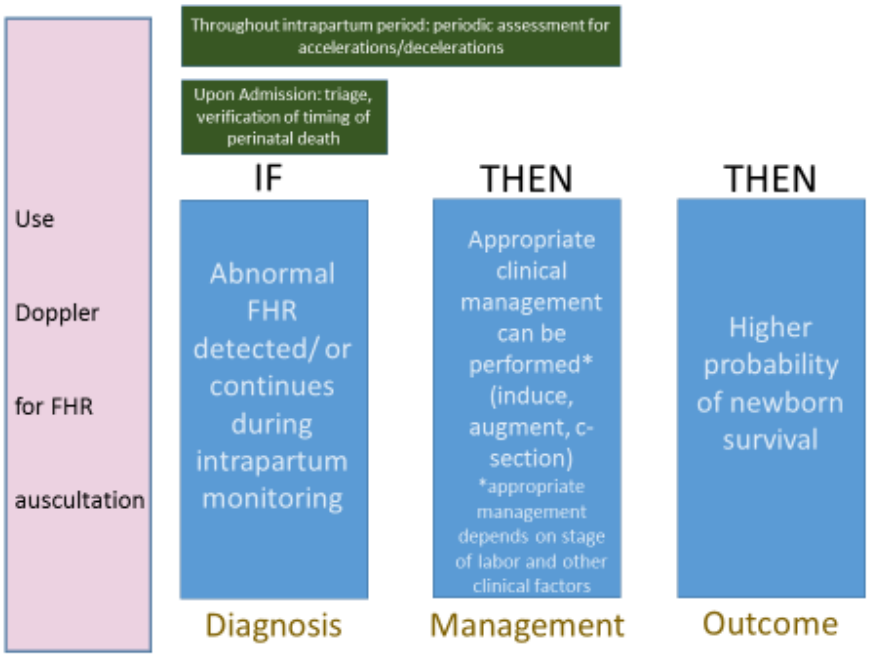
- Assess changes in rates of perinatal mortality and cesarean section deliveries before and after an intervention in which Doppler was used to assess FHR upon admission to labor and delivery services in ten health facilities in Kagera region in Tanzania
- Examine rates of perinatal mortality and cesarean section deliveries in similar health facilities with no intervention during the same timeframe in neighboring Mara region in Tanzania
- Present a micro-cost analysis of Doppler for triage into admission during the intervention, for consideration for potential plans for scale-up

4.2 Methods

Pathway from Auscultation of FHR to Perinatal Mortality

To improve newborn survival and reduce intrapartum stillbirths, Doppler must be used as a diagnostic tool to inform clinical management (Figure 4.1). The greatest impact on reducing perinatal deaths will be achieved if Doppler is used as recommended by WHO[7] and leaders of the professional community,[8] intermittently throughout the intrapartum period. The current study looked at a limited application of the use of Doppler for FHR auscultation. In the current study intervention, Doppler was used for FHR assessment upon admission rather than intermittently throughout the intrapartum period. The pathway to potential impact for FHR detection on admission is the same as for intermittent monitoring; however, auscultating at admission gives only one opportunity to detect an abnormality and cannot detect a problem that develops during labor management.

Figure 4.1. Use of Doppler to reduce to perinatal mortality



Study Design

We conducted an observational study in facilities that had been provided hand-held Dopplers for assessment of FHR upon admission to labor and delivery (Kagera region) and compared them with facilities that received no intervention (Mara region). Data from Kagera/intervention facilities were drawn from a parent study data set, which involved primary data collection from the facilities, while data from Mara/comparison sites were drawn from the national health management information system (HMIS). Intrapartum stillbirths, newborn deaths, and cesarean sections were compared in Kagera/intervention facilities and Mara/comparison facilities pre- and post- intervention. Costs associated with adapting training materials, training trainers, training health care providers and use of the Doppler in the health facility were examined.

Study Setting

Kagera and Mara regions are near Lake Victoria in the Lake Zone of Tanzania, with similar demographic characteristics (Table 4.1). Both regions have among the highest levels of maternal and neonatal deaths in the country.[16]

Table 4.1. Selected demographic characteristics of Kagera and Mara regions in Tanzania, Demographic and Health Survey 2015–16

	Kagera	**Mara**	**Range in Tanzania**
Total population	2,458,023	1,743,830	54.2 million
Population density	97 people per kilometer^2	80 people per kilometer^2	51 people per kilometer^2
Average household size	4.7 people	5.6 people	4.9 people
Institutional delivery rate	45%	50%	40% (Simiyu region)—91% (Kilimanjaro region)
Had cesarean delivery in pregnancy in past 5 years	2.9%	4.0%	1.1% (Simiyu region)–17% (Dar es Salaam)
Percentage of newborns with a postnatal care visit within 2 days of delivery	33.8%	24.5%	15.1% (Simiyu region)–64.2% (Mtwara region)

The intervention/Kagera sites were part of the parent study that validated an indicator on perinatal mortality occurring after admission to the health facility.[17] The intervention, using Doppler for assessment of FHR upon admission, was conducted in the study facilities for 6 months, from November 2016–April 2017. Before parent study data collection, health care providers in study sites were trained on correct classification of perinatal death and use of Doppler to assess FHR, and were taught to record FHRs upon admission in the facility HMIS register. A Doppler called the Moyo, developed by Laerdal Global Health for use in LMIC settings, was used in the study (Moyo is available in a strap-on model which provides continuous monitoring, or as a hand-held device for intermittent monitoring. The study

employed the latter). Two Doppler devices were put in each study facility's maternity ward for use during the admission process. Eighty-two percent of skilled birth attendants at study facilities were trained -the remainder were on leave or otherwise unable to attend training. There was an assumption that the remaining providers would be oriented to use of Doppler by those who had been trained. Use of the Doppler was requested but not mandated. Health care providers admitting women to the labor and delivery wards then used either a Doppler device or Pinard stethoscope to auscultate the fetal heart. During the 6 months of data collection in these sites, both Doppler and the Pinard stethoscope were available to midwives assessing women admitted to the labor and delivery ward. Midwives were requested to use the Doppler for assessment upon admission. Use of Doppler as opposed to Pinard stethoscope to assess FHR upon admission was universal or close to universal in all sites, except for the regional hospital (91% adherence) and one designated district hospital (83% adherence).[17]

The time periods used in the current analysis are the pre-intervention period (November 2015–April 2016) and period in which the intervention ran, called the post-intervention period (November 2016–April 2017). The pre-intervention period was selected to be the same 6 calendar months in the year preceding the intervention period, to account for seasonality of births.[18]

Intervention and Comparison Sites

The 10 intervention health facilities in Kagera region had high volume of deliveries (over 365 deliveries per year). All sites provided comprehensive emergency obstetric care (CEmONC) capabilities (the signal functions of CEmONC include the capability to conduct cesarean deliveries), although following selection, two health centers in Kagera (Health Centers A and B) did not provide cesarean deliveries in the pre- or post-study periods due to human resource challenges. All of the Mara sites included in the study provided CEmONC.

The 10 comparison facilities from Mara were selected post hoc. Sites were selected to be part of the analysis if they were the same level of health facility (i.e., regional referral hospital, district hospital, or health center).

Study Measures

The primary outcome measures of this study were perinatal deaths (combining fresh stillbirth [FSB] and newborn death) and cesarean deliveries, expressed as a rate out of 1,000 admissions. Both newborn deaths and FSBs were taken from the maternity register, which does not record the timing of newborn death. Since the study team was not able to say whether the death occurred within 24 hours of delivery, the death is simply "death before discharge."

Power Calculation

Given an average perinatal death rate of 3% in the pre-intervention period in Kagera sites,[19] a decline to 2% (33% reduction) would be detectable with 5,735 admissions. This is after adjusting for variation in perinatal death rates between different levels of health facility (health center, district hospital, regional hospital) with a design effect (DEFF) of 1.5. With the study's level of 9,701 admissions in the post-intervention period, we have more than 80% power to detect the difference in the outcome variable between pre- and post- intervention periods.

Data Collection, Management, and Data Cleaning

Because this was a secondary data analysis, no primary data were collected, but a few sites in Mara were visited to examine facility registers to find missing data. Data were taken from two sources. Data from the Kagera study sites were taken from the study dataset, which was derived from data extracted from the maternity registers in the study sites. Data from the Mara sites were derived from

the national database (DHIS2), which are summarized reports of data extracted from the maternity registers.

Kagera site data were extracted from a CommCare (Dimagi, Cambridge, Massachusetts) file into an Excel file, where Mara data were entered. All data were then imported into SPSS version 25 (IBM SPSS Statistics for Windows, Armonk, NY) for analysis.

Data cleaning was performed by running queries to find missing variables or variables with values outside of expected parameters. Roughly 10% of the files were checked against the original data extraction forms to verify that the values were entered correctly.

Analysis

Descriptive statistics (frequencies and proportions) were calculated. The rate or risk of perinatal death was calculated by dividing the primary outcome measure (FSBs and newborn deaths before discharge) by the total number of admissions to the maternity ward and multiplying by 1,000 to get a rate per 1,000 admissions. Cesarean delivery rates were similarly calculated. Using these rates, we calculated risk differences and 95% confidence intervals on risk differences in the pre- and post-intervention period, as well as risk difference contrasts (RDC) between Kagera and Mara sites, and 95% CIs on RDCs. Because rates of perinatal deaths and cesarean deliveries differed substantially according to level of facility (regional hospital, district hospital, health center), these analyses were run separately on different levels of health facility. For the RD and RDC calculations, the null hypothesis was that there would be no difference – thus, if the CI crossed 0 there was a significant difference.

Micro-cost Analysis

The costs assessed in this analysis consisted of costs for startup, the recurrent costs associated with using Doppler in facilities, and a calculation of a range of cost per woman admitted to health facility

(Table 4.2). Projected costs are for startup and capital costs are presented as financial rather than economic costs – ie as a program implementer would budget them.

Table 4.2. Overview of costs included in micro-costing analysis

Stage	Task / cost	Components of task	Relevant costs
STARTUP	Revision of training materials and training Master Trainers	Revise Laerdal's Moyo training materials; create curriculum for training; train trainers, including refresher on use of Doppler for admission for master trainers	Technical staff time for adapting training materials and refreshing master trainer skills; costs of venue and materials for training.
STARTUP	Training health care providers to use Doppler and correctly classify perinatal death outcomes	Transporting trainers, materials and curricula to the health facilities. Paying per diem for trainers. Transporting trainees to training site, paying per diem for trainees. Any costs for venue and/ or food provided during training.	Staff hours; trainee costs; venue costs; per diem costs for trainers and trainees; transport costs; materials and equipment costs
CAPITAL	Purchasing and supplying Doppler and accompanying goods for using Doppler for FHR assessment	Purchasing Doppler, ultrasound gel and swabs for the health facilities	Cost of Doppler multiplied by the number of Dopplers per facility
COST PER CLIENT ASSESSED	Cost per woman admitted to the health facility to be assessed using Doppler	Number of assessments done per facility per year; cost of Doppler	Estimate of number of procedures per year

Data associated with costs of the intervention were collected as described below:

- Equipment costs were obtained by consulting with websites or getting pro forma invoices from companies which manufacture that product
- Salary costs were obtained by consulting with government agencies (government salaries) and with a non-governmental organizations working on maternal and child health in Tanzania (NGO salaries)

- Costs for per diem were Government of Tanzania official rates

Costs were classified as capital, startup and recurrent costs. Data were entered into a preformatted Excel spreadsheet for further analysis. Training data were obtained from study staff and referring to publications associated with the parent study.[20] The overview of training for health care providers is shown in Table 4.3.

Table 4.3. Health care providers trained and annual delivery volume in Kagera sites

Site	Number of health care providers from maternity ward trained	2015 annual deliveries
Regional Hospital A	16	4,300
District Hospital A	20	1,007
District Hospital B	19	1,402
District Hospital C	15	1,035
District Hospital E	12	1,078
District Hospital F	28	3,959
District Hospital E	14	2,665
Health Center A	20	1,382
Health Center B	8	375
Health Center C	11	608
Total	163	17,811

4.3 Results

In Kagera/intervention sites, 10,022 women were admitted for labor in the pre-intervention period and 9,701 in the post-intervention period. In Mara/comparison sites, 11,316 women were admitted for labor in the pre-intervention period and 12,366 in the post-intervention period (Table 4.4).

Table 4.4. Overview of study facilities, pre-intervention (November 2015 – April 2016) and post-intervention (November 2016 – April 2017) in Kagera and Mara regions

	Admissions		**Newborn deaths**		**Fresh stillbirths**		**Cesarean deliveries**		**Perinatal mortality rate per 1,000 admission**		**Cesarean delivery rate per 1,000 admissions**	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Kagera (intervention)												
Regional Hospital A	2114	2383	143	100	25	29	339	429	67.6	41.9	160.4	180.0
District Hospital A	510	740	4	19	0	4	17	128	7.8	25.7	33.3	172.9
District Hospital B	769	839	17	18	4	3	195	207	22.1	21.5	253.6	246.7
District Hospital C	689	662	15	10	7	6	178	197	21.8	15.1	258.4	297.6
District Hospital D	624	339	14	9	5	3	187	116	22.4	26.6	300.0	342.2
District Hospital E	1863	1240	66	30	43	22	506	357	35.4	24.2	271.6	287.9
District Hospital F	1741	1647	52	34	8	7	315	322	29.9	20.6	180.9	195.5
Health Center A	938	933	4	3	2	1	14	0	4.3	3.2	14.9	0
Health Center B	184	201	0	1	0	0	0	0	0	4.9	0	0
Health Center C	590	717	2	2	2	1	62	101	3.4	2.8	105.1	140.9
Total	10022	9701	317	226	96	76	1813	1857	31.6	23.3	180.9	191.4
Mara (comparison)												
Regional Hospital AA	2195	2133	132	87	41	58	356	326	60.1	40.8	162.2	152.8

	Admissions		Newborn deaths		Fresh stillbirths		Cesarean deliveries		Perinatal mortality rate per 1,000 admission		Cesarean delivery rate per 1,000 admissions	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
District Hospital AA	1370	1475	61	53	19	10	90	117	44.5	35.9	65.7	79.3
District Hospital BB	705	771	40	36	10	8	74	100	56.7	46.7	104.9	129.7
District Hospital CC	1370	1475	15	29	11	11	45	68	10.9	19.7	32.9	46.1
District Hospital DD	996	1042	14	20	13	19	70	115	14.1	19.2	70.3	110.4
District Hospital EE	1276	1363	20	24	10	18	125	141	15.7	17.6	98.0	103.5
District Hospital FF	1901	1974	48	90	23	36	214	146	25.3	45.6	112.6	74.0
Health Center AA	186	298	2	1	2	1	0	0	10.8	3.4	0	0
Health Center BB	770	853	7	12	1	4	66	38	9.1	14.1	85.7	44.6
Health Center CC	547	982	4	8	4	8	12	29	7.3	8.2	21.9	29.5
Total	11316	12366	343	360	134	173	1052	1080	30.3	29.1	93.0	87.3

Perinatal Death

Perinatal mortality rates in Kagera intervention sites, by level of health facility, can be seen in Figure 4.2, and rates in the same period in the comparison sites in Mara can be seen in Figure 4.3.

Figure 4.2. Perinatal mortality per 1,000 admissions, Kagera region, pre-intervention period (Nov 2015 – Apr 2016) and post-intervention period (Nov 2016 – Apr 2017)

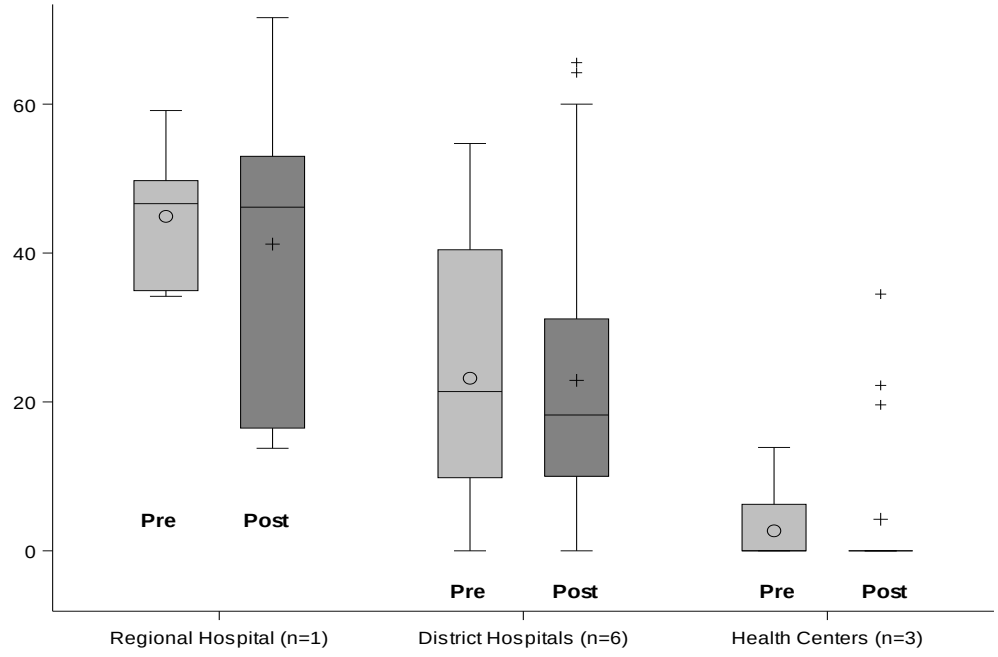
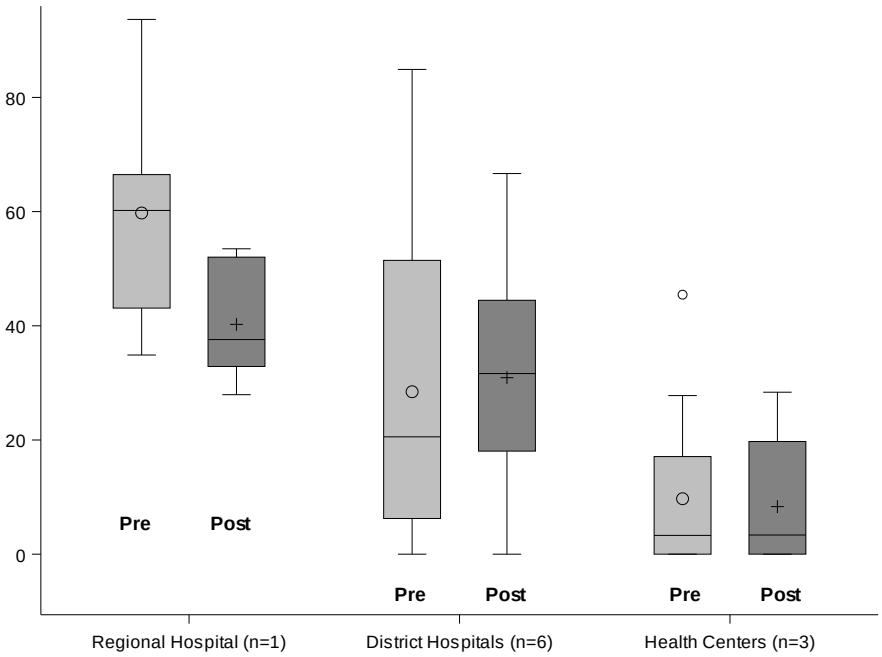


Figure 4.3. Perinatal mortality per 1,000 admissions, Mara region, pre-intervention period (Nov 2015 – Apr 2016) and post-intervention period (Nov 2016 – April 2017)



Perinatal deaths per 1,000 admissions significantly declined in the regional hospital in the intervention region (Kagera) as well as in Mara's regional hospital (Table 4.5). As Kagera saw a decline of 25.7 deaths per 1,000 admissions and Mara saw a (non-significant) decline of 19.3 deaths per 1,000 admissions, the difference in the difference was 6.3 deaths per 1,000 admissions, and this was a significant difference.

Table 4.5. Perinatal mortality per 1,000 admissions in regional hospitals, pre- and post-intervention, Kagera and Mara regions

Region	Pre-intervention period	Post-intervention period	Risk difference	Risk difference 95% CI	Risk difference contrast	Risk difference contrast 95% CI
Kagera	67.6	42.0	-25.7	**-39.1 - -12.3**	-6.3	-25.0 - 12.3
Mara	60.1	40.8	-19.3	**-32.4 - -6.3**		

Note: Bold text denotes statistical significance

While regional hospitals noted a decline in perinatal mortality in post as compared to pre-intervention, among district hospitals in intervention region (Kagera), perinatal deaths did not significantly decrease, nor did this measure decrease in Mara region district hospitals (Table 4.6). In fact, in the post-intervention timeframe, perinatal deaths slightly and non-significantly increased among district hospitals in the non-intervention region (Mara). There was a risk difference contrast (RDC) of -10.3 deaths per 1,000 admissions, and this was non-significant.

Table 4.6. Perinatal mortality per 1,000 admissions in district hospitals, pre- and post-intervention, Kagera and Mara regions

Region	Pre-intervention period	Post-intervention period	Risk difference	Risk difference 95% CI	Risk difference contrast	Risk difference contrast 95% CI
Kagera	27.1	21.9	-5.2	-10.8 - 0.4	-10.3	**-17.9 - -2.6**
Mara	26.0	31.1	5.1	-0.1 - 10.3		

Note: Bold text denotes statistical significance

Among health centers in the intervention region (Kagera), perinatal deaths din not decrease in the pre- and post-intervention periods in either Kagera or Mara regions (Table 4.7). There was a non-significant risk difference contrast (RDC) of 1.5 deaths per 1,000 admissions.

Table 4.7. Perinatal mortality rates per 1,000 admissions in health centers, pre- and post-intervention, Kagera and Mara regions

Region	Pre-intervention period	Post-intervention period	Risk difference	Risk difference 95% CI	Risk difference contrast	Risk difference contrast 95% CI
Kagera	3.5	3.2	-0.3	-4.1 - 3.6	-1.5	-8.8 - 5.9
Mara	8.6	9.8	1.2	-5.1 - 7.5		

Note: Bold text denotes statistical significance

Cesarean Deliveries

Cesarean delivery rates in Kagera intervention sites, by level of health facility, can be seen in Figure 4.4, and rates in the same period in the comparison sites in Mara can be seen in Figure 4.5.

Figure 4.4. Cesarean deliveries per 1,000 admissions, Kagera region, pre-intervention period (Nov 2015 – Apr 2016) and post-intervention period (Nov 2016 – Apr 2017)

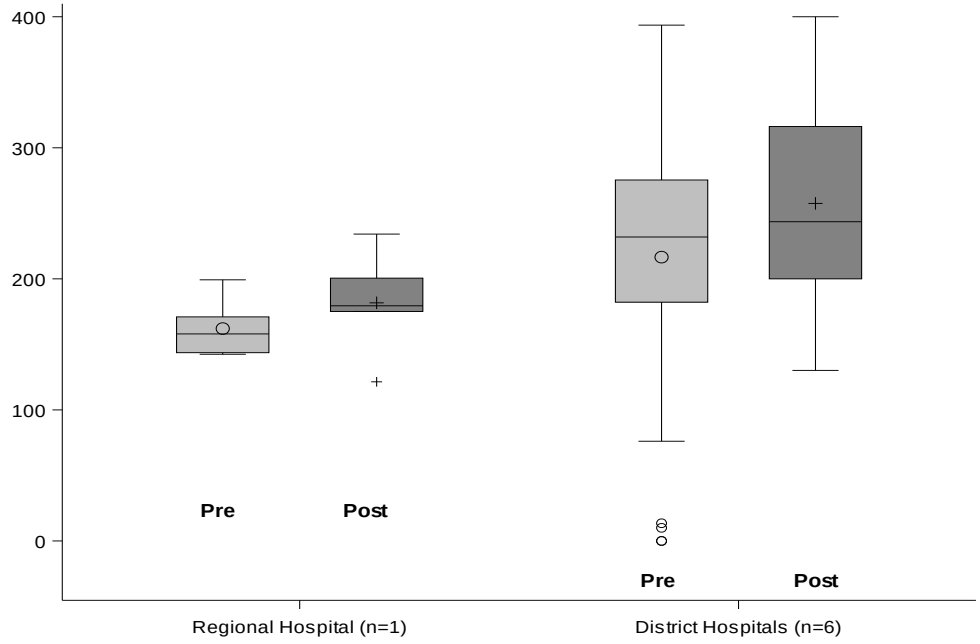
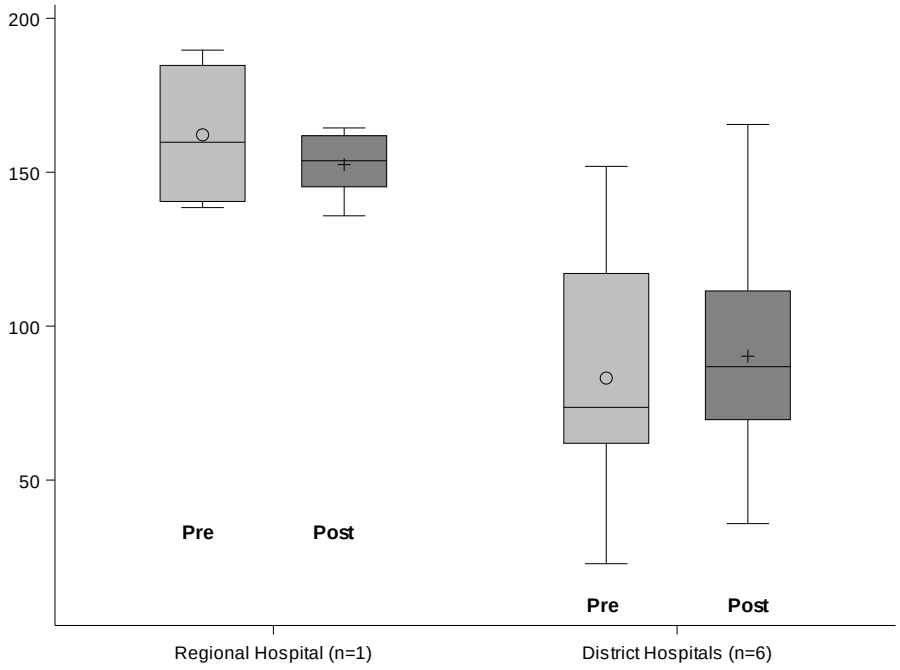


Figure 4.5. Cesarean deliveries per 1,000 admissions, Mara region, pre-intervention period (Nov 2015 – Apr 2016) and post-intervention period (Nov 2016 – Apr 2017)



Cesarean deliveries per 1,000 admissions did not increase in the regional hospital in the intervention region (Kagera) nor in the comparison region (Mara) in the pre- and post-intervention periods (Table 4.8). The difference in the difference was 29 cesarean deliveries per 1,000 admissions, and this was a significant difference.

Table 4.8. Cesarean deliveries per 1,000 admissions in regional hospitals, pre- and post-intervention, Kagera and Mara regions

Region	Pre-intervention period	Post-intervention period	Risk difference	Risk difference 95% CI	Risk difference contrast	Risk difference contrast 95% CI
Kagera	160.4	180.0	19.7	-2.3 - 41.6	29.0	-1.9 - 59.9
Mara	162.2	152.8	-9.4	-31.1 - 12.4		

Note: Bold text denotes statistical significance

Cesarean deliveries did not significantly increase at district hospitals in either the intervention region (Kagera) nor the comparison regions in the pre- and post-intervention periods (Table 4.9). There was a risk difference contrast (RDC) of 16 cesarean deliveries per 1,000 admissions, and this was significant (-1.7 – 33.8).

Table 4.9. Cesarean deliveries per 1,000 admissions in district hospitals, pre- and post-intervention, Kagera and Mara regions

Note: Bold text denotes statistical significance

Region	Pre-intervention period	Post-intervention period	Risk difference	Risk difference 95% CI	Risk difference contrast	Risk difference contrast 95% CI
Kagera	225.6	242.7	17.1	1.7 - 32.5	16.0	**-1.7 - 33.8**
Mara	83.8	84.8	1.1	-7.7 - 9.8		

Summary

Table 4.10 summarizes the overall increases or decreases in the study's outcome measures.

Table 4.10. Summary of study outcome measures by level of health facility

Level of health facility	Cesarean deliveries	Perinatal mortality
Kagera (intervention)		
Regional Hospital	Increased	Decreased
District Hospitals	Remained same	Remained same
Health Centers	Not applicable	Remained same
Mara (comparison)		
Regional Hospital	Remained same	Decreased
District Hospitals	Remained same	Remained same
Health Centers	Not applicable	Remained same

Micro-costing

Overall Costs of Doppler Intervention

The overall costs to roll out this intervention with Doppler was $16,813 (Table 4.11).

Table 4.11. Overall costs of Doppler for study sites in Kagera

Type of cost	Description of cost	Amount
STARTUP	Revision of Training Materials	$1703
STARTUP	Training of health care providers	$6870
CAPITAL	Doppler for 10 health facilities for 6 months	$7920
CAPITAL	Ultrasound gel and swabs for Doppler	$321
	Total	**$16,813**

These are further detailed below.

Training

The overall cost of revising training materials and standardizing master trainers was $1703 (Table 4.5). The training materials built upon existing user guide developed for use with the Moyo Doppler device, which was developed by Laerdal Foundation. The guide was adapted for use, and Observed Structured Clinical Examinations (OSCE) tools were developed to assess health care provider competency in using the Doppler. This took a total of 24 working hours of three subject matter experts. An event was held in which 21 people attended, which allowed Master Trainers who would then be training health care providers to review the new materials and refresh their skills on using the Doppler device. Of these, six were government employees who were provided with a half per diem for their time (Table 4.11).

Table 4.12. Costs associated with revising training materials and standardizing master trainers

Task	Cost description	Cost (USD)
Hours to revise training materials and create OSCE	8 hours x 3 subject matter experts x $96.15 per hour*	$769
Purchase of 4 Doppler devices for training purposes	$198 per device	$792
Cost for Standardizing Master Trainers (half day training for 21 people)	21 people x $2 supplies per person x $40 room fee	$82
Per Diem Costs	half per diem for government employees, equivalent to $10 x 6 government employees attending training	$60
Total costs for standardizing Master Trainers		**$1703**

*2080 working hours per year x subject matter experts with average salary of $66,666 per year (range $60,000 – $80,000)

The total costs associated with training of health care providers was just under $6,900 (Table 4.12). This included costs associated with transport and accommodation of trainers from an NGO, regional facilitators, and allowances for health care providers. There were no costs for venues as the training was conducted on-site at the health facilities.

Table 4.13. Costs associated with health care provider training

Item	Description	Cost
Staff costs	Accommodation, per diem, airfare, fuel for car, airport transfers for 5 NGO staff	$4,780
Facilitators costs for regional facilitators	2 regional facilitators per diem from $43.53 - 52.25 per day for 9 days, plus airfare	$940
Per diem for regional facilitators	4 regional facilitators for 2 days, $21.77 per day	$174
Health care providers lunch allowance	$4.35 for 224 person allowances	$975
Total		**$6,870**

A total of 163 health care providers were trained (Table 4.4). Dividing the overall costs of health care provider training by the number of health care providers trained, the cost per health care provider is $42 per health care provider (Table 4.13).

Table 4.14. Health care providers trained in use of Doppler for admission to labor, by health facility, October 2016

Site	Number of health care providers from maternity ward trained	Overall training cost by number of providers at facility
Regional Hospital A	16	$674
District Hospital A	20	$843
District Hospital B	19	$801
District Hospital C	15	$632
District Hospital E	12	$506
District Hospital F	28	$1,180
District Hospital E	14	$590
Health Center A	20	$843
Health Center B	8	$337
Health Center C	11	$464
Total	163	$6870

Use of Doppler

An annualized average cost per Doppler assessment upon admission to the study health facilities was $0.46, and ranged from $2.13 to $0.20 per client, based on delivery volume at the facility (Table 4.14). Two Dopplers were provided to every facility, and their use was followed for the six-month period in which data were collected for the study. In the course of the six months, three Dopplers (15%) became non-functional. The causes for the Dopplers breaking down were not captured and thus were not known as either user error or device error. However, for the sake of estimation, we inputted four Dopplers purchased per year per facility, to allow for breakage.

Table 4.15. Annualized cost of Doppler and supplies against delivery volume and cost per delivery

	Cost of Doppler devices in USD (4 per health facility per year / $198 per Doppler) (a)	**Annual cost of ultrasound gel in USD (1 litre/500 clients/$7 litre) (b)**	**Annual cost of swabs in USD (500 swabs/500 clients/$2 per 500 units) (c)**	**Annual delivery volume (d)**	**Annualized cost of Doppler per woman admitted in USD** $\frac{a+b+c}{d}$
Regional Hospital A	792	60.20	17.20	4,300	0.20
District Hospital A	792	14.10	4.03	1,007	0.80
District Hospital B	792	19.63	5.61	1,402	0.58
District Hospital C	792	14.49	4.14	1,035	0.78
District Hospital D	792	15.09	4.31	1,078	0.75
District Hospital E	792	55.43	15.84	3,959	0.22
District Hospital F	792	37.31	10.66	2,665	0.32
Health Center A	792	19.35	5.53	1,382	0.59
Health Center B	792	5.25	1.50	375	2.13
Health Center C	792	8.51	2.43	608	1.32
Total	7,920	249.35	71.24	17,811	0.46

4.4 Discussion

This study found no increases in cesarean delivery nor perinatal mortality in the intervention or comparison sites, with the exception of regional hospitals. In both regional hospitals, a significant decrease in perinatal deaths in the post- versus pre-intervention period was seen. In the intervention region, this was accompanied by an increase in cesarean sections. Thus, only in Kagera regional hospital was the expected or desired outcome seen: that of increased cesarean deliveries and decreased perinatal mortality upon use of Doppler for admission to labor and delivery services. Because the

comparison region also showed a significant decline during the same timeframe, the intervention's effect is further questionable.

The limited positive results on the outcome measures is not entirely unexpected. A systematic review of fetal monitoring during the intrapartum period in LMIC concluded that while Doppler helped predict perinatal outcomes and detect fetal distress, use of Doppler was not associated with a reduction of adverse perinatal outcomes. Two additional randomized controlled trials (RCTs) showed that use of Doppler for intermittent monitoring throughout labor resulted in no reduction[12] or limited reduction in adverse perinatal outcomes in the Doppler arm.[13] While these studies had experimental designs and thus greater ability than the current study to attribute causality, all of the studies described had reduction of adverse perinatal outcomes as a secondary measure.[9–11,13,14]

Virtually all studies examining intrapartum FHR monitoring using Doppler have found that Doppler is more effective at detecting abnormal FHRs as compared to Pinard stethoscope.[22,13,9,11] If more abnormal FHRs were detected, a corresponding increased rate of cesarean delivery might be seen in the study facilities. While cesarean section is not the only appropriate clinical management of abnormal FHR (induction or augmentation of labor might be indicated), information on induction or augmentation are not available in the Tanzanian HMIS, and thus we use cesarean section rates as our sentinel indicator of clinical management. In this study, cesarean delivery rates increased significantly in regional hospitals and non-significantly in district hospitals following introduction of Doppler for admission to labor and delivery services. These findings provide limited optimism for a role of Doppler to improve detection of fetal heart abnormalities and resultant management. Indeed, in two studies of FHR monitoring using Doppler, an increase in cesarean deliveries were seen: in Tanzania, cesarean section rates in the continuous monitoring using Doppler arm were 5.4% compared to 2.6% in the Pinard arm ($p<0.01$);[10] in Zimbabwe, cesareans deliveries were 24% in the Doppler arm compared to 15% in the Pinard arm.[9]

While it is encouraging that perinatal mortality declined in the regional hospital following introduction of the Doppler, the answer to why perinatal mortality did not decrease across the board in the current study or other cited studies may lie in case management upon detection of abnormal FHR, or lack thereof. Clinical management upon detection of abnormal FHR is highlighted in the study's Theory of Change (Figure 1). None of the interventions that introduced Doppler included a quality improvement program or focused heavily on improved clinical decision-making and management of the woman and fetus.[9–12,14] It is possible that what has been missing in all of the interventions is a focus not on the technology (i.e., Doppler versus Pinard stethoscope), but rather on clinical management of a fetus with an abnormal FHR.

Our Theory of Change maps out a very linear route to how using Doppler to improve intrapartum FHR monitoring could reduce in perinatal mortality, without considering other systematic barriers. Yet systematic barriers to rolling out improved intrapartum and newborn care are well documented and include human resources, infrastructure, and behavioral barriers on the part of both health care providers and clients. [23] The linear improvement of perinatal outcomes upon improvement of FHR monitoring has not yet been demonstrated in practice or even in the context of research, and this perhaps calls for an approach which takes these systems issues into account. The findings from both this and other studies bring us to the next question: How can Doppler, with its apparently superior diagnostic capability, be used in the clinical setting in Tanzania to improve newborn survival and reduce intrapartum stillbirth? A recently published professional consensus on best practices for intrapartum fetal monitoring in the LMIC setting, which recommends the use of Doppler for FHR monitoring, brings together the larger picture of monitoring throughout the intrapartum period.[8] A bottleneck analysis of rollout of HBB can also provide input into potential systems issues which might reduce effectiveness.[23]

Clinical decision-making, provider preference, and supportive quality improvement measures may all be missing pieces in the puzzle before use of Doppler contributes to measurable differences in

rates of perinatal mortality in the LMIC facility setting. In addition to clinical management using Doppler, health care provider comfort level, familiarity, and preferences must also be taken into account. Midwives in a Tanzanian hospital stated that they preferred to auscultate the FHR using the device with which they were most familiar and thought that more training on Doppler was needed before use in intrapartum care.[24] A dearth of high-quality evidence on barriers and facilitators for optimal fetal monitoring strategies has been described[21]—this includes knowledge of provider preference for technology for intrapartum FHR monitoring.

The total cost of revising training materials to produce a learning package for training health care providers, and standardizing Master Trainers in the training materials, was roughly $1700. Of note is that the Doppler used in the study (the Moyo) is in the mid-range of cost compared to other handheld Doppler devices on the market, which range from a low cost of $49.95 (SonoLine B https://www.babydoppler.com/) to upwards of $600 (Huntleigh Dopplex non-directional Doppler https://mfimedical.com/products/huntleigh-dopplex-d900). However, the Moyo, which can be used either continuously or intermittently, as recommended by WHO, comes with high quality, user-friendly training materials. Any further application of training using Moyo or other Dopplers for FHR assessment upon admission can draw on the current study's training curriculum and OSCE materials, to save some resources associated with scale up. However, each program should investigate the best type of Doppler device for available programmatic resources. The average annualized cost of FHR assessment using Doppler per woman admitted to the labor and delivery ward in the study health facilities, with a generous estimate of replacement of four Doppler devices per year per facility, was $0.46. The cost per client is relatively low in relation to other maternal health interventions. Comparatively, a study in Rwanda found that in the least expensive of the four recommended antenatal care visits, the cost was $5.6[25] and in Uganda, a study noted a unit cost of $3.3 for distribution of misoprostol for prevention of post-partum hemorrhage.[26]

The current study is an observational study in a real-world service delivery setting. The data were subject to limitations, such as having to drop facilities from the analysis that were supposed to be providing CEmONC but weren't, and dropping facilities that had not been recording newborn deaths due to formatting challenges with the HMIS tools. In this study, the team encountered accuracy and completeness concerns from its HMIS-derived data, which is an acknowledged problem.[27] Despite these challenges, we feel that the current analysis adds to the information available nationally on benefits of use of Doppler in intrapartum care. Further, we feel that this type of observational study is a good example for program planners in Tanzania or similar settings to evaluate services using available evidence. With any study with negative results, the question must be posed whether study design contributed to the lack of change in the outcome measure. In this case, a major limitation is that the intervention included only assessment of FHR upon admission rather than intermittently throughout the intrapartum period, as recommended by WHO. Additionally, other health systems barriers, such as infrastructure, referral practices, or quality of practice, might have been confounding factors which were not controlled for by this study. While the current study has the advantage of including more deliveries as compared to recent RCTs, the improvement was less than anticipated, which may have meant that the study was underpowered to show change in the outcome variable. The selection of facilities in neighboring Mara region as comparison sites occurred post hoc. Future studies examining mortality associated with use of Doppler for intrapartum FHR monitoring should include a study design which allowed for appropriate comparison and takes other health system factors into account. The current study provides basic information on costs associated with training of health care providers, purchase of Doppler and costs per client. To adequately inform scale up, a more thorough costing exercise which greatly addresses depreciation or continuing maintenance costs, will be necessary. Ultimately, larger scale systems issues, including opportunity costs and cost effectiveness, must be addressed in order for program planners to have adequate information for decision-making around Doppler.

4.5. Conclusion

This study yielded observational findings suggesting that use of Doppler to auscultate FHR during admission to labor and delivery services may have contributed to reduced perinatal mortality in regional hospital, but not district hospitals in Tanzania. Cesarean deliveries, the proxy indicator for clinical management for detection of abnormal FHR, did not change as expected: where perinatal mortality decreased in the regional hospital, cesarean deliveries did not significantly increase, and where perinatal mortality in district hospitals did not decrease, cesarean deliveries did. These findings compound those of multiple other studies which show that largely, case management practices have not directly improved to match the superior diagnostic capacity of Doppler at assessing fetal heart abnormalities. Further studies and program learning should include health care provider supports (protocols, guidelines, and job aids for health care providers for fetal heart abnormalities), be designed to address other health system barriers which might contribute to adverse perinatal outcomes, and focus on intermittent fetal heart monitoring rather than fetal heart assessment upon admission to labor and delivery services.

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CHAPTER 5: PLAN FOR CHANGE

Summary of Findings

As stated many times throughout this study, intrapartum stillbirth and very early newborn death are unacceptably high in the LMIC setting.[1] While a newborn death in Tanzania is no less heartbreaking and tragic than a newborn death in the United States, the rate of this event is starkly different depending on where you are from: 6 per 1,000 births in high income countries compared to 21.3 per 1,000 births in LMIC. While in high income countries, intrapartum stillbirths are 0.9 per 1,000 births, this is as high as 25 per 1,000 births in parts of Africa.[2] These tragedies, which are largely preventable with simple and known interventions,[3] have thus been tied to lack of political or institutional will in the form of policies[4] and quality of care.[5]

This study has synthesized literature about how Doppler has been used to improve in intrapartum care LMIC. It has examined cesarean deliveries and perinatal mortality in health facilities in which Doppler was used for admission to labor and delivery services, and provided information on costs associated with Doppler use. And it has assessed policy-makers' views on the facilitators and barriers to scale up of Doppler for improved FHR monitoring in Tanzania, and how scale up would align with national policy priorities.

In my Plan for Change, I will describe what I have and will continue to do to provide evidence and advocacy for policy makers and practitioners working to improve intrapartum care in Tanzania. I will also describe what is needed to contextualize Doppler as part of overall quality of case management of women in labor to improve newborn survival in Tanzania.

Broadening the Focus

The findings from this study underscore the need for a broader approach: that Doppler should be one part of a number of inputs to improve intrapartum care to achieve the goal of reduced perinatal mortality.

The literature review has shown that Doppler has demonstrated superiority at detecting fetal heart abnormalities. This goes a long way towards recommending Doppler over Pinard stethoscope, the current standard of care. But improved diagnostic capacity for fetal heart abnormalities is clearly not all that is needed to reduce deaths. In research studies conducted on Doppler, including the current study, the prevailing question was whether this greater diagnostic capacity would result in reduced perinatal deaths and other adverse outcomes. In the majority of studies, it didn't.[6–9] In the present study, while the results leaned in that direction, this finding was not consistent across the different levels of the health system. An additional argument for incorporating Doppler into intrapartum care is as a health information systems strengthening tool. Health information systems are part of WHO's building blocks,[10] and use of Doppler to measure timing of perinatal deaths could contribute to strengthening quality of care while building up health systems. This is further validated by the findings of two studies, conducted in seven countries, which recommend use of this indicator.[11-12]

These studies reveal an implied inference that introducing Doppler as a superior technology for detecting fetal heart abnormalities would improve perinatal outcomes. The researchers investigating Doppler were not alone in this thinking. Globally, the move to increase technology in health services is a powerful wave, affecting maternal and newborn services as well as other fields. Maternal and child health is among the leading technology- enabled programs, according to a systematic review of m-health in LMIC.[13] In practice, while some outcomes in LMIC have improved with m-health tools such as

patient reminders, outcomes to e-health interventions for clinical management have not shown the same level of improvements.[14]

At the end of the day, Doppler is simply a diagnostic tool which can provide better, faster information to a health care provider for making timely decisions in the intrapartum period. Expecting reduced perinatal deaths after introducing Doppler could be equivalent to giving construction workers better watches and then expecting a reduced time in getting the construction project finished. Many steps are needed to translate the workers' more accurate ability to tell time into the desired goal (a shorter timeframe for completing the building). Similarly, in intrapartum care, many clinical management decisions must be made following detection of an abnormal FHR in order to reach the goal of fewer perinatal deaths.

In order to truly assess dimensions of feasibility and effectiveness of Doppler for scale-up, more rigorous implementation science studies must be conducted. The current study has a number of notable limitations which have been described, and largely constitute a starting point for further investigations. There are many models for implementation science, which have been summarized nicely[15] and great examples exist specific to health services[16] which can serve as guidance to planners in Tanzania. In addition, program learning via systematic monitoring of implementation, or "demonstrating by doing," will be important to build a strong platform for learning. If the experiences of people within the health system are positive, and implementation outcomes are documented and studied, the platform for advocacy will be significantly strengthened.

Incorporation of quality of care has a key role in scale up of Doppler or in other innovations meant to improve perinatal outcomes. Indeed, addressing quality of care surrounding the intervention is critical, as illustrated by the example of the Antenatal Corticosteroids Trial (ACT). Starting in 2011, a multi-country, cluster-randomized trial on antenatal corticosteroids (ACS) was conducted in Argentina,

Guatemala, Zambia, Kenya, Pakistan and India. This intervention, commonly used in the United States, was expected to reduce neonatal mortality among low birthweight (LBW) infants by preventing pre-term delivery. Use of ACS was successfully increased among the intervention clusters in all country sites. Very unfortunately, not only did deaths among LBW babies remain high, rates of stillbirth and neonatal mortality significantly increased among women receiving the intervention.[17] The increase in deaths was linked to bacterial infections in babies born in the intervention health facilities.[18] In secondary analyses, quality of care factors in the health facilities played an influential role in differential outcomes between sites: sites with better indicators of care (Guatemala and Pakistan) showed reductions in neonatal mortality.[18] In retrospect, researchers realized that quality factors, such as establishing gestational age, were critical in appropriate provision of ACS only to women at risk of pre-term birth, and not to women whose full-term baby may suffer adverse effects.[19]

Using Doppler to improve intrapartum FHR monitoring in Tanzania or similar settings will not unexpectedly increase perinatal mortality in health facilities. But the ACT is an important reminder to never omit attention to clinical management and quality of care to an intervention in health services, especially in the resource-poor environment of intrapartum care in Tanzania. Among intervention sites in this study, perinatal mortality significantly decreased in district hospitals and health centers but not in the regional hospitals. There were clearly contextual factors which contributed to this finding, and quality of care is likely among them. Further studies and program learning should take complexity, case management practices and quality of care into account in designing, tracking and reporting on programmatic efforts to improve intrapartum fetal heart monitoring.

Steps Taken to Introduce Doppler into Health Services in Tanzania

I have facilitated two major steps so far to provide evidence to key stakeholders in Tanzania regarding Doppler and improved intrapartum care. These include:

- A skill-building exercise with health care providers from 20 health facilities in Kagera and Mara regions of Tanzania to help them track perinatal mortality in their health facilities;
- A panel presentation on Doppler presented to the East, Central and Southern Africa College of Obstetrics and Gynaecology (ECSACOG) and the Association of Gynecology and Obstetrics of Tanzania (AGOTA).

These are described below:

Skill-building exercise: In July 2018, I led a full-day skills lab entitled "A Day of Action for Intrapartum Care" for 40 health facility staff from Mara and Kagera region of Tanzania. The first part of the day was presentation of findings from the facility perinatal mortality indicator study and a study on maternal and perinatal death surveillance and response (MPDSR); the second half of the day was a hands-on skills lab demonstrating assessment of FHR upon admission, recording results and monitoring perinatal deaths which occur after admission to the health facility. This important research-to-practice presentation of results allowed participants to walk away with skills for measuring and perinatal deaths and prepare strategies for preventing them.

The skills lab was very well liked by the nurses, midwives and other health care professionals who attended. Further information (day's agenda, presentations, and feedback from participants) is contained in Appendix 2.

Panel presentation at ECSACOG / AGOTA Annual Meeting: On September 24, 2019, a panel entitled "Doppler to improve intrapartum fetal heart monitoring: what is the evidence from Tanzania and globally?" was held at the AGOTA / ECSACOG Annual meeting in Dar es Salaam, Tanzania. I proposed the panel, which brought together experts from across the country to discuss the potential role of Doppler in improving intrapartum fetal heart monitoring, and use of Doppler to help establish

measurement of potentially preventable perinatal deaths. The results of the systematic review from the current study were presented. Pictures from the presentation can be seen in Appendix 3.

Steps Yet to Be Taken

One outstanding step yet to be taken in the path to improved FHR monitoring in Tanzania is to improve guidance to health care providers and health facility administrators on referral systems and case management when fetal heart abnormalities are detected. This is currently a gap among protocols and clinical guidance in Tanzania. One excellent model for health care providers is the decision-tree for intrapartum care, a stepwise protocol developed in UK under the National Institute for Excellence (NICE).[20] These must be produced by the Government of Tanzania, likely with input from non-governmental organizations, in order to reflect both international and national standards and evidence.

I will contribute to filling this gap by work with national subject matter experts, MOHCDGEC and PO-RALG colleagues to design clinical protocols and national level guidance to improve fetal heart monitoring and management of fetal heart abnormalities. All tools will be designed to be relevant to either Doppler or Pinard stethoscope, and to coincide with other national standards, such as use of partograph. I will provide stakeholders with the latest evidence on the benefits and limitations of Doppler as an alternative to Pinard stethoscope.

Training and Clinical Mentoring to Health Care Providers: My colleagues and I will educate regional, district and health facility administrators on the available evidence on improved intrapartum FHR monitoring, and be a resource for use cases and discussion of integration of Doppler into intrapartum care. As a team, we will recommend that any introduction of Doppler is paired with effective training on improved management of abnormal FHR, along with clinical mentoring and supportive supervision.

One of the major recommendations arising from the current study is the need for program learning from facility-level initiatives to integrate Doppler into intrapartum care. While some recent work has elucidated the "nuts and bolts" of integration of Doppler into the admission process,[21] much more experience needs to be captured and described in order to effectively integrate Doppler into care processes. I will be an advocate for evidence-based learning, whether this is a formal research study or a health facility systematically tracking and reviewing implementation of improved intrapartum monitoring practices.

Documenting client and health care provider experiences for FHR monitoring with Doppler: A particular gap identified in the systematic review is client and health care provider preferences for Doppler as compared to Pinard stethoscope. This subject has only been addressed by two studies, both of which were extremely small in scope and limited in quality.[22,23] I will work with stakeholders in Tanzania to promote systematic collection of client feedback on their preferences for FHR monitoring and other aspects of quality intrapartum care, as promoted by WHO in the move towards Respectful Maternal Care.[24]

Summary

The results of the current study suggested that Doppler for FHR assessment may have a role to play in improvements to intrapartum care. While these findings were neither conclusive nor consistently demonstrated across levels of health facility, the findings leave room for optimism. Doppler is no silver bullet, but it is a superior tool for detecting fetal heart abnormalities as compared to Pinard stethoscope. While acknowledging real constraints of resources devoted to intrapartum care in Tanzania, I also feel strongly that Tanzanian women deserve the best tools for monitoring fetal heart rates of their baby. Additionally, Tanzanian health care providers deserve to have the best information to allow them to make good clinical management decisions for their clients. For these reasons, I will

work towards intrapartum care in which Doppler is more readily available to health care providers in Tanzania, not losing sight of Doppler being one component of broader quality improvement agenda for intrapartum care. I will work to make this a reality by being a champion and a leader on improving FHR monitoring and clinical management of fetal heart abnormalities. I will promote program learning on integrating Doppler into intrapartum care by designing monitoring and evaluation tools which can be integrated into existing programs. I will promote analysis by national level stakeholders, including revisiting the example of scaling up HBB in Tanzania. I will strive to serve Tanzanian women and their families by working tirelessly to prevent newborn deaths.

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APPENDIX 1: KEY INFORMANT INTERVIEW (KII) QUESTIONNAIRE

Doppler for Improved Intrapartum Care in Tanzania
Key Informant Interview Questionnaire

Introduction: This study looks at potential barriers and facilitators to integration of Doppler into intrapartum care in the public health sector in Tanzania. The primary research question leading the questionnaire is:

- What are the barriers and facilitators to use of / scale up of the Doppler to improve facility-based intrapartum care in Tanzania?

This interview tool will capture perspectives of key informants using a qualitative, in-depth interview format.

Directions: Introduce yourself. Administer informed consent, sign the form and interview the key informant. Attach the informed consent to this form.

Introduction: Hello, I am Marya Plotkin. I work for Jhpiego and am doing a doctoral degree with the University of North Carolina at Chapel Hill and this interview is part of the study. I would like to talk to you about your views on the potential facilitators and barriers to integrating the Doppler into intrapartum care in government health facilities which offer maternity services in Tanzania. Your answers will be collated with other key stakeholders' views to inform a qualitative analysis of the potential facilitators and barriers to scale up of the Doppler for intrapartum services in Tanzania.

Date of Interview _____

Name of Key Informant _____

Position / Job Title _____

Institutional Affiliation _____

Note start time of interview:

Section 1. Background characteristics and icebreakers

1. What is your current job title?

2. How long have you been working for _____ ?

3. What is your favorite part about working for _____ ?

4. If you could live in any city in Tanzania, which one would it be? Why?

Section 2. Affordability _____

1. Can you tell me, what do you feel is the current resource availability for improving intrapartum care in the government health facilities in Tanzania? At national level? At district level? At facility level?

Probes: *where do financial resources for improving intrapartum care in Tanzania come from? Are they cyclical? What would be the next opportunity to find funds to improve intrapartum care?*

2. I want to use another example of improving intrapartum and newborn care in Tanzania to compare to that of using Doppler for improved intrapartum care. Do you have any experience with rollout of the HBB program in Tanzania? In your understanding, what financial and other resources were needed from external donors for rollout of HBB initiative? From MOHCDGEC?

Probes: *How do you think the resources needed for scaling up Doppler for intrapartum care might be similar to HBB? How might it be different?*

3. We have discussed the resources needed and the example of how HBB was scaled up in Tanzania. What affordability barriers do you anticipate if Doppler were to be scaled up to all facilities providing maternity services?

Probes: *How could those financial barriers be strategically anticipated? What would be some ways to work around them?*

4. In addition to barriers, there might be facilitators which would help move the initiative to integrate Doppler into intrapartum care. What facilitators for financing this initiative do you anticipate?

Probes: *How could those financial facilitators be strategically anticipated? What would be some ways to enhance them?*

Section 3: Practicability _____

1. In your opinion, what are current priorities for improving intrapartum care in public health facilities in Tanzania?

Probes: *What are the ones detailed in policy/ Roadmap? What are some of the more politically driven agenda areas which might or might not be in the Roadmap? Where would improving intrapartum care fall in terms of national priorities? Regional or district priorities?*

2. We have discussed financial resources which might be required to scale up Doppler for intrapartum care. What other, non-financial resources would be needed to scale up use of Doppler in intrapartum care in Tanzania? From MOHCDGEC? From NGO's? From external donors?

3. What human resource and systems barriers do you anticipate if Doppler were to be scaled up to all facilities providing maternity services?

Probes: *Do you think the biggest barrier would be human resources? Health care provider adoption? Finances? Quality of usage?*

4. What facilitators do you anticipate?

Probes: What d*o you think the biggest facilitator to adopting Doppler for improved intrapartum care? Do you think professional associations have a role to play? Community?*

Section 4. Acceptability _____

1. How do you feel that use of Doppler in intrapartum care aligns with current national priorities for maternal and newborn care?

Probe: Are there competing priorities? Are there synergistic factors?

2. Is it likely that using Doppler for intrapartum care will be acceptable to the District medical authorities? facility managers? nurse/midwives providing intrapartum care?

Probe: *Why or why not?*

Note end time of interview

APPENDIX 2: LEARNING RESOURCE MATERIALS: DAY OF ACTION FOR IMPROVING INTRAPARTUM CARE

Overview

Results from the FPM Indicator Study provided input that the FPM Indicator is a valid measurement to calculate using HMIS data, and that it is likely to be an important new metric to link to quality improvement measures to improve intrapartum health care. [36] Maternal and perinatal death surveillance and response (MPDSR) is an important quality improvement approach, which is recommended by both WHO as well as Tanzania's Ministry of Health, Community Development, Gender the Elderly and Children (MOHCDGEC). [2191] Two studies were conducted in Kagera and Mara regions of Tanzania which addressed these two approaches to improving quality of intrapartum and newborn care and reducing perinatal and newborn mortality. The studies were the FPM Indicator study (conducted in Kagera region from November 2016 - April 2017) and a multi-country MPDSR study. The main purpose of the FPM Indicator Study was to validate perinatal outcomes as recorded in the HMIS and assess the feasibility of calculating the indicator at facility level, and the purpose of the MPDSR study was to identify gaps and characterize the stage of implementation/ institutionalization in the health facilities, in order to make recommendations to improve the process.

Purpose

The purpose of the event was to feedback results from both studies to health facility staff from the health facilities where the studies were conducted, and to build skills based on key results. It is well documented that translating research into action is a gap of many studies (find references). The two study teams both had a desire to go beyond traditional boundaries of research and attempt to apply findings to facility level. I led the process of designing, orienting colleagues to, and co-facilitating an event called The Day of Action for Improving Intrapartum Care.

This appendix contains the agenda, Power point presentation slides, skills building session facilitators guides, and findings from the evaluation of the Day of Action, which was held on July 13, 2018.

Day of Action Agenda

Day of Action

Agenda

July 13, 2018

New Mwanza Hotel, Mwanza

Welcome to the Day of Action for Maternal and Perinatal Death Surveillance and Response (MPDSR) Study and Facility Perinatal Mortality (FPM) Indicator Study!

Our Goal: to translate research findings into practice at facility level to enhance accountability for reduction of maternal and perinatal deaths in Tanzania.

Time	Activity	Facilitator
8:00 – 8.30	Registration	All
8.30 – 8.40	Welcome and Introductions	Dr. Dunstan Bishanga
8.40 – 9.30	Presentation of FPM Indicator Study Results	Marya Plotkin
9.30 – 10.00	Q and A	Marya Plotkin
10:00 -10:20	Tea	All
	Energizer	Volunteer
10.20 – 10.50	Presentation of MPDSR Study Results	Dr. Ruth Lemwayi
10.50 – 11.10	Update/ Highlight: National MPDSR review process	Dr. Lipingu
11.10 – 12.00	Q and A	Dr. Lipingu and Ruth Lemwayi
12.00 – 1.00	Plenary Discussion: Thinking through how we could apply results	Gaudiosa Tibaijuka
1.00 – 2.00	Lunch	All
2.00 – 4.00	Skills labs: FPM Indicator Calculation MPDSR strengthening scenario Each participant will attend 45 minute skills lab and then rotate to the next skills lab	FPM Indicator Calculation Skills Lab (Marya, Ruth, Filbert, Tiba) MPDSR Skills Lab (Dr. Lipingu, Nyakina, Joseph, Godlisten, Schola, Mary Mwakyusa, TBD)
4.00 – 4.30	Plenary: What were the pearls? What were your thoughts?	Gaudiosa Tibaijuka Marya Plotkin
4.30 – 4.45	Wrap up	Dr. Bishanga
	Participants fill in Evaluation Form	

Facilitator's Guide: FPM Indicator Calculation

FPM Indicator Study Skills Lab Facilitators Guide

Objectives:

- Participants will be able to confidently calculate the FPM Indicator
- Participants will be able to discuss the benefits and drawbacks of using the indicator
- Participants will be able to discuss timing of calculation as well as the relation to quality improvement
- Participants will discuss what would be needed to introduce the indicator in to their workplaces

Description of Skills Lab (6 – 8 people)

Materials needed:

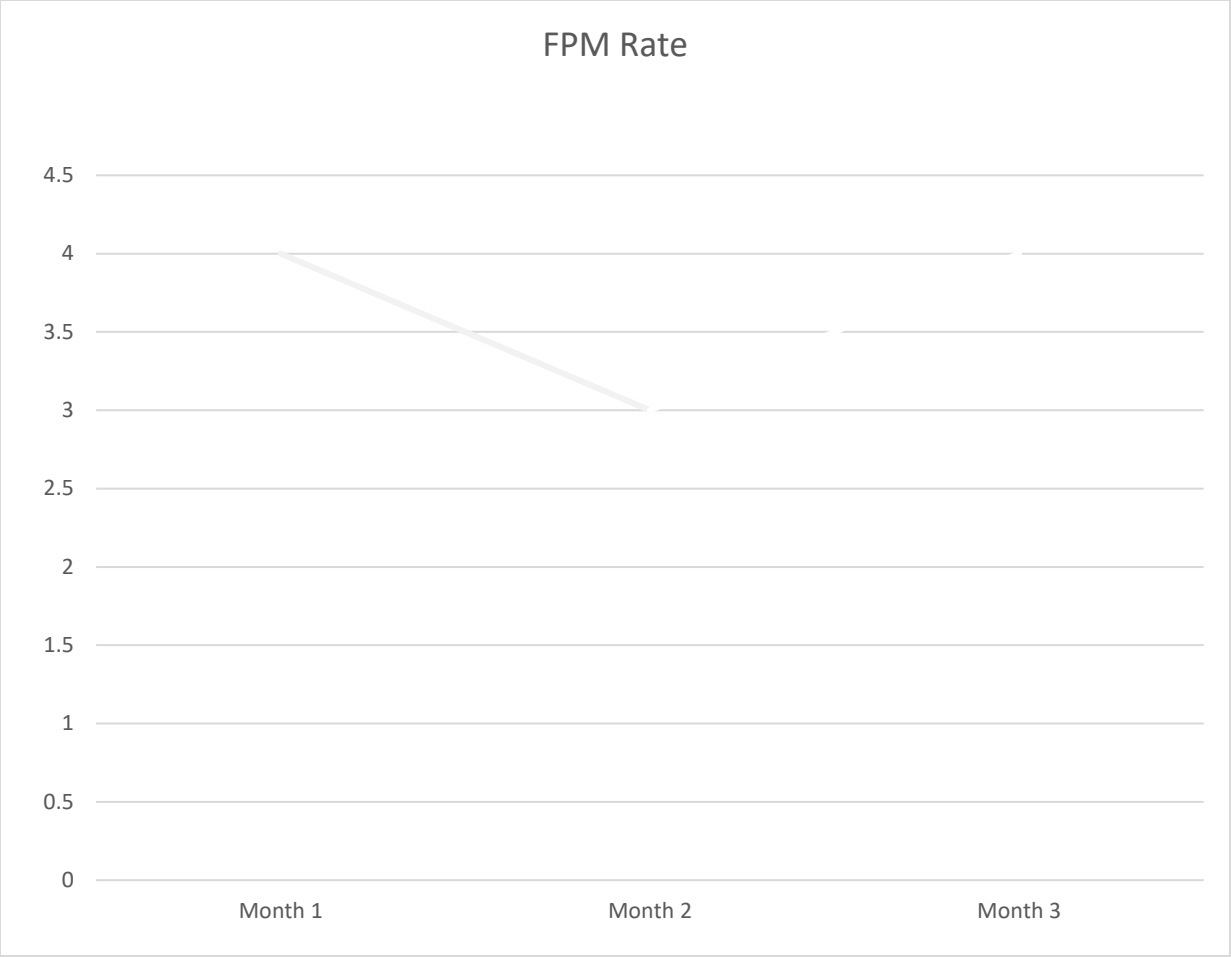
- Filled maternity register with columns filled in as an example
- Six months of filled monthly summary forms
- FPM Indicator Study Skills Lab Worksheet
- Flipchart and markers

Participants will be welcomed to a table with seats. On the table will be a maternity register, pre-filled with dummy data, as well as prefilled monthly summary forms for six months. Participants will be reminded of the purpose of the FPM Indicator and how to calculate the FPM Indicator.

Participants will fill in the worksheet using the monthly summary forms for the six months of data. They will plot the values using the blank table in the worksheet. One member of the team will be asked to draw the 6 month chart on a flipchart. (30 minutes)

Worksheet for Facility Perinatal Mortality (FPM) Study Skills Lab

Month	Total Admissions with Heart Rate Assessed	Total FSB	Total Newborn Deaths	FPM Indicator Total FSB + Total Newborn Death * 100 Total Admissions with Heart Rate Detected
Jan	302	2	12	4.6
Feb	259	0	5	1.9
March	251	2	6	3.2
April	189	0	4	2.1
May	304	2	0	0.7
June	289	1	0	0.3



Discussion Questions: Following charting of the FPM Indicator, facilitators should start a discussion with participants. (15 minutes). The following Discussion Questions can be used to prompt discussion (note: **questions and answers should not be read.** Use the answers to inform your responses, but the participants should be encouraged to work out answers with some assistance from the facilitators)

- Q: What are the benefits of using the FPM Indicator with a denominator of women with fetal heart tones assessed?

A: The denominator of women who have positive fetal heart tone helps make the indicator specific to potentially preventable perinatal deaths, ie deaths which occur after the woman is admitted to the health facility. Evidence has shown that anywhere from half to three quarters of deaths which occur to the neonate after the woman has been admitted are preventable with known interventions.

- How does that compare with looking at all perinatal deaths?

A: Including both macerated and fresh stillbirths would have the effect of diluting the power of the indicator to be a proxy for quality of care. Macerated stillbirths would generally occur before the woman reaches the health facility and thus is not related to quality of care at that facility. The aim of the FPM indicator is to allow health facilities to track mortality which can be linked to quality of care.

- Q: Do you think that Doppler is necessary to be able to calculate the FPM Indicator?

A: A Doppler is not necessary. A Pinard stethoscope can be used as well. However, there are certain advantages to a Doppler. A recent study in Tanzania showed that the Doppler was superior to the Pinard stethoscope at detecting fetal heart tones.

- What could a regular assessment of FPM Indicator tell facility staff? What might facility staff do with the information if they had it regularly?

A: Because facility-based perinatal death is so closely linked to care received by women in the intrapartum period, the FPM Indicator has been suggested by WHO as a proxy of the quality of intrapartum care. Regular assessments of the FPM Indicator could be used by facility staff to benchmark improvements to quality of intrapartum care.

- Q: WHO guidance on calculation of case fatality rates tells us that where deaths are under 20 per month, the indicator should be calculated quarterly or even annually. Do you think this should be the case for the FPM Indicator as well?

A: When events are rare and the cases of perinatal death are few, the indicator will become unstable. The difference of one or two deaths might make the rate look like a dramatic increase or decrease, but may not be linked to changes in quality of care. There is not a known threshold of how many deaths per month would cause the indicator to be stable. However WHO guidance on case fatality rates suggests that when deaths are under 20 per month, the indicator should be calculated on a quarterly, biannual or even annual basis. Thus facilities should look at the number of deaths which occur on a monthly basis and make a decision regarding how frequently the FPM Indicator should be calculated.

- Q: If a quality improvement initiative were started in that facility, do you think the facility would see an improvement in the FPM indicator? When would the improvement occur in relation to the QI intervention – immediately, or after some months?

A: We do postulate that improvements to quality of intrapartum care would result in a reduction of the FPM Indicator, but since the indicator is very new, we do not know how much, how fast and how sustained reductions in mortality will be seen. It is important that health facilities document their experience using the FPM Indicator so we can all learn and share experiences.

- Q: What would it take to introduce the FPM Indicator into your workplace?

A: It is clear that there are some new things which need to be introduced in order to calculate the FPM Indicator. For example, a new column needs to be introduced into the HMIS register on FHR present, and one in the monthly summary. Doppler devices to detect FHR upon admission is not necessary but would facilitate calculation of the indicator. However, many elements of health care provider practice would feed into this as well. These might include provider practice of assessing FHR, and health facility practice of using data for decision-making.

Q: What does the rate tell you?

A: the rate tells you the level of potentially preventable perinatal deaths occurring in the health facility. It does not comparable between health facilities, since every health facility will have a different level of perinatal mortality based on things like health seeking behavior in the catchment population, location of facility, and other factors.

A: What would cause the rate to differ in higher or lower level facilities?

The referral system will cause different rates between the levels of health facility since obstetric emergencies and high risk pregnancies are referred up the system. Thus we would expect to see higher rates of facility perinatal mortality at referral facilities compared to lower level health facilities. These may not mean poorer quality of care at the higher level health facilities. It is more useful to look at one facility's FPM rate over time than it is to compare different facilities.

Worksheet for Facility Perinatal Mortality (FPM) Study Skills Lab

Month	Total Admissions with Heart Rate Assessed	Total FSB	Total Newborn Deaths	FPM Indicator Total FSB + Total Newborn Death *100 Total Admissions with Heart Rate Detected

Discussion Questions:

Ni nini viashiria yanakueleza? What does the rate tell you?

Nini kinasababisha viashuria haya kutofautiana kwenye vituo vya juu (Hospitals and Health centers) au vituo vya chini (Dispensaries)? What would cause the rate to differ in higher or lower level facilities?

Kwa vituo vya afya vyenye vifo vingi, je viashiria vinapaswa kuchukuliwa kila mwezi au kila baada ya miezi mitatu? Kwa nini? Vituo vyenye vifo vichache? Should the indicator be calculated monthly or quarterly with facilities with a lot of perinatal deaths? Few perinatal deaths? Why?

MPDSR Study Skills Lab

Description of Skills Lab (6-8 people)

The skills lab will start with introduction of the objectives below

Objectives:

1. Understand the six steps of MPDSR audit cycle
2. Standardized understanding of MPDSR implementation process
3. Review and critique the MPDSR review according to MPDSR cycle

Facilitator will present and explain the WHO Maternal and Perinatal Audit cycle below and participants will review the six steps in the cycle. Throughout the skills lab, attention will be brought back to the WHO cycle.

The skills lab will consist of a review of two different case notes, one regarding a maternal death and the other regarding a perinatal death. The facilitators will be divide participants into two groups of 10 each and one group will be given Maternal death and another group early newborn deaths cases. Facilitator will walk the participants through the case notes. (30 minutes)

Following the review of the case notes, participants will be asked to write down on sticky notes by responding to the following from the ***SUMMARY*** of the case notes, how ***MPDSR FORM*** was filled and ***ACTION PLAN*** of the cases.

1. **SUMMARY :**Is the information in the summary adequate

Weakness/gaps identified in the summary

2. **MPDSR FORM:** Is the form completely filled
3. **ACTION PLAN:** Is the problem identified reflects to the cause of death?

    Is Intervention set address the identified problem?

Flip charts will be posted on the wall with the heading of the SUMMARY, FORM and ACTION. Participants will post the sticky notes under the appropriate flip chart. Facilitator them let participants

to read sticky notes that were posted on flipcharts. And will discuss the common information and make comments (25 minutes).

Summary in Plenary (5 minutes)

Materials/resources

- *Case notes: one maternal and one early neonatal*
- *Flipchart and sticky notes and markers for plenary discussion activity*

Evaluation of Day of Action

FPM and MPDSR Studies Day of Action

Mwanza, Tanzania

June 13, 2018

Event Evaluation Worksheet

Jina / Name _____

Mkoa / Region _____

Kada / Cadre _____

Kituo cha Afya / Health Facility Name _____

Maelekezo / Directions: *Tafadhali zungushia au andika jibu kwenye maswali yafuatayo (*please either circle or write in answers to the question below)

1. On a scale of 1 – 5, how well did you understand the results of the MPDSR study?

Kwa kipimo cha 1-5, ni kwa kiasi gani ume elewa matokeo ya tafiti ya MPDSR

1 2 3 4 5

(sijaelewa vizuri/ didn't understand well) *(nimeelewa vizuri/ understood very well)*

*Nini kiboreshwe katika mrejesho wa matokeo ya utafiti wa MPDSR? (*What could have been better in the presentation of results of the MPDSR study?)

*Nini umependa katika marejesho ya matokeo ya utafiti wa MPDSR? (*What did you like in the presentation of results of the MPDSR study?)

2. On a scale of 1 – 5, how well did you understand the Facility Perinatal Mortality Study?

Kwa kipimo cha 1-5, ni kwa kiasi gani umeelewa matokeo ya tafiti ya FPM

1 2 3 4 5

(sijaelewa vizuri/ didn't understand well) *(nimeelewa vizuri/ understood very well)*

*Nini kiboreshwe katika mrejesho wa matokeo ya utafiti wa FPM? (*What could have been better in the presentation of results of the FPM study?)

*Nini umependa katika mrejesho wa matokeo ya utafiti wa FPM? (*What did you like in the presentation of results of the FPM study?)

Maelekezo (Directions): *Tafadhali zungushia jibu linalofaa kwa maoni/mtazamo wako* (Please circle the answer which best fits your views):

1. *Nimejifunza kitu kipya ambacho sikua nakijua kabla ya siku ya leo* (I learned something new, which I didn't know before today):

Nakubali	*kiasi*	*Sikubali*
Strongly agree	Partially Agree	Disagree

2. *Mafunzo kwa vitendo (tulivyojifunza mchana) yamenisaidia kufikiri kuhusu namna ya kutumia matokeo ya utafiti kwenye kituo changu cha kutolea huduma.* The skills labs (afternoon sessions) helped me think about how I can apply the study findings in my facility

Nakubali	*Nakubali kiasi*	*Sikubali*
Strongly agree	Partially Agree	Disagree

3. *Nahisi naweza kutumia matokeo ya utafiti wa MPDSR kwenye kazi yangu na kituo changu cha afya.* I feel I can apply the findings from the MPDSR study in my work in my health facility

Nakubali	*Nakubali kiasi*	*Sikubali*
Strongly agree	Partially Agree	Disagree

Ni kitu/vitu gani vitasaidia kutumia matokeo ya utafiti wa MPDSR katika kazi yako ya kotoa huduma za afya? What thing or things would help you apply the findings from the MPDSR study in your work providing health care?

4. *Nahisi naweza kutumia matokeo ya utafiti wa FPM kwenye kazi yangu na kituo changu cha afya*. I feel I can apply the findings from the FPM study in my work in my health facility

Nakubali	*Nakubali kiasi*	*Sikubali*
Strongly agree	Partially Agree	Disagree

Ni kitu/vitu gani vitasaidia kutumia matokeo ya utafiti wa FPM katika kazi yako ya kotoa huduma za afya? What thing or things would help you apply the findings from the FPM study in your work providing health care?

Participant Feedback from Evaluation

Table 1. Participant understanding of MPDSR Study findings

Q1. On a scale of 1 - 5, how well did you understand the results of MPDSR study?	n	%
5 - understood very well	24	59
4 - understood mostly	17	41
Total	**41**	**100**

Table 2. Participant understanding of FPM Indicator Study findings

Q1. On a scale of 1 - 5, how well did you understand the results of FPM Indicator study?	n	%
5 - understood very well	26	63
4 - understood mostly	14	34
3 - didn't understand very well	1	2
Total	**41**	**100**

Table 3. Qualitative Feedback on Likes on MPDSR Study Findings

Quotes: Things which were done well/ liked by participants (MPDSR)
Kutengeneza action plan zinazoendana na root cause / to make an action plan which goes along with root causes -health care provider
I really identified myself to be well involved with MPDSR - health care provider
The way that results and recommendations were organized for improvement - district council member

*Nimependa namna ya taarifa za utafiti zilivyokusanywa na kuchambuliwa kutoka hatuo ya DHIS na vituon*i / I liked the way that the research was collected and selected from the DHIS and the facilities - health care provider
Mambo yote yamekwenda vizuri wafundishaji walikuwa makini na kutoa maelezo ya kina/ Everything went well. The facilitators were sharp and were providing useful information -health care provider
How to use WHO MPDSR Audit Cycle to improve quality of care - health care provider
Nilipenda elimu juu ya MPDSR cycle, how to make action plan -health care provider
Things which could have been better:
Sample size could have been more than what was employed in the study - health care provider
Comparison of our findings (in Tanzania) with the three other countries where the study was done - district council representative

Table 4. Qualitative Feedback on Likes on FPM Indicator Study Findings

Quotes: things which were done well/ liked by participants (FPM Indicator)
Calculation of FPM Indicator
Matumizi sahihi ya moyo yatasaidia kupunguza vifo vya watoto at least 90% / correct use of the Doppler will help reduce newborn death by at least 90% -health care provider
Nimependa jinsi watafiti walivyotoa mrejesho kwa kujiamini kile walichofanya / I liked the way the researchers gave the feedback since they really believed in the work that they did -health care provider
All the presented slides were very meaningful - district council representatives
Napenda jinsi ya kupata idadi ya perinatal death kwa kufanya hesabu / I liked the way of calculating perinatal deaths

Napenda jinsi ya kukokotoa FPM kupitia samary fomu pamoja na mpangokazi/ I liked the way to gather the data on FPM using the summary form as well as the implementation plan
What could have been done better
Muda wa kutoa mrejesho mfupi / the time for the presentation was short
Kipengele cha matumizi ya foetoscope against doppler yangezwa kwenye mrejesho / The issue of foetoscope compared to Doppler should be emphasized in the study feedback - health care provider

Table 5. Participant recommendations

Recommendations
Naomba MTUHA Book wa kuandika vifo vya watoto wachanga kolumu iwekwe kwa ajili ya kuandikishwa/ I would like to see a column added to record newborn deaths so that they can be registered (referring to monthly summary form for MTUHA book 12 -DMO office representative
HMIS tools should be useful to address early neonatal death - health care provider
Utafiti waendelee kufanya tafiti zaidi ikiwezekana wahusisha hata walioko vituoni ili kujenga uwezo wao na kuapanua mawazo / This research should continue and if possible even health care providers should be involved in order to build their capacity and deepen their understanding -health care provider
MTUHA ziongezwe vipengele vya kutumia kwenye FPM / The HMIS tools should include the data elements to calculate facility-based perinatal mortality -health care provider
The indicator for perinatal death needs to be more refined for babies referred from one facility to another who are not recorded in HMIS Book 12 - how can they also be included in the real data / statistics for early neonatal deaths? - district council representative
MTUHA organizers should be involved to help create the missing column -health care provider
Napendekeze pia MSB yafanike (kwenye indicator) / I think MSB should be included in the indicator - district council representative
Ongoing MPDSR monitoring and evaluation at facility level -health care provider

Tunahitaji kuboresha kifundi watumishi wa ngazi zote waelewe umuhimu wa MPDSR / We need to improve skills of health care providers at all levels of the system to understand the importance of MPDSR - district council representative
Ongeza doppler machine! / We need more doppler devices! -health care provider
How do we track on a community basis? - district council representative

APPENDIX 3: DOPPLER PANEL PRESENTATION AT THE ASSOCIATION OF GYNECOLOGISTS AND OBSTETRICIANS OF TANZANIA (AGOTA)

Title of Panel: Doppler to improve intrapartum fetal heart monitoring: what is the evidence from Tanzania and globally?

September 23, 2019
AGOTA/ ECSACOG Annual Meeting
Dar es Salaam

Introduction: Monitoring fetal heart rates (FHR) and taking appropriate action in case of abnormal FHR has been demonstrated to be a gap in intrapartum care in Tanzania. Doppler has been shown in multiple randomized controlled trials to be more effective than Pinard stethoscope at detecting abnormal FHR, but had limited impact on reducing perinatal mortality in the same studies. This panel will pull together Tanzanian researchers who have been involved in research on improving fetal heart monitoring to discuss the benefits and limitations of expanding use of Doppler for improving intrapartum care, including using Doppler to assess and record FHR upon admission to labor for calculation of an indicator to track perinatal deaths which occur after admission to the health facility.

Presentation Titles (Presenter):

Facilitator: Dr. Hussein Kidanto

1. Uses of Doppler to Improve Intrapartum Care in LMIC: Key findings from a Systematic Review (Dr. Benjamin Kamala)
2. What does it look like to integrate Doppler into admission to labor and delivery services? Findings from a process analysis (Ms. Gaudiosa Tibaijuka)
3. Measuring perinatal mortality in the health facility setting: a new indicator to track and prevent stillbirth and newborn death in Tanzania's facilities (Dr. Christosom Lipingu)

Presentation #1: Uses of Doppler to Improve Intrapartum Care in LMIC: Key findings from a Systematic Review

Benjamin Kamala,[1] Hussein Kidanto,[2] Sheena Currie,[3] Marya Plotkin[3]

[1]Stavenger University, Norway

[2]Aga Khan Medical University, Tanzania

[2] Jhpiego

Photo caption: Dr. Kidanto Hussein presents findings from the systematic review on Doppler in LMIC, AGOTA Annual Meeting, September 23, 2019

Background

Using Doppler to improve detection of intrapartum fetal heart rate (FHR) abnormalities, linked to appropriate, timely intrapartum care, can save lives. There is accumulating evidence that Doppler may have advantages over the standard method of assessing FHR in low- and middle-income countries (LMIC) – the Pinard fetoscope. While multiple studies have looked at efficacy of Doppler at evaluating abnormal FHR in the LMIC health facility setting, no review has yet been conducted on these studies.

Objective

To present key findings from a literature review on uses of Doppler to improve intrapartum care in LMIC, including FHR monitoring, and programmatic services measurements on quality of intrapartum care, and provider and client preferences for FHR monitoring methods.

Methods

PubMed, Web of Science, Embase, Global Health, and Scopus databases were searched from inception to October 2018, by combining terms for Doppler, perinatal outcomes, and FHR monitoring. Selected studies were reviewed full text following an abstract / title search. compared Doppler to Pinard stethoscope for detecting/monitoring intrapartum FHR, described use of Doppler for assessing a new indicator linked to quality of care, or described provider and client preferences for FHR monitoring in LMIC settings. Two team members independently screened and collected data. Risk of bias was assessed using EPOC criteria.

Results

1464 records were retrieved using the search criteria, 19 were selected for full text review, and 8 met the study criteria, for a total of 11 studies from eight countries included in the study. While Doppler was superior at detecting abnormal intrapartum FHR as compared to Pinard fetoscope, Doppler was not associated with improved perinatal outcomes. Using Doppler on admission helped accurately measure perinatal deaths occurring after facility admission. Studies on client and health care provider preferences related to Doppler or Pinard stethoscope for FHR monitoring were insufficient to draw any conclusions.

Conclusion

Much is needed, including studies and program evaluation, to translate improved detection of FHR abnormalities using Doppler to improved case management and eventually prevention of perinatal deaths. More study is also needed on provider and client preferences related to Doppler and other means of FHR monitoring. Doppler should be used to assess FHR upon admission, in order to calculate an indicator on intrapartum care quality.

Presentation #2: What does it look like to integrate Doppler into admission to labor and delivery services? Findings from a process analysis

Gaudiosa Tibaijuka,[1] Christosom Lipingu[1], Felix Bundala,[2] Mary Carol Jennings,[3] Lusekelo Njonge,[1] Ruth Lemwayi,[1] Mary Drake[1] Jeremie Zougrana[1], Dunstan Bishanga,[1] Marya Plotkin[4]

[1]Jhpiego Tanzania

[2] Ministry of Health, Community Development, Gender, the Elderly and Children

[3] Johns Hopkins University

[3] Jhpiego Baltimore, USA

Photo caption: Ms. Gaudiosa Tibaijuka presents on integrating Doppler into admission to labor and delivery services, AGOTA conference, September 23, 2019

Introduction

In 2016 – 2017 a study on perinatal mortality was conducted in Kagera region and handheld Doppler devices were provided to health care providers in 10 health facilities to assess fetal heart rates when women were admitted to labor and delivery services. As part of the study, a training was designed and

conducted for 163 health care providers, and 87 providers underwent observation while triaging 112 women for admission to maternity services.

Objective

To present lessons learned on training health care providers to use Doppler and record results; competency scores for using Doppler; time spent using Doppler upon admission; and needs for maintenance of Doppler.

Methodology

A process evaluation was conducted on training outcomes for health care providers trained in October 2016, and observational study was conducted on health care providers using the Doppler to assess fetal heart upon admission to labor and delivery services from November 2016 – April 2017.

Results

A knowledge assessment, using the Objective Structured Clinical Examination (OSCE) methodology, showed that providers score showed a significant increase in skills from pre-test to post-test. Twelve percent failed examination at first, but all passed upon coaching and remediation. The average length of time for admission was 30.6 minutes, and of that time an average of 4.1 minutes were used to assess fetal heart rate using the Doppler (including locating, using and storing the device and recording the results).

Conclusion

The half-day training on use of Doppler for triage upon admission and recording results was effective in communicating needed skills and competencies, and minimal inputs (ultrasound gel, wipes) were needed for continued use of the device. Documentation of the experience in Kagera will provide concrete information for planning for other facilities interested in improving fetal heart assessment during the admission process.

Presentation #3: Measuring perinatal mortality in the health facility setting: a new indicator to track and prevent stillbirth and newborn death in Tanzania's facilities

Christosom Lipingu[1], Gaudiosa Tibaijuka,[1] Felix Bundala,[2] Lusekelo Njonge,[1] Ruth Lemwayi,[1] Dunstan Bishanga[1], Mary Drake,[1] Mary Carol Jennings,[3] Sheena Currie, [4]Jeremie Zougrana[1], Marya Plotkin[4]

[1]Jhpiego Tanzania

[2] Ministry of Health, Community Development, Gender, the Elderly and Children

[3] Johns Hopkins University

[4] Jhpiego Baltimore, USA

Photo caption: Dr. Christosom Lipingu presents on facility perinatal mortality indicator study, AGOTA, September 23, 2019

Introduction

Improving quality of intrapartum care is of high priority in Tanzania. A 2017 study in Kagera region, showed the validity and feasibility of calculating an indicator which measures perinatal mortality occurring after the woman is admitted in labour. High sensitivity and specificity of the MTUHA data was demonstrated, following which every facility calculated rates of perinatal deaths which occurred after admission to the facility.

Objective

To demonstrate the validity of MTUHA data on intrapartum stillbirths and newborn deaths, and use the MTUHA data to calculate a facility-perinatal mortality (FPM) rate which can be linked to quality of intrapartum care. To discuss the rollout of such an indicator in Kagera region.

Methodology

A prospective indicator validation study was conducted in 10 high volume health facilities in Kagera region. Data on adverse perinatal outcomes from the MTUHA register was compared to a gold standard perinatal death audit to verify classification of death. Then data from the MTUHA was used to calculate the FPM indicator. Health care providers were capacitated with skills on calculating the indicator.

Results

Very high sensitivity and specificity (range 9.5.7 – 100%) of the gold standard audits was seen to predict type of adverse perinatal outcome in the MTUHA register. Given the confidence MTUHA register, the FPM indicator was calculated. Results showed FPM rates which corresponded with levels of health facility, with the regional hospital having a rate of 4.2% of all admissions in which a fetal heart was detected experiencing a perinatal death, and district hospitals having an average rate of 2.4%. The participatory workshop was well-received and health care providers were eager to calculate FPM indicator rates in their facility, to have reference points for initiatives to improve quality of care.

Conclusion

The FPM Indicator is a valuable tool that health facility staff can use to track potentially preventable perinatal deaths which occur in the health facility. The indicator can be used to look at trends over time, and relate to quality of care initiatives. To be scaled up, “fetal heart rate upon admission” must be added to MTUHA and providers should be oriented to calculation.