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Meron Siira April 22, 2020

Development, Implementation, and Evaluation of an Electronic Obstetric and Neonatal (OBNN) Database at Muhimbili National Hospital, Dar es Salaam, Tanzania: A Special Studies Project

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Abstract

Development, Implementation, and Evaluation of an Electronic Obstetric and Neonatal (OBNN) Database at Muhimbili National Hospital, Dar es Salaam, Tanzania: A Special Studies Project

By: Meron Siira

Background: Tanzania has one of the highest maternal mortality rates (MMR) and neonatal mortality rates (NMR) in the sub-Saharan region with an estimate of 556 maternal deaths per 100,000 live births and 19 neonatal deaths per 1,000 live births. In 2011, the MMR at Muhimbili National Hospital (MNH) was roughly 1,541 per 100,000 live births, considerably higher than national estimates. Previous literature has indicated substandard care factors for women delivering at MNH and has demonstrated a need for quality improvement (QI) initiatives in order to reduce poor maternal and neonatal outcomes in health facilities.

Purpose: Launched in 2018, the Emory-Muhimbili Partnership for Health Administration Strengthening and Integration of Services (EMPHASIS) seeks to collaboratively build capacity for quality improvement, research infrastructure, and business processes at MNH. Collaboratively, the team decided to address the startling need for data collection at MNH as one of the first steps towards improving QI processes. The main purpose of this project was to provide a tool to aid in clinical decision-making in order to improve the ability to undertake QI initiatives. Additionally, the project intended to build capacity for staff-led research and improve hospital and ministry reporting processes for nurses and midwives.

Methods: The database was developed in collaboration with obstetrician-gynecologists and midwives at MNH with use of standard indicators. Implementation took place over a three-month period. Maternity block staff were trained for data collection through group workshops and continuous hands-on education. A one-month pilot with 100% data collection was completed and additional modifications were made to the database. Eighteen qualitative interviews were conducted with staff to evaluate project implementation as well as barriers and facilitators for similar electronic data collection systems at MNH.

Results: A collaborative decision was made with hospital leadership to transition from paper-based data collection to solely electronic data collection in the maternity block roughly three months after implementation began. Staff overwhelmingly reported positive experiences with project implementation and use of the database. Benefits ranged from improving data privacy and security to improved workflow. A key challenge identified was lack of reliable access to network connection.

Discussion: Hospital leaders and staff recognize the need for quality improvement initiatives in the MNH maternity block, but lack high-quality, real-time data in order to inform their decision-making. Successful implementation of the OBNN Database in the Maternity Block may drive the desire for improving data collection systems hospital-wide. Increasing access to data for decision making may improve outcomes for patients at MNH, assist staff with administrative reporting, and provide opportunity for staff-led research.

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CHAPTER 1: INTRODUCTION

In 2015, approximately 2,100,000 babies were born in the United Republic of Tanzania at a rate of 5,700 babies born a day (UNICEF, 2017). Tanzania has one of the highest maternal mortality rates (MMR) and neonatal mortality rates (NMR) in the sub-Saharan region with an estimate of 556 maternal deaths per 100,000 live births and 19 neonatal deaths per 1,000 live births (Ministry of Health, 2016). In 2015, Tanzania failed to meet the Millennium Development Goal (MDG) aimed at reducing maternal mortality indicating a halt in progress towards improving outcomes for mothers and newborns. Reaching the Sustainable Development Goal 3 target (SDG target 3.1) of 140 deaths per 100,000 live births will continue to remain a significant challenge (Afnan-Holmes et al., 2015).

Experts in global maternal and newborn health widely agree that a functioning health care system is imperative to address maternal and neonatal mortality and morbidity in low-income contexts (Bwana, Rumisha, Mremi, Lyimo, & Mboera, 2019; Mgaya, Kidanto, Nystrom, & Essén, 2016; Shija, Msovela, & Mboera, 2011). Improving access to health facilities has long been the focus of many maternal and neonatal programs and initiatives, however, it is now widely recognized that simply increasing access to and utilization of healthcare services is not sufficient. While the number of births occurring in skilled health facilities in Tanzania has increased from 50% in 2010 to 63% of all births in 2015, there has not been a substantial decrease in the MMR (Ministry of Health, 2016). Recent work in Tanzania actually suggests that facility based maternal mortality may actually be rising as a study published in 2019 suggested that the hospital-based maternal mortality ratio increased by over 40% between 2006-2015 (Bwana et al., 2019).

A growing body of literature has identified major gaps in the delivery of essential, life-saving services for mothers and children in low resource contexts. Poor outcomes in health facilities have often been attributed to inadequate services, delay in treatment, and mismanagement of care (Ergo, 2011; Roncarolo, Boivin, Denis, Hébert, & Lehoux, 2017; Samuels, Amaya, & Balabanova, 2017). Ongoing efforts to further elucidate and respond to these issues in health facilities have led researchers towards a focus on improving the overall quality of care provided to women and children. Health systems strengthening and improving quality of care in Tanzania health facilities has the potential to make a large impact on maternal and neonatal outcomes (World Health Organization, 2016c).

Problem Statement

Muhimbili National Hospital (MNH) is one such health facility. Located in Dar es Salaam, Tanzania, MNH is one of the largest referral-level health facilities in the country. Over 8,000 deliveries are performed at MNH each year, making MNH a high-volume obstetric facility. Its role as a referral-level facility also indicates that the acuity level of patients seen at MNH may be high. In 2011, the MMR at MNH was roughly 1,541 per 100,000 live births, considerably higher than national estimates (Pembe, Paulo, D'mello, & van Roosmalen, 2014). Previous literature has indicated substandard care factors for women delivering at MNH and has demonstrated a need for quality improvement (QI) in the MNH maternity block (Kamala, Mgaya, Ngarina, & Kidanto, 2018; Kidanto, Massawe, Nystrom, & Lindmark, 2006; Mdegela, Muganyizi, Pembe, Simba, & Van Roosmalen, 2012; Muganyizi & Kidanto, 2009; Pembe et al., 2014). Hospital leadership at MNH also indicated a desire to improve outcomes in the maternity block by improving QI processes and supporting staff-led research.

In order to better serve the patient population at MNH, there is a need to improve QI processes and research capacity at MNH which includes the collection of systematic, high-quality, real-time data. The WHO and other international organizations have widely acknowledged the need for health facility data for clinical decision-making; however, there is a lack of sustainable, locally owned data collection, especially in resource-poor settings. MNH currently has no health information system specifically designed to support planning, management, and decision-making at MNH.

Purpose

Launched in 2018, the Emory-Muhimbili Partnership for Health Administration Strengthening and Integration of Services (EMPHASIS) seeks to collaboratively build capacity for quality improvement, research infrastructure, and business processes at Muhimbili National Hospital (MNH). The partnership consists of key leadership at MNH, including members of the hospital strategic leadership team, as well as three primary Emory faculty members. Collaboratively, the team decided to address the startling need for data collection at MNH as one of the first steps towards improving QI processes.

Dr. Andrew Mgaya, an obstetrician-gynecologist, had previously begun developing a set of indicators for use in the maternity block and had conceptualized the implementation of an electronic data collection system. Therefore, along with the hospital-leadership, the decision was made to continue his efforts and support data collection efforts in the maternity block. The main purpose of this project was to provide a tool to aid in clinical decision-making in order to improve the ability to undertake QI initiatives. Additionally, the project intended to build capacity for staff-led research and improve hospital and ministry reporting processes for nurses and midwives.

Project Goals

The goal of this project was to design, initiate, and evaluate a pilot platform for continuous, real-time, and high-quality data collection in the maternity block at MNH. The project was designed to involve staff midwives and nurses in all aspects of data collection, as well as to promote their ownership of the project and their ability to use data to develop and implement their own quality improvement and research activities. Ultimately, the project seeks to provide MNH staff with easy access to usable data for the purposes of quality improvement, reporting, and staff-led research.

Significance

While research regarding the use of electronic health systems continues to expand, there is a dearth of information regarding the use of electronic information systems in Tanzania and almost no data on the utilization of data for local decision-making. The design, implementation, and evaluation of this database can serve as an example for projects that seek to improve upon quality improvement processes and decision-making in similar clinical settings. More specifically, the successes and challenges of this project may be used to implement similar systems at MNH and other referral-level facilities in Tanzania. Potential impacts on quality improvement in the maternity block from this project may improve patient outcomes at MNH. These improvements may further reinforce the need to focus efforts on bolstering health facilities in order to continue to best serve women and children in Tanzania.

Definition of Terms

MMR: Maternal Mortality Rate

NMR: Neonatal Mortality Rate

MDG: Millennium Development Goal

SDG: Sustainable Development Goal

MNH: Muhimbili National Hospital

QI: Quality Improvement

TDHS: Tanzania Demographic and Health Survey

OBNN: Obstetric and Neonatal Database

WHO: World Health Organization

IOM: Institute of Medicine

CS: Cesarean Section

eHealth: Electronic Health Systems

EMR: Electronic Medical Records

EDC: Electronic Data Capture

EMoC: Emergency Obstetric Care

IPC: Infection and Prevention Control

QIT: Quality Improvement Team

WIT: Work Improvement Team

mHealth: Mobile Health Technologies

CHAPTER 2: LITERATURE REVIEW

Maternal Health in Tanzania

Approximately 810 women die every day from preventable causes related to pregnancy and childbirth and over 94% of these deaths occur in developing countries. Significant progress has been made towards improving maternal mortality worldwide; between 2000 and 2017, maternal mortality dropped by about 38% (World Health Organization, 2019). Despite progress globally, maternal mortality remains a problem in Sub-Saharan Africa and the number of maternal deaths continues to be unacceptably high. The problem is particularly devastating because the vast majority of maternal mortalities are preventable with appropriate interventions.

Tanzania is among the eleven countries in Sub-Saharan Africa that comprised roughly 86% of all estimated global maternal deaths in 2017 (World Health Organization, 2016b). In the 2015-2016 Tanzania Demographic and Health Survey (TDHS), the estimated maternal mortality ratio (MMR) was 556 deaths per 100,000 live births. A review of past TDHS from 2004-2016 demonstrates there is no evidence that the MMR has changed substantially over the last decade in Tanzania (Ministry of Health, 2016). It is unclear why the MMR has stagnated; therefore, meeting the Sustainable Development Goal (SDG) of 140 deaths per 100,000 live births by 2030 remains a substantial challenge.

The causes of maternal mortality estimated in 2014 for sub-Saharan Africa by the WHO include indirect causes (29%), hemorrhage (25%), hypertension (16%), unsafe abortion (10%), and sepsis (10%) which are well-known problems (Countdown to 2030, 2018). While problems are often easy to identify, finding solutions for improving maternal outcomes requires a broad range of interventions that address social, economic, and geographical barriers. Evidence-based

strategies such as access to family planning, antenatal care, routine care during birth, and emergency obstetric care are important factors in preventing maternal deaths.

Maternal mortality in resource-scarce settings is often attributed to Thaddeus and Maine's "three delays" model, which explains the primary drivers of maternal mortality and morbidity, and recognizes the complexity of receiving appropriate, evidence-based care in various settings. Specifically, the model characterizes these drivers according to delay in deciding to seek care, delay in reaching care in time, and delay in receiving adequate treatment (Thaddeus & Maine, 1994). As of 2016, a majority of births in Tanzania appear to be taking place in health facilities; 63% of all births occurred in a health facility while in urban areas 86% of all women deliver in a health facility (Ministry of Health, 2016). Women also generally receive skilled attendance during birth, especially during their first births in which 78% are attended by a skilled provider. Antenatal coverage has also exceeded 90% for at least two decades, though only half (51%) of women receive the recommended four visits (Ministry of Health, 2016). Women in Tanzania are still unable or unwilling to access health facilities and services, though trends are positive for increasing the percentage of women receiving care before, during, and after birth.

The third delay - a delay in receiving adequate treatment - also deserves appropriate attention. A recent retrospective analysis published in 2019 found that from 2006-2015, hospital based maternal mortality increased from 40.24 in 2006 to 57.94 per 100,000 live births in 2015 (Bwana et al., 2019). In 2011, a maternal mortality study done at Muhimbili National Hospital in Dar es Salaam, found that the MMR was 1,541 per 100,000 live births, which is more than three times the national estimate. While a high MMR may be inherent to referral level facilities due to

complicated or high-risk patients, it might also point to issues of quality within referral level facilities or the facilities that are providing the referrals (Pembe et al., 2014).

Despite several government-led initiatives to improve maternal health, Tanzania did not meet its Millennium Development Goal in 2015 aimed at reducing maternal mortality. Insurmountable barriers for women attempting to access adequate care in health facilities continue to halt progress towards the Sustainable Development Goals in 2030. While the Tanzanian government subsidizes maternal health services, critics argue that current national support for maternal services is not adequate to address the delays in receiving care and must be revitalized in order to move towards improved maternal health (Afnan-Holmes et al., 2015; Armstrong, Magoma, & Ronsmans, 2015; Kibusi, Sunguya, Kimunai, & Hines, 2018; Rumishael S Shoo, 2017; Shija et al., 2011).

Neonatal Health in Tanzania

The WHO defines the neonatal period as the first 28 days of life, which represents one of the most vulnerable times in a child's life. Over 2.6 million neonatal deaths occurred in 2016, or roughly 7,000 newborn deaths every day (WHO, 2019). Roughly 98% of all neonatal deaths occur in low resource countries and over two-thirds occur in Africa or southeast-Asia (Garces et al., 2017). Many neonatal deaths occur within 24 hours of birth and are caused by generally preventable causes such as complications of preterm birth, infectious disease, and asphyxia (Baqui et al., 2016; Bhutta et al., 2011; Garces et al., 2017).

In Tanzania, the 2015-2016 TDHS estimated the neonatal mortality rate at 25 deaths per 1,000 live births which has consistently declined since 1999. Unexpectedly, the same survey found that mortality rates are higher among households in the highest wealth quintile and that children living in urban areas were less likely to survive (Ministry of Health, 2016; Ogbo et al.,

2019). In a study of 6 lower and middle income countries, Tanzania was found to have the highest proportions of neonatal deaths within the first 24 hours (65.5%)(Baqui et al., 2016).

Tanzania also has a high rate of stillbirths at a rate of 25.9 deaths per 1,000 births which is the ninth highest rate in the world (Chuwa et al., 2017). Several factors such as smoking, alcohol use, diabetes, maternal age, and infection amongst others, have been shown to be associated with stillbirths (Bhutta et al., 2011). However, in sub-Saharan African limited research on stillbirths has made determining causes and potential interventions difficult though perinatal deaths could also be preventable, especially in health facilities. Though Tanzania has made important strides forward towards reaching the new Sustainable Development Goals (SDGs), more research is needed to understand neonatal and perinatal deaths.

Quality Improvement (QI) in Low-Resource Settings

The World Health Organization (WHO) broadly defines Quality Improvement (QI) as "an approach to improvement of service systems and processes through the routine use of health and program data to meet patient and program needs" (WHO, 2017). Quality improvement in healthcare settings is essential for contributing to a healthier population. While QI projects generally improve health outcomes in developed settings, the efficacy of QI initiatives in low-resource settings is less clear. The WHO has called for a renewed focus on quality improvement initiatives in low-resource settings, noting that "many global and national health strategies are not sufficiently considering the issue of measuring and improving health-care quality in low-resource settings" (Nambiar, 2017). In fact, QI initiatives may prove to have an even greater potential in resource-poor settings, as the gap between care delivered and the best possible care is often larger (Leatherman, Ferris, Berwick, Omaswa, & Crisp, 2010). Quality improvement within health systems must have a collaborative nature in which policymakers, managers, and

healthcare providers work together to address system wide issues for healthcare delivery. Understanding quality improvement in low-resource setting requires renewed efforts towards engaging all stakeholders while simultaneously working to strengthen investments in the healthcare system.

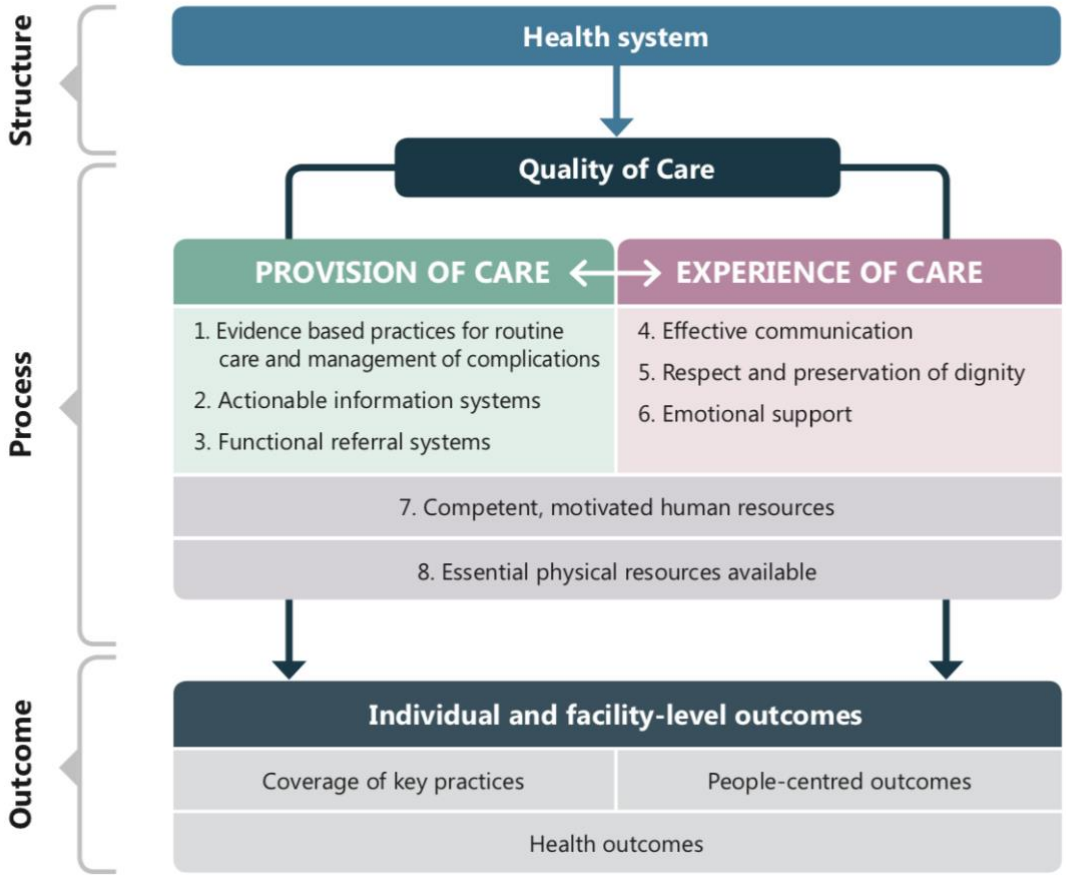
Defining Quality Improvement

Quality Improvement (QI) is widely acknowledged to be critical in providing safe, effective, patient-centered, timely, efficient, and equitable healthcare, as defined by the Institute of Medicine (IOM)(Hughes, 2008; Nambiar, 2017). The IOM definition of quality healthcare is comprehensive and encompasses three key components of quality: clinical (safe and effective), interpersonal (patient centered) and contextual (timely, efficient, and equitable). Quality healthcare is a complex concept that requires review of multiple setting-specific factors that may be difficult to measure and evaluate, especially in resource-poor contexts. There is ongoing work to identify and further define indicators and metrics to inform our understanding of healthcare provided to patients in various settings. These measurements provide a basis for clinicians, organizations, and governments to identify areas for improvement and successes in increasing

quality of care; unfortunately, many indicators currently used around the world have not been validated. Especially in resource-poor settings, common indicators for quality improvement and health outcomes are not matching up, therefore encouraging efforts for more deliberate and intentional measurement, monitoring, and evaluation of quality improvement projects and processes will be key.

In the last several years, there has been a great amount of work surrounding the improvement of evidence-based guidelines for maternal and neonatal care. Work done by the WHO, the American College of Obstetrics and Gynecologists, among others, has improved the ability to capture the nature of care provided to mothers and their newborns. In 2016, the WHO

Fig. 1. WHO framework for the quality of maternal and newborn health care



developed 8 standards for improving the quality of maternal and newborn care which clearly outline the domains of care that should be assessed and monitored within health facilities(World Health Organization, 2016c). These renewed efforts are promising for improving maternal and neonatal health and meeting the Sustainable Development Goals set for 2030 which aim to reduce maternal and neonatal mortality.

Implementing QI Projects in Low-Resource Settings

The U.S Department of Health and Human Services identifies four key areas for a successful quality improvement project: (1) QI work as systems and processes (2) focus on patients (3) focus on teamwork (4) focus on use of data (U.S Department of Health and Human Services, 2011). Unfortunately, barriers to successful implementation may also be more extreme in low resource settings than in developed ones. Dixon-Woods et al. describes ten challenges for improving quality healthcare that cover three broad themes. The first challenges (1-4) relate to design and planning of QI initiatives, challenges 5-8 consist of concerns regarding organizational and institutional settings, while the last challenges (9-10) refer to sustainability of QI concepts (Dixon-Woods, McNicol, & Martin, 2012). The WHO offers a framework which attempts to address many of the barriers to implementing QI projects in low-resource settings which includes systems thinking, participatory approach, accountability, evidence-based, and innovative evaluation. In support of this framework, a review of 27 applications in 12 less-developed countries found that collaborative improvement can produce significant results as a strategy for health systems strengthening (Franco & Marquez, 2011). Implementation of QI projects are often multilevel, integrative, and system wide. QI projects may include interventions aimed to improve the system's environment, improve clinical care, or to strengthen health infrastructures (Goyet, Broch-Alvarez, & Becker, 2019). When designing and implementing interventions to improve

the quality of care for women's health, the Maternal Task Force calls policymakers to think about four key questions:

1. What are the best strategies for accurately measuring quality of maternal health care?
2. In what ways might high quality care look different across diverse sociocultural settings?
3. How does the WHO definition of quality of care compare to the real-life experiences of women receiving maternity care services?
4. What kinds of program, policy changes, and other interventions are most effective for addressing issues of quality? (Maternal Health Task Force, 2019)

Quality Improvement for Maternal and Neonatal Healthcare in Sub-Saharan Africa

Simply increasing access to and utilization of healthcare services is not sufficient for improving maternal and neonatal health outcomes. With increasing numbers of deliveries in health facilities, improving quality of care in these settings is imperative for preventing maternal and neonatal mortality and morbidity. Globally, 70% of maternal deaths are due to complications of pregnancy and childbirth like hemorrhage, hypertension, sepsis, and abortion. Similarly, preterm birth, asphyxia, intra-partum perinatal deaths, and neonatal infections account for more than 85% of newborn deaths (World Health Organization, 2016c). However, facilities are often not equipped to handle these complications. In a recent study in five African countries, nearly nine out of ten facilities that provided obstetric services did not have the capacity to perform cesarean sections though these primary care facilities delivered 44% of all facility births. Of the facilities that were defined as "primary care" 47% had skilled staff available at all times, 36% had safe water, and only 11% had electricity (Kruk, Leslie, et al., 2016). A review of 40 Kenyan Health facilities in 2013 found that none of the studied facilities met the strict WHO standard for

having emergency obstetric care services (EMoC) (Echoka et al., 2013). Similarly, a study in Northern Tanzania found that the main barrier to appropriate care was not access, but was the quality of healthcare within the facilities (Olsen, Ndeki, & Norheim, 2004, 2005). A growing body of literature has identified major quality gaps in the delivery of basic and life-saving maternal and child health within clinical settings in low-resource settings (Austin et al., 2014; Baker et al., 2015; Brizuela, Leslie, Sharma, Langer, & Tunçalp, 2019; Echoka et al., 2013; Filby, McConville, & Portela, 2016; Goyet et al., 2019; Hodgins & Agostino, 2014; Kruk, Leslie, et al., 2016; Lawn et al., 2014; Maternal Health Task Force, 2019; Olsen et al., 2004, 2005; Sharma et al., 2015; Souza et al., 2013; Tunçalp et al., 2015; World Health Organization, 2015, 2016c). Taken together, these findings suggest a need to shift the global framework that emphasizes expansion of coverage and access to one that prioritizes quality clinical care and improvement of health facilities. In "Time for a quality revolution in global health" Kruk et al argues this point exactly - that the core strategy of the millennium development goals of simply improving access to health services will not be sufficient to deliver on the SDGs by 2030 (Kruk, Larson, & Twum-Danso, 2016).

Health Facility Focused Quality Improvement in Tanzania

Quality improvement has been a priority in Tanzania since the 1990s when the Tanzania Vision 2025 was initiated and imagined that all Tanzanian citizens would have "access to quality primary health care". Unfortunately, few targeted quality improvement interventions have been implemented and systematically evaluated nationwide in recent years. In 2011, the Tanzanian National QI Framework was revised and the Tanzania Five Year Development Plan (2011-2016) recognized quality improvement as an integral component of the health sector goals; however, there was a lack of substantial planning towards devising a national strategic plan for QI. Instead,

a series of thematic projects and initiatives such as KAIZEN, 5S, and IPC (Infection and Prevention Control) have been implemented in some urban facilities (Ministry of Health and Social Welfare, 2011). There has also been a focus on supportive supervision in regional and district hospitals. Facilities reportedly have formed quality improvement teams (QIT) and work improvement teams (WIT) in order to encourage and support QI activities in health facilities. It is unclear whether many of these teams are operational or make meaningful contributions to quality improvement in Tanzanian health facilities (Nangawe, 2012).

There is a nascent body of work surrounding QI in Tanzanian health facilities which reinforces the challenge in providing a "culture of quality improvement" (Bosse et al., 2013; Mackfallen, 2019; Mwidunda, 2015). For example, in a quality improvement study designed to improve newborn care and newborn resuscitation in 52 health facilities, scores for providers conducting resuscitation scenarios remained stagnant or dropped, though other improvements in skin-to-skin care, delayed cord clamping, and breastfeeding were noted (Makene et al., 2014). Another study aimed at improving quality of maternal health care in 12 primary care facilities in rural Tanzania through a multi-faceted intervention resulted in no meaningful improvement in quality. The authors of this study concluded that weak starting quality, poor infrastructure, and low provider competence hindered the effectiveness of the intervention and prevented a high-level of implementation (Larson, Mbaruku, Cohen, & Kruk, 2019). Successful interventions reported in the literature include supportive supervision and continuous quality improvement approaches (Renggli et al., 2018).

Clearly, there is a need for new and innovative quality improvement approaches in Tanzania. Additionally, renewed efforts towards measuring, monitoring, and evaluating quality improvement interventions in health facilities will be essential. While the Tanzanian government

has ensured a strong basis for the development of QI, a detailed strategic plan alongside resources will be imperative for the future of QI in Tanzanian health facilities.

Electronic Health Systems in Low-Resource Settings

Electronic health systems (eHealth) show promise for improving health care delivery in low resource settings. The goal for utilization of eHealth systems is to improve health system efficiency and health outcomes. While high income countries now almost solely utilize computer-based systems for data collection and storage in health settings, lower income countries have only just begun to transition to electronic health information systems. There is a growing body of work surrounding eHealth systems like electronic medical records (EMRs), mobile health technologies (mhealth), and electronic data capture systems (EDC) which demonstrates their potential for use in lower income countries (Agarwal, Perry, Long, & Labrique, 2015; Aminpour, Sadoughi, & Ahamdi, 2014; Blaya, Fraser, & Holt, 2010; Bull, Thomas, Nyanza, & Ngallaba, 2018; Byass et al., 2008; Dickinson, McCauley, Madaj, & van den Broek, 2019; J. D. King et al., 2013; Mukasa, Mushi, Maire, Ross, & de Savigny, 2017; Syzdykova, Malta, Zolfo, Diro, & Oliveira, 2017; Thriemer et al., 2012). In 2016, the WHO investigated the use of "big data" amongst its member states for the first time, demonstrating its rising importance for improving national level analysis of health (World Health Organization, 2016a).

The last ten to twenty years have seen a substantial investment in eHealth technologies in lower resource settings from global organizations, development agencies, researchers, and governmental entities which have led to a proliferation of eHealth interventions. 83% of WHO member countries reported at least one mHealth initiative in 2016 and EHR systems have been reported in 47% of countries (World Health Organization, 2016a). However, eHealth systems are

still largely specialized, short-term solutions implemented in small-scale settings and there remains a lack of rigorous, high-quality evidence to support the effectiveness of eHealth in low resource environments. As technologies rapidly develop, the multidisciplinary field of eHealth continues to grow and change rapidly as well, creating challenges to understanding how best to implement these interventions in low-resource settings (Bastawrous & Armstrong, 2013).

Barriers and Facilitators to eHealth Technologies in Low-Resource Settings

Generally, eHealth is considered an inevitable and even promising development for use in low-resource settings. Several publications have reported "lessons learned" from implementation of eHealth systems in low-resource settings. In a recent review of EHR systems in sub-Saharan Africa, the authors argued that there are no generic barriers or facilitators for eHealth systems in all resource-constrained settings; instead "local systems, people, process, and product" interplay to determine success of implementation (Jawhari, Ludwick, Keenan, Zakus, & Hayward, 2016). Nevertheless, there are several repeating barriers and facilitators that emerge from the literature.

Within the local system, infrastructure is a key factor in determining the success of an eHealth system including connectivity to reliable power and the ability to update hardware or software over time. Fraser et al. recommends using the internet if possible, as simplifying data management to one server that can be well-supported increases chances of success. However, they also stress the need to adequately evaluate network reliability and prepare for offline data entry and viewing if needed which may include reverting back to a paper and pencil (Fraser & Blaya, 2010). Additionally, multiple case studies address the need to ensure proper storage and backup of data which prevents any unnecessary crises including loss of money, time, and motivation to develop electronic systems. Security of electronic equipment as well as data is a

widely addressed issue. Studies in rural Malawi and Kenya reported theft of several tablets and SD cards though other studies reported no issues with safety of their equipment. Password protection for devices, encryption, and secured storage of equipment were discussed as facilitators for safe and successful data collection (Dickinson et al., 2019; Fraser & Blaya, 2010; C. King et al., 2014; McLean et al., 2017; Onono, Carraher, Cohen, Bukusi, & Turan, 2011; Syzdykova et al., 2017).

Interactions between patients, providers, administrators, staff and their digital environment is also critical. Barriers typically reported are high staff turnover, absence of local technical support, and low levels of computer literacy (Fritz, Tilahun, & Dugas, 2015). Staff by-in and acceptance is also important and clear leadership might play an important role in this transition (Jawhari et al., 2016). Staff may find that the additional training and practice needed to adopt new electronic processes are time-consuming, however, despite certain disadvantages, staff in several studies found they preferred the electronic system to paper and pencil. After implementation of a data capture system in rural northern Malawi, staff preferred the electronic system due to a general desire to move "with the times", flexibility of certain electronic features like skip patterns in surveys, and the reduction of cumbersome papers (McLean et al., 2017). A number of authors observed that EMR implementation does not, by itself, improve efficiency or effectiveness of care, but that it uncovers dysfunctional processes or poor workflow. Determining the appropriate transition of workflow towards electronic data collection is an essential aspect for implementation and also requires the engagement of staff and local leadership (Fraser & Blaya, 2010; Jawhari et al., 2016). Cultivating project champions and ensuring that the data is owned and actually used by the organization collecting data is important

for long-term success. Ensuring that local users have the tools to access and analyze the data encourages the involvement of local staff and leadership (Fraser & Blaya, 2010).

The electronic product itself can be a limiting or facilitating factor. Bugs, missing features, lack of customizability, poor performance can reduce the efficacy of these electronic systems in low resource settings. The cost of products is also important for resource-poor settings and open sourced or free software may be facilitators for the success of eHealth systems. Training local developers and IT personnel can help to reduce dependence on outside software and development support (Fraser & Blaya, 2010; Jawhari et al., 2016).

Effectiveness of eHealth Systems in Low-Resource Settings

Evaluations of eHealth systems require significant resources and can be challenging, especially in low-resource settings. As with most public health interventions, implementation should have evaluations built into the process, however, some benefits of electronic systems may be difficult to quantify. Most studies evaluating eHealth interventions in low resource settings have been focused on implementation rather than patient outcomes. Large scale, rigorous studies are needed to determine if eHealth systems can improve outcomes in these settings. Several studies have demonstrated the ability of electronic systems to improve the quality of data collection. An evaluation of an EDC in Ethiopia found that 30% of the EDC tool questionnaires compared to almost 42 % of the paper and pen data capture had one or more types of data quality errors (Zeleke et al., 2019). Similarly, a comparison of mobile electronic devices and paper-based tools in the Rufiji Household and Demographic Survey in Tanzania detected a significant difference in errors for paper versus electronic collection (17% of paper records, but only 2% for electronic records) (Mukasa et al., 2017). Another study using personal digital assistants for data collection in a study in rural Kenya had similar findings (Onono et al., 2011). Studies involving

laboratory management systems and pharmacy information systems have also reported a similar reduction in errors after implementation (Blaya et al., 2010). Though there is evidence to suggest that eHealth systems improve the quality of data collected, there is still limited information regarding the effect these systems have on patient outcomes. Additional rigorous trials are needed to understand how these systems will impact care in low resource settings.

eHealth in Tanzania

In 2013, Tanzania published an eHealth strategy and defined their mission "to support the transformation of the Tanzanian healthcare system by leveraging ICT to improve the health and social welfare of all citizens." Additionally, they outlined several strategic goals to give direction for the eHealth mission (Ministry of Health and Social Welfare, 2013). It is unclear what national or regional systems currently exist in Tanzania; however, several smaller eHealth interventions have taken place. One study introduced an eHealth platform in rural areas with the goal of improving maternal health care delivery through improving knowledge and clinical decision-making skills of mid-level providers. Implemented in ten different facilities, the study found that its teleconferencing and mobile teleconsultation platforms were well utilized except in one facility where there was poor connectivity. 57% of users acknowledged they learned something new and were able to utilize it in clinical practice and over half demonstrated competencies in simple-use of the systems after an evaluation (Nyamtema et al., 2017). Another study in Tanzania that utilized PDAs, found several benefits to use including high staff acceptability, cost efficiency, and accuracy of data collection (Thriemer et al., 2012). Most studies reviewed regarding eHealth systems in Tanzania recognize challenges with network stability but found that the eHealth systems had significant benefits regardless (Mitchell, Hedt-Gauthier, Msellemu, Nkaka, & Lesh, 2013; Renggli et al., 2018). More robust and large-scale

information is needed regarding eHealth interventions in the Tanzanian context, though initial evidence is promising for use of eHealth systems.

Fig.2. How to address ten challenges in improvement from "Ten Challenges in Improving Quality in Healthcare: Lessons from the Health Foundation's Programme"(Dixon-Woods et al., 2012)

Design and planning of improvement interventions

Challenge 1: Convince people that there's a problem

Use hard data and to secure emotional engagement by using patient stories and voices.

Challenge 2: If you do it, will it work? Convince people of the solution.

Come prepared with clear facts and figures, have convincing measures of impact and be able to demonstrate the advantages of your solution.

Challenge 3: Data collection and monitoring systems

This always takes much more time and energy than anyone anticipates. It's worth investing heavily in data from the outset. Assess local systems, train people and have quality assurance.

Challenge 4: 'Projectness' and ambitions

Over-ambitious goals and too much talk of 'transformation' can alienate staff if they feel the change is impossible. Instead match goals and ambitions to what is realistically achievable and focus on bringing everyone along with you. Avoid giving the impression that the improvement activity is unlikely to survive the time-span of the project.

Organisational and institutional contexts, professions and leadership

Challenge 5: Organisational context, culture and capacities

Staff may not understand the full demands of improvement when they sign up, and team instability can be very disruptive. Explain requirements to people and then provide ongoing support. Make sure improvement goals are aligned with the wider goals of the organisation, so people don't feel pulled in too many directions.

Challenge 6: Tribalism and lack of staff engagement

Overcoming a perceived lack of ownership and professional or disciplinary boundaries can be very difficult. Clarify who owns the problem and solution, agree roles and responsibilities at the outset, work to common goals and use shared language.

Challenge 7: Leadership

Getting leadership for quality improvement right requires a delicate combination of setting out a vision and sensitivity to the views of others. 'Quieter' leadership, oriented towards inclusion, explanation and gentle persuasion, may be more effective.

Challenge 8: Incentivising participation and 'hard edges'

Relying on the intrinsic motivations of staff for quality improvement can take you a long way, especially if 'carrots' in the form of incentives are provided—but they may not always be enough. It is important to have 'harder edges'—sticks— to encourage change but these must be used judiciously.

Beyond the intervention: sustainability, spread and unintended consequences

Challenge 9: Securing sustainability

Sustainability can be vulnerable when efforts are seen as 'projects' or when they rely on particular individuals.

Challenge 10: Side effects of change

It's not uncommon to successfully target one issue while also causing new problems elsewhere. This can cause people to lose faith in the project. Be vigilant about detecting unwanted consequences and be willing to learn and adapt.

CHAPTER 3: DESIGN & IMPLEMENTATION

Introduction

This special studies project follows the design, implementation, and evaluation of the Obstetric and Neonatal (OBNN) Database Project in the Muhimbili National Hospital (MNH) maternity block with the purposes of improving QI processes, hospital-wide reporting, and capacity for staff-led research. Challenges and successes demonstrated by this project will be used to make recommendations to MNH leaders for future data collection projects. Lessons learned may also benefit similar endeavors in other referral-level facilities in similar settings.

Design

The OBNN Database was conceptualized by Dr. Andrew Mgaya, an Obstetrician-Gynecologist Specialist at MNH and was intended to provide a platform for continuous, real-time, and high-quality data collection in the maternity block at MNH. The project was intended to involve staff nurse-midwives in all aspects of data collection, as well as to promote ownership of the project by involving them in every step of project development and implementation. The project was specifically designed for the following purposes: A) provide a way to monitor and evaluate quality of care and quality improvement projects in the MNH maternity block, B) reduce the amount of hard-copy documentation by staff and make mandatory reporting to the Ministry of Health easier, and C) present opportunities for research projects conducted by nurses, midwives, and doctors. The OBNN Database was designed for internal, hospital use; therefore, all data collection will be available for use by care providers on the maternity wards, individually, or in collaboration.

Setting

Muhimbili National Hospital (MNH) is a highly respected referral-level institution. Located in Dar es Salaam, MNH has a 1,500-bed capacity that attends between 1,000 to 2,000 outpatients and roughly 1,000 to 1,200 inpatients each week. With 25 departments and over 106 units, Muhimbili is an expansive organization offering a wide range of medical services to the citizens of Tanzania. In 2014, over 8,000 deliveries occurred at MNH and the maternal mortality rate was 313 deaths per 100,000 live births. The MNH maternity block consists of 120 patient beds that are staffed by obstetricians, residents, registrars, interns, and nurse-midwives. 10 distinct wards include labour and delivery services, obstetric operating rooms, a maternal ICU, antenatal, neonatal, and postnatal wards. Women generally move between all wards within the maternity block and the patient flow is determined by a complex set of variables including to what physician service the woman was assigned, how she is paying for care, what conditions she may have, and from where she was admitted. Several reviews and audits performed by providers within the maternity block at MNH suggest there is need for improving the quality of care provided to patients (Elsa Georgsson, 2018; Litorp et al., 2015; Mgaya, 2017; Mgaya et al., 2016).

Development

In coordination with the Research, Consultancy, and Training Unit at MNH, REDCap was selected as the platform for database creation. REDCap is a secure, web application for creating and maintaining online surveys or databases. Designed to collect virtually any kind of data, its HIPAA-compliant environment and large network of collaborators and institutional partners made REDCap an easy choice for use at MNH. All data collected is contained on

MNH's REDCap server and is owned and managed by the hospital itself. Ownership of data was an important consideration for leaders at MNH.

The OBNN database questionnaire was developed by a team of physicians, midwives, nurses, and IT staff at Emory University and MNH. It was created to replace hardcopy documentation of hospital required maternal and neonatal health indicators collected after delivery. Additionally, it was designed to capture all Ministry of Health required variables for reporting.

In 2018, iPad tablets were purchased for use in all 10 units in order to maximize accessibility and usability of the database. Tablets with SIM-card capabilities were specifically chosen in order to mitigate any issues with lack of network. Written agreements were signed by each ward's In-charge to ensure safety of the equipment. A plan for storage and maintenance of the devices was developed with the wards' In-charges.

Implementation

Implementation was conducted in several distinct phases. First training was conducted with key leaders in maternity block staff. A pre-test of database variables was conducted with several staff leaders and subsequently a one-month pilot test of the database occurred in July 2019. The maternity block staff transitioned from hard-copy data collection to complete database use in September 2019.

Training

Maternity block staff were trained in 4 sessions of 5-10 staff members. Each training session lasted 1.5 hours and consisted of an explanation of the OBNN Database, an overview of REDCap, demonstration of how to use the tablets, and demonstration of data entry. Ongoing

training occurred on an individual basis on an as-needed basis within the wards. Staff errors were addressed in real-time and changes were made to the database to help facilitate quality data collection.

Pre-Test

Database variables were tested against patient data and input from staff was addressed. Several changes were made to the database to increase efficiency and improve the quality of data collected. Examples of changes included:

- Adding risk factors not included (i.e. preeclampsia)
- Creating a clear maternal and neonatal disposition
- Adding frequently used antibiotics
- Changing layout of cesarean section question to better fit the current flow of documentation
- Adding several questions regarding family planning, maternal disabilities
- Updating branching logic
- Updating database aesthetics including spelling, grammar, and capitalization

Reiteration of training was important in order for staff to successfully enter data. Help and troubleshooting use of the tablet, password entry, and data collection was important for staff in the first two to three months of the project. Many staff members needed several sessions of reinforcement before they became comfortable entering data individually. It was unclear what role the language barrier played versus unfamiliarity with the technology. Facilitators to the pre-test were engaged staff members who were able to share their knowledge with others in the wards. One of the major barriers discovered during the project pre-test concerned reliable and convenient internet connection. Though MNH has a hospital-wide network that receives strong

and reliable signal in the Maternity Block, this network is inaccessible to hospital projects not directly tied to their current EMR system due to policy and network constraints. Though project staff considered working with the off-line version of REDCap, there was concern about consistently uploading data, merging the data successfully, and staying true to the project's initial goal of providing access to "real-time" data. Therefore, the tablets were equipped with Vodacom SIM cards. Unfortunately, due to the nature of the tablet software, it was impossible to add data directly to the tablet using the tablet itself. Data needed to be added through the Vodacom App or through another device; however, reloading 10 tablets every month is a substantial time commitment for staff members. Data is unable to be added for a longer period due to VodaCom restrictions. A reliable way to consistently add data to the tablets was determined by local staff and data was subsequently added every week to the tablets.

Pilot-test

Starting on July 1st, a one-month pilot was carried out with 100% data collection ensured by project staff. During this period roughly 65% of all data (572 deliveries in July) was recorded by staff with significant motivation required to ensure data collection. The sheer volume of deliveries occurring daily made it difficult to keep up with data cleaning in real-time for auxiliary staff, therefore it became clear that data must be entered in accurately, in real-time, for the project to be successful. Motivating staff to enter data into the tablet proved to be the biggest challenge. One of the simplest solutions, was to remove the manual entry book and solely offer the tablets as a mode of data entry. Barriers to this solution included the number of people that routinely accessed this book, staff comfortability with electronic data collection, pushback from staff/leadership, unfamiliarity with new processes and a lack of leadership providing a clear

directive for change. During the pilot, there were several areas identified as potential subjects for future training for data entry which included:

- Gravida/Para/Living: Staff had difficultly entering these variables accurately and would oftentimes report G/P/L as 1/1/1-possible explanations could be the wording of the variable, the location of the question in the sequence of questions, typos, or a misunderstanding of the concept of gravida/para/living.
- Antibiotics: Staff was reporting pre-operative antibiotics under the antibiotics section that concerned patients who received antibiotics on arrival in the Labour Ward
- Birthweight: Staff often recorded in kilograms instead of grams which caused problems filling the rest of the form
- Missed Variables: Variables were sometimes missed, and the warning RedCap gives about missed variables was ignored
- Missed Forms: Only one form would be filled out, and staff failed to proceed to the other forms
- Password entry: Staff frequently had issues entering the REDCap password correctly due to the requirement for both upper and lower case letters. Once the incorrect password was entered too many times, the REDCap account was locked and had to be reset by REDCap administrators

Project Launch

After the one-month trial period, strengths and weaknesses were assessed by all stakeholders and solutions to major barriers were formed in order to officially launch the project. A project launch date was set for September 1st. Previously identified project champions problem-solved on the ground from September 1st-September 3rd and by September 4th, the

manual entry maternity book had been removed and data entry was taking place solely electronically.

Barriers

Understaffing*:* Understaffing is a chronic issue. With high patient volume, staff burnout and perceptions of workload are high. Introducing a new project into this environment can lead to staff apathy and non-interest in the project.

Lack of clearly defined MNH Leadership: While a clear leadership structure exists within Muhimbili, it is unclear where real-time decisions are made and how hospital leadership work together to instigate change. Obtaining the support of high-level leaders who were willing to be closely involved in the project was challenging due to time constraints, their workload, and aversion to change. Possible reasons for aversion to change amongst leaders is fear of failure or shame of sponsoring a failing project. A presentation regarding REDCap given to the Board of Directors was an important step in getting all leaders on board with the project. After the end of two months of trial periods, leadership agreed to move forward with finalizing the project and removing the maternity book for total electronic data collection.

Delivery Number: Every woman who delivers at MNH is assigned a delivery number in the maternity book which is housed in the Labour ward. This number is used for reporting to the Ministry of Health as well as for official birth certificate documentation. This number is used if the woman loses the birth certificate or needs other official documentation about her child from the hospital; she can give her delivery number and date of birth for access to these records. The delivery number starts at zero (0001) at midnight on January 1st and continues for the year until it is reset the following January. This number is a central part of reporting and recording a birth and there were initially issues about how best to record this number in REDCap.

Technology Considerations: Comfortability with technology varies greatly amongst staff and continued to be a challenge for the project. Many of the staff were not familiar with Apple iPads and struggled with basic tasks such as finding the right app and turning on the devices. Continued training was successful in increasing the comfortability with the devices. A major issue was the ability of staff to input the correct REDCap password which requires both upper and lower case letters as well as numbers. Staff often struggled to capitalize letters and after several incorrect password attempts, were locked out of the system. This presented a significant issue because a REDCap administrator must reset a password, which takes time due to several required, distinct steps. This issue improved with time, practice, and implementation of a clear protocol if an account was locked.

High Volume: One of the largest challenges was the high volume of patients in the maternity block. In July 2019, over 500 deliveries occurred at Muhimbili. Data cleaning and quality is a large task that would require weekly if not daily attention. Staff would need to take time to review data and assess it for completeness and accuracy.

Internet Access: Though MNH has a hospital wide WIFI network that has reliable connection in the maternity block. There were bureaucratic as well as technical hurdles to connect iPads permanently to this network. It was unclear exactly what these issues included. Instead, the iPads were equipped with SIM cards that were loaded with internet bundles through Vodacom. Each SIM card will be loaded weekly to prevent any outages in network connectivity.

Staff Motivation: Staff motivation and interest in the project is variable and is tied closely with their perceptions of research projects and quality improvement. Staff are accustomed to research conducted without much internal collaboration. Communicating that the project is long-term and the data is owned by MNH was difficult and needed to be reiterated. Additionally, many staff are

used to being paid for what they perceive as additional work such as collecting data for a research project. By the end of the pilot, staff had a better understanding of what the project's aims and objectives were.

Facilitators

Project Champions: Several staff in the Labour ward took a unique interest in the project and were instrumental in garnering support, helping to train staff, and increasing motivation. They provided new ideas and a deeper understanding of how the project could be changed and adapted to fit the needs of the staff.

Staff Interest in Learning New Skills: Many of the staff became excited about opportunities for personal development. These interests included desire to learn new technologies, conduct their own research, gain analytical skills, and establish their own programs. This project was a way for them to gain additional experience.

Need for Improved Reporting: All of the staff recognized a need for improved reporting processes which was a facilitator of this project. Much of their documentation is repetitive and time consuming. They were interested in ways to improve efficiency and accuracy of their reporting on a daily, weekly, and monthly basis. Data visualization and ease of access to data for analytical purposes were appealing to staff leadership as well.

CHAPTER 4: EVALUATION

In-Depth Interviews

Introduction

A qualitative evaluation was conducted in January 2020 amongst staff in the maternity block at MNH, roughly six months after full implementation of the OBNN database. In-depth interviews were used to explore perceptions and experiences of quality improvement processes in the maternity blocks at MNH among different types of providers including implementation of the Obstetric and Neonatal (OBNN) Database project, as well as to identify and describe perceived challenges and opportunities for implementation of subsequent quality improvement interventions in maternal and newborn services. An interview guide was developed collaboratively with local stakeholders and the database project team. This guide was designed to elicit critical feedback on electronic database systems at MNH. The Emory University Institutional Review Board determined this study was exempt from review.

Methods

Open-ended, semi-structured interviews were conducted in English with eighteen providers in the maternity block including nurses, midwives, residents, registrars, and specialists. Purposive sampling was used to identify staff. Interviews took place in the OBNN Database Office within the maternity block during regular working hours at the convenience of the providers or in individual staff offices. Interviews lasted 30 minutes to an hour and all interviews were audio-recorded with verbal informed consent, except one with a specialist who did not permit audio recording. In that case, detailed notes were taken during the interview.

A list of deductive codes was created based on previous observed barriers and facilitators for quality improvement at MNH. Inductive codes were developed using an initial set of 5 transcripts from concepts and observations emerging from the data. Codes were used to systematically identify text from the interviews. Text was organized and compared using MAXQDA software and major concepts were identified. Attention was paid to differences between types of providers and the experience level of staff.

Results

Eighteen providers in the maternity block were interviewed, of which five were men and thirteen women. Their average work experience at MNH was 13.2 years. Nine interview participants held leadership positions within the maternity block. The other participants were specialists, registrars, or nurse-midwives. Several informative challenges and benefits emerged from the data and are summarized below. Challenges focused around the lack of reliable access to network connection while successes ranged from protection of data to improved workflow.

Challenges

Providers experienced several key challenges, the greatest of which was access to network connectivity for online data collection. Slow network, or more often, complete lack of connection to network causes major disruption to staff workflow. Without internet connectivity, participants stated that they were unable to obtain a delivery number for patients and that records for patients would pile up. Once network connectivity returned, several records had to be entered at one time which created a burden on staff.

> "That's a very big challenge because you can have a queue of patients...particularly in the Labour Ward. You have a delivery, maybe four deliveries, and they want to take this patient to other wards. So, you need to fill each patient and you miss, there is, some

> of...there is network problem, so you cannot proceed because the data is not there...you cannot get a delivery number because until you fill to the end is when the delivery number is out for that patient…"

Participants also mentioned that a lack of network connectivity prevented them from doing timely reporting within the wards for their "bed state" report which facilitates shift change. Network connectivity also caused a missing data problem for nurses in the post-natal wards, as when they went to enter data on a patient, that patient's ID was missing from the system. Network connectivity issues at times when patient volume is high was indicted as being more detrimental to their workflow. One participant indicated that network reliability would be the one issue most detrimental to online database collection systems at MNH.

Another often expressed concern was regarding the sustainability of repair and maintenance on the tablets. Concerns included potential problems with updating software or repairing broken or damaged equipment. Technological skills were perceived as a barrier to achieving successful data collection, as well. Many participants indicated that staff were slow to learn technological skills and were unfamiliar with certain features of REDCap which prevented smooth workflow. However, most participants suggested this issue was mitigated by the increased use of personal electronic devices such as cell phones and laptops. Other suggestions for mitigation of this issue included more hands-on training for staff and introduction to these types of electronic systems during their training in nursing or medical school. Two participants mentioned that there was an expectation to use personal devices like computers or cell phones for use during the workday if other equipment was not available, which they indicated was not possible for all staff.

> "I think they [electronic systems] could be successful if, and only if, we start ... below ..... down there maybe from the nursing school, from the medical school using, um,

> computers, datas, you know so that your slow to introduce a newer thing in the, in the career, it's put in in your curriculum"

"System breakdown" also impacted the use of the database by staff. Failure of one ward to enter data impacted the ability of staff to enter data in other areas in maternity services. This "system breakdown" in data collection caused missing data that impacted their abilities to run reports and produce accurate data for use within their wards. Most participants indicated this was an issue with training and could be resolved over time but were frustrated that missing data in one area of the form could impact their ability to input data in form due to branching logic.

> "For example, when we discharge babies in my unit, so when I enter data after discharge, you can see some files from post-natal wards are not entered in data base. So, when the post-natal nurse didn't enter the data I won't succeed."

When problems with the database arose, participants were overall pleased with the support they received from the persons designated to assist with the REDCap database, though they expressed concern that there was not continual support for issues during the evening, night, or weekend shifts which caused delays in issue resolution. Issues can go unresolved for an entire shift which greatly impacts data collection. Participants who expressed frustrations or experienced challenges with the database generally felt that the issues described could be alleviated and often provided suggestions for solutions. The outlier was the issue of network connectivity, to which participants were much more negatively impacted and were unable to provide any further suggestions for improvement.

Benefits

Benefits of the use of the OBNN Database generally outweighed the challenges. The database was perceived positively by almost all staff who described several improvements in data collection and workflow. Many participants indicated that the database reduced their daily

workload. Utilizing tablets in each ward helped to reduce the need for staff to walk back and forth between wards to document information in certain manual-entry books. Staff also felt that they spent less time inputting data and preparing the manual entry books (drawing the grid for variables, etc.). Staff, especially physicians, indicated that they would like to introduce more electronic systems like tablets to reduce the need to move back and forth between patients and workstations, therefore maximizing their time conducting patient care and minimizing their time spent documenting. Additionally, participants indicated that having a set data form for data entry provided structure to their reporting without having to free-hand information within the manual-entry books.

> "…it helps us doing our job because later in the years back with just no database, we just skip the delivery, we go int the labour ward, maybe we're just writing, writing, writing, sometimes we forget it. But now, here it is, another delivery, just put the file in here…"

Set data entry forms also improved data quality and that improvement was generally seen as a benefit to the OBNN database. Staff mentioned that the system alerted them when a variable had been missed, enabling them to return and properly input it. They felt that the system helped to ensure that all information was being recorded in contrast to the manual-entry books, where certain variables were often intentionally skipped or unintentionally overlooked.

> "I think the benefit is the .... things are done there and then you don't need someone to use the counter book and I haven't used the database there but I am sure they are put in such a way that you don't miss any of that data. You have to fill a to get into b so ... that is not waste. When they use hardcopies it's just up to somebody's discretion can leave the whole column not filled at all, but I'm sure of the computers. They're normally having conditions whereby if you haven't filled a, b, c, d you can't get to b…"

Some staff mentioned feelings of "being updated" and felt that real-time data collection was helpful for staff collaboration across different wards. Participants in the quality improvement office mentioned that real-time data collection was much more helpful for making

changes within the wards and provided better and faster access to data for hospital staff and researchers. Many participants who were leaders within the ward suggested that the database was helpful for their hospital and ministry required reporting on a weekly and monthly basis. The electronic database was also viewed by many participants as a safer alternative to recording data on paper. Participants indicated that they had more control over who saw and accessed their data, as the tablets were protected by passwords and the database itself allowed control over project users. Data protection was important to staff and they appreciated the greater control over their patient data than the manual-entry books provided.

Data for Decision-Making

Introduction

The Obstetric and Neonatal Database at MNH has the potential to provide local and facility-based information to guide decision-making for clinicians and administrators. REDCap's easily navigable system provides a platform in which authorized users can easily download information for evaluation and analysis. There has been documented success in Tanzania for improving data-driven decision making through data-use workshops and several studies have successfully used paper-based obstetric records at MNH to report findings (Braa, Heywood, & Sahay, 2012; Kamala et al., 2018; Kidanto et al., 2006; Muganyizi & Kidanto, 2009; Pembe et al., 2014). However, the arduous task of extracting data from paper-based data and the high number of incomplete records (over 20% reported by one study) makes using this data for decision-making difficult (Kamala et al., 2018). Hospital administrators are hopeful that the implementation of the OBNN database will provide impetus to improve real-time, quality data-driven decision-making at MNH. In order to better understand the usability of the data collected, several analyses were performed with the pilot data collection in July 2019. Included below is a

short descriptive analysis of maternal demographics, mode of delivery, and indication for cesarean section. Results were provided to key hospital leaders.

Methods

Data collected during the pilot from July 1st, 2019 to July 31st, 2019 at MNH were analyzed to provide an initial demonstration regarding the potential utilization of data for decision making. This was a retrospective analysis of 909 deliveries. All deliveries conducted at MNH during this time frame were available for review. Records that were incomplete were excluded from analysis. SAS 9.4 was used to perform all analysis. Continuous variables were expressed as the mean +/- SD or the median, as appropriate. Categorical data were expressed as frequencies.

Results

Records for 909 deliveries were complete and were included in analysis. Cesarean section (CS) delivery was performed in 53.19% (483) of all deliveries. 46.81% of women were referred to MNH by an outside facility, while 53.19% of women were self-referrals. The majority of women resided in urban areas (92.30%). The average age of women delivering was 29.48 years. 96.04% of women were currently married. One or more risk factors were present in 66.12% of deliveries, while 33.44% of deliveries had no identified risk factors. The top three indications for CS were previous CS (42.89%), preeclampsia (9.0%) and other (7.74%).

Table 1. Maternal Characteristics, by Mode of Delivery: Muhimbili National Hospital, Dar es Salaam, Tanzania, July 2019

		Vaginal (n= 425) 46.81%	Cesarean (n= 483) 53.19%	All Deliveries (n=909)
Age (years)		μ=29.21 SD=5.69	μ=29.72 SD=5.53	μ=29.48 SD=5.6
Antenatal Care History		μ=5.04 SD=2.12	μ=5.14 SD=1.70	μ=5.09 SD=1.91
Marital Status	Married	405 (44.55)	468 (51.49)	873 (96.04)
	Single	21 (2.31)	15 (1.65)	36 (3.96)
Education	< Secondary Level	139 (15.31)	161 (17.73)	300 (33.04)
	> Secondary Level	286 (31.59)	322 (35.46)	608 (66.96)
Residence	Urban	406 (44.66)	433 (47.63)	839 (92.30)
	Rural	20 (2.20)	50 (5.50)	70 (7.70)
Payment Category	Private	143 (15.75)	205 (22.58)	348 (38.33)
	Cost-Sharing	282 (31.06)	278 (30.62)	560 (61.67)
Referral Status	Referred	172 (18.94)	253 (27.86)	425 (46.81)
	Non-Referred	253 (27.86)	230 (25.33)	483 (53.19)
Presence of Risk Factors	No	212 (23.32)	96 (10.56)	308 (33.88)
	Yes	214 (23.54)	387 (42.57)	601 (66.12)
HIV Status	Positive	23 (2.53)	25 (2.75)	48 (5.28)
	Negative	403 (44.33)	458 (50.39)	861 (94.72)

Table 2. Indications for Cesarean Section: Muhimbili National Hospital, Dar es Salaam, Tanzania, July 2019

	N	%
Previous CS	205	42.89
Preeclampsia	43	9.00
Other	37	7.74
Obstructed Labour	33	6.90
BOH	18	3.77
Fetal Distress	16	3.35
Unknown	14	2.93
Big Baby	12	2.51
Oligohydramnios	12	2.51
Eclampsia	11	2.30
Malpresentation	9	1.88
PROM	9	1.88
Poor Progress	9	1.88
Breech	8	1.67
Failed Induction	8	1.67
APH	6	1.26
Cord Prolapse	6	1.26
Abruptio Placenta	5	1.05
HTN	5	1.05
Reduced Movement	4	0.84
Trial of Scar	4	0.84
Retained Twin	2	0.42
Diabetes	1	0.21

CHAPTER 5: DISCUSSION

Introduction

Health Information Systems (HIS) can produce large amounts of data over an extended period of time. HIS are known to be important tools for measuring and improving health services, however, the literature suggests that this data is rarely used locally in health decision-making (Abajebel, Jira, & Beyene, 2011; Avan, Berhanu, Umar, Wickremasinghe, & Schellenberg, 2016; Wickremasinghe, Hashmi, Schellenberg, & Avan, 2016). Continuous collection and utilization of data at the health facility or district level is essential for improving health outcomes, though capacity-building surrounding this core need is often neglected. Where capacity exists, it is often concentrated at the national level. There has been some effort to decentralize HIS, however, complex private and public funding is challenging, and donors often implement their own data collection strategies and fail to involve or consider local partners. This leads to fragmented data collection systems, that again, are unable to be used locally to improve operational and clinical decision making (AbouZahr, 2005; Bhattacharyya et al., 2016; Chitama et al., 2011; Kimaro & Sahay, 2007). While there have been several initiatives to improve collaboration for national level decisions-making, there is limited evidence for improving local data systems in low-resource settings for decision making. Ultimately, the need for data in health decision-making is well known and substantial work has been done to improve access and availability of data. Less work has been conducted on how this data is actually used in the local context (Mutale et al., 2013; Mutemwa, 2005; Nutley, McNabb, & Salentine, 2013).

The Obstetric and Neonatal Database (OBNN) has the potential to provide real-time, high-quality data for local decision-making at Muhimbili National Hospital (MNH). This project, under the umbrella initiative, EMPHASIS, oversaw the design, implementation, and evaluation

of a database intended for decision-making surrounding quality improvement as well as for research purposes at a referral-level hospital in Dar es Salaam, Tanzania. Important to the project's mission was to collaboratively build sustainable infrastructure for quality improvement and research. As local collaborators and Emory partners identified a gap in information, the maternity block was selected as a test case for implementation of an HIS designed to facilitate planning, management, and decision-making at MNH.

Project Evaluation

Staff generally expressed enthusiasm at using an advanced electronic tool in their daily work and overall users reported significant advantages to using the OBNN database over paper records including increased efficiency and improved quality of data collection. Given that use of an electronic system for patient indicators was new for all staff involved, it is not surprising that staff indicated initial discomfort with the REDCap software and expressed concerns about the sustainability of electronic equipment. Issues with the internet connectivity is an unresolved issue and will remain a substantial barrier to new electronic projects at MNH until hospital administrators prioritize improving network capacity. This is a documented problem with implementation of electronic health systems in low resource contexts. Emphasis should be placed on improving network accessibility in health settings in order to support sustainable locally based data collection projects.

Project Data

Staff perceived that data collected with the OBNN database was of higher quality than paper records. While an audit of paper records was not conduced, the data quality rules implemented in the OBNN database ensured accurate and complete data collection. This project

adds to previous literature suggesting that electronically collected data may be of higher quality than paper-based data. The findings of the short descriptive analysis were similar to findings published in the literature from previous studies conducted at MNH. The high rate of CS (53.19%) and the prevalence of risk factors (66.12%) already point to potential areas for quality improvement or staff-led research. Additionally, the data provides important real-time data regarding patient demographics, including information about referral facilities and catchment areas. The ability to extract data in real-time for analysis and evaluation at MNH is promising for data-driven decision-making. This analysis helps to underscore the ability of staff at MNH to conduct their own simple analyses to help improve clinical and administrative decision-making at MNH.

Project Sustainability

Collaboration and project ownership were critical goals of this project. Conception and design of the OBNN database included hospital administrators, obstetrician-gynecologists, nursing leaders, and nursing staff. The OBNN database had inputs from several different key groups of individuals to ensure the data would be useful and applicable to the local context. During implementation, an on-the-ground support person was available for three months to answer questions and facilitate training of staff members in real-time. The project team felt that this was time well spent and was critical to the lasting success of the database. Repeated instruction and assistance with integration into staff's existing workflow was essential to ensure uptake of the database. Project ownership was developed with repetition of training and reiteration of project goals and benefits. The identification of project champions was also critical for project sustainability in this context. Project champions assisted with trouble shooting, database development, and collaboration with hospital leadership. The project champions

themselves crafted new roles and leadership opportunities for themselves, indicating that electronic data systems have the potential to increase opportunities for staff engagement.

Limitations

The most impactful limitation to this project was limited access to reliable network connectivity. Ultimately, the project had to pay for iPads that were SIM-card enabled and had to upload new data every week to each tablet, at a substantial cost. This threatens the stability and sustainability of the project and other projects like it at MNH. Investments into network capacity for use by hospital staff and hospital projects must be a priority for MNH in the coming years. Other limitations included unclear procedures for approving and implementing projects at MNH. A lack of clear leadership within the Maternity ward led to a delay in official approval for the project and created barriers to implementation. Increased openness and involvement of MNH leadership is integral for expanding and improving upon projects undertaken by staff. This project could have benefited from a quantitative evaluation of data quality, however, a lack of time and resources prevented this from occurring. Continuous review of data quality by local staff will therefore be important.

Strengths

Strengths of this project were focused on collaborative and sustained engagement by local collaborators and Emory partners. Extensive input on database design led to increased acceptability for uptake. Ample and concentrated hands-on real-time training also ensured project uptake and sustainability with staff. Staff were able to ask questions and practice with the equipment with assistance close at hand which encouraged confidence in using the electronic data collection system. Project champions were also identified earlier and were engaged with the

project throughout. Time was spent conducting additional training with project champions to build skills and ensure technical problems could be answered in the local context.

Recommendations

The use of REDCap was a decision made by local collaborators and Emory partners to ensure sustainability due to its capabilities as a user-friendly, free, browser-based platform. The successful implementation of the OBNN database has already inspired the creation and development of additional REDCap databases at MNH including a renal registry. Important take-aways from this project include the importance of supporting and investing in building capacity for network connectivity for future projects, allowing lengthy time for staff training and staff uptake, identification of project champions within each department, and close collaboration with hospital leadership. Future projects at MNH, and potentially in other similar low resource contexts, should keep these aspects in mind.

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APPENDIX

Qualitative Interview Guide

Provider Perceptions of Quality Improvement for Maternal and Newborn Care at Muhimbili National Hospital (MNH) in Dar es Salaam, Tanzania

Purpose of the Project:
To identify and describe perceived challenges and opportunities for implementing quality improvement interventions among providers of maternal and newborn health services at MNH (nurses, midwives, doctors).

Date: _____

Start Time: _____

End Time: _____

Introduction:

Karibu. Jina langu ni Meron. I am a Master's Student at Emory University in Atlanta, Georgia. I am here at Muhimbili to help support implementation of the Perinatal Database and quality improvement in the maternity wards. This database is a tool for all of the regular care providers on these wards to use, including nurses, midwives, and doctors. Specifically, it was developed for the following purposes: A) provide a way to monitor and evaluate quality of care and quality improvement projects, B) reduce the amount of hard-copy documentation and make mandatory reporting easier, and C) present opportunities for research projects conducted by nurses, midwives, and doctors. All data collected will be available for use by care providers on the maternity wards, individually or in collaboration. The purpose of this interview is to understand how you feel about the Perinatal Database and also about change processes for quality improvement more generally on the Maternity Blocks at MNH.

Your participation in this interview is completely voluntary and you will not be paid. You can choose to not answer questions or stop the questions at any time. Your responses will be anonymous, no one will know what you said to me. Your name, specific administrative title (beyond nurse, midwife, doctor), and other personal information will not be recorded. All data (audio-recordings, written notes, and transcripts) will be destroyed once the analysis is complete and the reports have been made.

- Are you willing to participate in this interview? *[Wait for consent]*

For me to remember exactly what you said, I would like to record this interview on my phone.

- Is it ok for me to record the interview with my phone? *[Wait for consent]*

INTERVIEW GUIDE

Warm Up Questions

1. Within your role as a [NURSE, MIDWIFE, DOCTOR], what are your main responsibilities here at the hospital?
    - How long have you worked here?
2. What are some things that you really enjoy about your work?
3. What are some things that are challenging about your work?

Perceptions of Quality Improvement

1. What does quality improvement mean to you?
2. What are the most important things you do in your job?
3. When you think there is a problem at work that might affect patient care or well-being, what do you do to fix it?
    - Are there any formal processes in place for handling these kinds of problems? If so, please describe…
    - How effective are these actions or processes?
    - Are there any challenges or barriers to dealing with problems?
4. What would help you do your job even better?
    - Human resources – leadership/unit organization, supportive supervision, training and mentorship, intraprofessional communication, workload changes
    - Material resources – infrastructure, medical supplies/equipment

Perceptions of QI and Research Implementation

1. What do you think about conducting your own quality improvement or research project at MNH in the future?
2. How do you think these projects can improve patient care?
3. What benefits do you think these projects might have for you personally?

Perinatal Database:

1. Can you describe the purpose of the Perinatal Database?
    - What is the purpose of documenting information in the mtua?
2. What was your experience with training for the Perinatal Database tool?
3. Is there anything about this tool that you're unsure of (*if so, what*)? Do you foresee any problems in implementing it?
4. What do you like about the Database? How do you think it might be of use to you?

Is there anything else you'd like to say about any of these topics?

ASANTE SANA! THANK YOU SO MUCH FOR YOUR TIME AND INTEREST!

Data Entry Forms

Maternal Background And Obstetric Data

Patient Registration Number	_____
Date of Data Collection	_____
Delivery Number	_____
Patient Name	_____ (First Middle Surname)
Residency	◯ Ilala ◯ Kigamboni ◯ Kinondoni ◯ Temeke ◯ Ubungo ◯ Bagamoyo ◯ Kisarawe ◯ Kibaha ◯ Kibiti ◯ Rufiji ◯ Morogoro ◯ Lindi ◯ Mtwara ◯ Others ◯ Not Recorded (Other=outside MNH Catchment areas)
Age	_____
Weight	_____ (Kg)
Height	◯ Above 150cm ◯ Below 150cm
Marital status	◯ Single ◯ Married ◯ Cohabiting ◯ Divorced
Level of Education	◯ No formal education ◯ Primary School ◯ Secondary School ◯ College or University
Maternal Disability	◯ Yes ◯ No

Disability Type

- ☐ Mental Illness
- ☐ Physcial Disability
- ☐ Blind
- ☐ Deaf
- ☐ Speech Impairment
- ☐ Albinism
- ☐ Skin Disability
- ☐ Hydrocephalus
- ☐ Spinal Bifida
- ☐ Spinal Injury
- ☐ Intellectual Disability
- ☐ Other

Antenatal Care Visits Attended

_____

Risk Factors/Complications

- ☐ Normal
- ☐ Aneamia
- ☐ Known Hypertension
- ☐ Pregnancy Induced Hypertension
- ☐ Multiple pregnancy
- ☐ APH
- ☐ Malpresentation
- ☐ Cardiac Diseases
- ☐ Diabetes
- ☐ Malaria
- ☐ Previous PPH
- ☐ PROM
- ☐ Previous CS
- ☐ Prolonged Infertility
- ☐ Reccurent Abortion
- ☐ Sickle Cell Disease
- ☐ Epilepsy
- ☐ HIV-positive
- ☐ Rh Negative
- ☐ Preeclampsia
- ☐ Others
- ☐ Unknown/Not Recorded
- ☐ preterm

(Choose all that apply)

APH

- ◯ Abruptio placenta
- ◯ Placenta praevia
- ◯ ruptured uterus
- ◯ vesa- praevia

Last Haemoglobin level (Hb)

_____

(gm/dl)

Number of Pregnancies (gravida)

_____

(Number should include the index pregnancy)

Number of Pregnancies that Reached 28 Weeks (parity)

_____

Number of Living Children

_____

Number of Previous Abortions	_____ (Previous pregnancies losses < 28 weeks)
Number of Previous Stillbirths	_____
Number of Previous Newborn Deaths	_____ (Include all neonatal deaths up to 28 days of life)
Gestation Age	_____ (in weeks)
Source of Admission	◯ Home ◯ Aga Khan Hospital ◯ Antenatal ward ◯ Amana hospital ◯ Bagamoyo District Hospital ◯ Buguruini Health centre ◯ Hindu Mandal Hospital ◯ Ibrahim Haji Hospital ◯ Kisarawe Distric Hospital ◯ Lugalo Military hospital ◯ Massana Hospital ◯ Mbweni Health Centre ◯ Mnazi Mmoja Health Centre ◯ Mwananyamala Hospital ◯ Rabininsia Hospital ◯ Sinza Health Centre ◯ Temeke Hospital ◯ TMJ Hospital ◯ Tumbi District Hospital ◯ Vijibweni Health Centre ◯ Others ◯ Unknown (Others = health facilities outside the list)
Reason for Admission	☐ Subspecialized care ☐ Care of newborn ☐ Lack of EmOC- Equipment/consumables ☐ Overcrowding ☐ Others/unknown/not documented
Referral Category	◯ Referred ◯ Non Referred ◯ Unknown/Not recorded
Payment Category	◯ Private ◯ Cost sharing ◯ Unknown/Not recorded
Date of Maternal Admission	_____
Time of Maternal Admission	_____

Were the Fetal Heart Beats Present on Admission	◯ Yes ◯ No
Received Dexamethasone Injection	◯ Yes ◯ No
How Many Doses	_____ (at 12mg 12hlry for past 7 days)
Received Antibiotics	◯ Yes ◯ No
What Type of Antibiotics	☐ Amoxyllin 2500mg ☐ Ampillicin /Ampiclox 500mg ☐ Azithromycin250/ 500mg ☐ Ciprofloxacin 500mg ☐ Clarithromycin 300mg ☐ Co amoxy clav/clavam/clavlin 625mg ☐ Ceftriaxone 1 gm ☐ Erythromycin 500mg ☐ Meropenem ☐ Nalidixic acid 500mg ☐ Vancomycin ☐ Metronidazole/Flagyl 500mg (Multiple answers are applicable)
Received Magnisium Sulphate	◯ Yes ◯ No
Reason for Magnesium Sulphate Treatment	☐ Muscle relaxant to prevent /treat Eclampsia ☐ Fetal Neoroprotection ☐ Not mentioned

Process Of Labour And Delivery

Was Labour Induced	◯ Yes ◯ No
What Was the Reason for Inducing Labour	☐ IUFD ☐ Hypertension ☐ Diabetes Mellitus ☐ Post dates/Post maturity ☐ Fetal malformation ☐ PROM ☐ Preeclampsia ☐ Eclampsia ☐ Others ☐ Unknown/Not Recorded (Multiple answer are applicable)
What was the Mode of Induction of Labour	☐ Misoprostol ☐ Dinoprostol ☐ Oxytocin ☐ Cervical Balloning (Multiple answers are applicable)
Was Labour Augmented with Oxytocin	◯ Yes ◯ No ◯ Unknown/Not Recorded
Was the Partogram Used	◯ Yes ◯ No
How Many Newborns Were Delivered	_____
Mode of Delivery 1st	◯ SVD ◯ CS ◯ LCVE ◯ ABD
Mode of Delivery 2nd	◯ SVD ◯ CS ◯ LCVE ◯ ABD
Mode of Delivery 3rd	◯ SVD ◯ CS ◯ LCVE ◯ ABD
Category of CS	◯ Elective CS ◯ Emergency CS ◯ Not recorded

Indication for CS	☐ Fetal Distress ☐ Reduced Fetal Movement ☐ Obstructed Labour/CPD ☐ Previous CS or myomectomy scar ☐ Trial of Scar ☐ Big Baby ☐ Breech at Term ☐ Hypertension in Pregnancy ☐ Poor Progress ☐ Multiple Pregnancy ☐ Malpresentation ☐ Previous VVF repair ☐ Previous MTCT of HIV ☐ Cancer of Cervix ☐ Myopia of the Lower Leg ☐ Diabetes Mellitus ☐ BOH ☐ Failed Induction ☐ Preeclampsia ☐ Eclampsia ☐ Cord Prolapse ☐ APH ☐ Abruptio Placenta ☐ PROM ☐ Failed LCVE ☐ Retained Twin ☐ Oligohydramnios ☐ Other Indications ☐ Not recorded/unknown
Who Decided the CS	◯ Specialist ◯ Resident ◯ Registrar ◯ Unknown/Not Recorded (Desion maker may be documented or consuluted by phone)
Decision of CS at Second Stage	◯ Yes ◯ No
Pre-Operative Antibiotics Given	◯ Yes ◯ No
Which Antibiotics	☐ Amoxyllin 2500mg ☐ Ampillicin /Ampiclox 500mg ☐ Azithromycin250/ 500mg ☐ Ciprofloxacin 500mg ☐ Clarithromycin 300mg ☐ Co amoxy clav/clavam/clavlin 625mg ☐ Ceftriaxone 1 gm ☐ Erythromycin 500mg ☐ Meropenem ☐ Nalidixic acid 500mg ☐ Vancomycin ☐ Metronidazole/Flagyl 500mg
What Time Were the Antibiotics Given	_____

Length of First Stage of Labour	_____ (hours)
Length of Second Stage of Labour	_____ (minutes)
Fetal Heart Monitoring During Second Stage of Labour	◯ Yes ◯ No ◯ Unknown
Date of Delivery 1st	_____
Time of Delivery 1st	_____
Date of Delivery 2nd	_____
Time of Delivery 2nd	_____
Date of Delivery 3rd	_____
Time of Delivery 3rd	_____
Removal of the Placenta	◯ Spontaneously expelled ◯ Controlled cord traction ◯ Manual removal
Active Management of Third Stage of Labour	☐ Uterotonics ☐ Controlled Cord Traction ☐ Uterine massage
Uterotonics Delivered	☐ Oxytocin ☐ Ergometrine ☐ Misoprostol
Estimated Blood Loss	_____ (in mls)
Was There PPH	◯ Yes ◯ No
Medical Management of PPH	☐ Oxyoticin ☐ Ergometrine ☐ Misoprostol ☐ Tranexamic Acid ☐ None (Multiple answers are applicable)

Surgical Management of PPH

- ☐ Intra-uterine baloon tamponade
- ☐ Perineal repair
- ☐ Cervical repair
- ☐ B-Lynch Suture
- ☐ Pelvic packing
- ☐ Abdominal Hysterectomy
- ☐ None

(multiple responses are applicable)

Received Blood Transfusion

- ◯ Yes
- ◯ No

State of the Perineum

- ◯ Intact
- ◯ Bruise/minor laceration
- ◯ Episiotomy
- ◯ 1st degree tear
- ◯ 2nd degree tear
- ◯ 3rd degree tear
- ◯ 4th degree tear
- ◯ Unknown/Not Recorded

	Female	Male	Unrecognizable
Sex 1	◯	◯	◯
Sex 2	◯	◯	◯
Sex 3	◯	◯	◯
Sex 4	◯	◯	◯
Sex 5	◯	◯	◯

Birth Weight 1st

_____

(in gm)

Birth Weight 2nd

_____

(in gm)

Birth Weight 3rd

_____

(in gm)

Newborn Clinical Status 1st

- ◯ Live Birth
- ◯ Stillbirth

Newborn Clinical Status 2nd

- ◯ Live Birth
- ◯ Stillbirth

Newborn Clinical Status 3rd

- ◯ Live Birth
- ◯ Stillbirth

Newborn Clinical Status 4th

- ◯ Live Birth
- ◯ Stillbirth

Newborn Clinical Status 5th

- ◯ Live Birth
- ◯ Stillbirth

	0	1	2	3	4	5	6	7	8	9	10
Apgar Score 1 min 1st	○	○	○	○	○	○	○	○	○	○	○
Apgar Score 1 min 2nd	○	○	○	○	○	○	○	○	○	○	○
Apgar Score 1 min 3rd	○	○	○	○	○	○	○	○	○	○	○
Apgar Score 1 min 4th	○	○	○	○	○	○	○	○	○	○	○
Apgar Score 1 min 5th	○	○	○	○	○	○	○	○	○	○	○

	0	1	2	3	4	5	6	7	8	9	10
Apgar Score 5 min 1st	○	○	○	○	○	○	○	○	○	○	○
Apgar Score 5 min 2nd	○	○	○	○	○	○	○	○	○	○	○
Apgar Score 5 min 3rd	○	○	○	○	○	○	○	○	○	○	○
Apgar score 5 min 4th	○	○	○	○	○	○	○	○	○	○	○
Apgar score 5 min 5th	○	○	○	○	○	○	○	○	○	○	○

	Suction	Stimulation	Ventilation	Nothing Done	No Record
Resuscitation Applied 1st	☐	☐	☐	☐	☐
Resuscitation Applied 2nd	☐	☐	☐	☐	☐
Resuscitation Applied 3rd	☐	☐	☐	☐	☐
Resuscitation Applied 4th	☐	☐	☐	☐	☐
Resuscitation Applied 5th	☐	☐	☐	☐	☐

	Yes	No	Unrecorded
BF Initiation 1st	○	○	○
BF Initiation 2nd	○	○	○
BF Initiation 3rd	○	○	○
BF Initiation 4th	○	○	○
BF Initiation 5th	○	○	○

	Fresh	Macerated	Unrecorded	Early neonatal death
Type of Stillbirth 1	○	○	○	○
Type of Stillbirth 2	○	○	○	○
Type of Stillbirth 3	○	○	○	○

Cause of Stillbirth 1st

- ☐ Maternal Complications
- ☐ Cord Prolapse
- ☐ Cord Around the Neck
- ☐ Cord Knoting
- ☐ Congenital Malformations
- ☐ Prolonged/Obstructed labour
- ☐ Fetal Hypoxia/Distress/Compromise
- ☐ Unknown

Cause of Stillbirth 2nd

- ☐ Maternal Complications
- ☐ Cord Prolapse
- ☐ Cord Around the Neck
- ☐ Cord Knoting
- ☐ Congenital Malformations
- ☐ Prolonged/Obstructed labour
- ☐ Fetal Hypoxia/Distress/Compromise
- ☐ Unknown

Cause of Stillbirth 3rd	☐ Maternal Complications ☐ Cord Prolapse ☐ Cord Around the Neck ☐ Cord Knoting ☐ Congenital Malformations ☐ Prolonged/Obstructed labour ☐ Fetal Hypoxia/Distress/Compromise ☐ Unknown
Newborn Disposal	◯ Mother ◯ Ward 36 ◯ Ward 37 ◯ Other ◯ Mortuary (one sick twin mandate admission of other twins)
Complications During Labour	☐ Haemorrhage ☐ Eclampsia ☐ Retained placenta ☐ Shoulder dystocia ☐ Cervical tear ☐ Others ☐ None (Multiple answers are applicable)
Maternal HIV status	◯ Positive ◯ Negative ◯ Unknown
Pre-test Counseling/Testing Given at Admission in Labour Ward	◯ Yes ◯ No
Maternal Disposal	◯ ICU ◯ Ward 32 ◯ Ward 33 ◯ Ward 38 ◯ Ward 39 ◯ IPPM ◯ Maternal Death ◯ Ward 35 ◯ Others
Cause of Death	☐ PPH ☐ APH ☐ Anaemia ☐ Eclampsia ☐ Sepsis ☐ Malaria ☐ Ruptured uterus ☐ Anaesthetic ☐ Others ☐ HIV/AIDS ☐ Tuberculosis ☐ Severe Preeclampsia ☐ Cardiomyopathy ☐ Stroke/Brain Hemorrhage ☐ Pulmonary embolism ☐ Hypertensive Heart Disease ☐ Unknown/Not recorded

Care of Cesarean Deliveries

Was Consent Form Filled	◯ Yes ◯ No
Was Preoperative Checklist Completely Filled	◯ Yes ◯ No
Blood Grouping Cross Matching Taken	◯ Yes ◯ No
Was the Postoperative Chart Filled	◯ Yes ◯ No (in 1st 24hours postop)
Surgical Complications	☐ None ☐ Cardiac Arrest ☐ Total High Spine ☐ PPH ☐ Other

Maternal Care In The Ward

Family Planning	☐ Received Counseling ☐ Received Services ☐ Declined Counseling ☐ Declined Services ☐ Nothing Offered
Length of Hospital Stay	_____ (in hours)
Maternal Outcome in the Ward	◯ Discharged ◯ Transfer out ◯ Death
Cause of Maternal Death in the Ward	☐ PPH ☐ APH ☐ Anaemia ☐ Eclampsia ☐ Sepsis ☐ Malaria ☐ Ruptured uterus ☐ Anaesthetic ☐ Others ☐ HIV/AIDS ☐ Tuberculosis ☐ Severe Preeclampsia ☐ Cardiomyopathy ☐ Stroke/Brain Hemorrhage ☐ Pulmonary embolism ☐ Hypertensive Heart Disease ☐ Unknown/Not recorded
Date of Discharge/Transfer Out	_____
Time of Mother's Discharge/Transfer	_____
Level of Haemoglobin at Discharge/Transfer	_____ (in g/dl)

Newborn Care In The Neonatal Ward

Place of Delivery	◯ Inborn ◯ Outborn
Date of Newborn Admission	_____
Time of Newborn Admitted	_____
How Many Babies Admitted in Neonatal Ward	_____
Reason for Newborn Admission	☐ For Care/observation ☐ Birth Asphyxia/Difficult in breathing ☐ Congenital abnormality ☐ Fever ☐ Neonatal jaundice ☐ Prematurity ☐ Persistent Hypoglycemia ☐ Hypothermia ☐ RDS ☐ Meconium aspiration ☐ Infant of diabetic mother ☐ Other
Newborn HIE Score on Admission 1st	_____
Newborn HIE Score on Admission 2nd	_____
Newborn HIE Score on Admission 3rd	_____
Newborn Temperature on Admission 1st	_____ (in centrigrade)
Newborn Temperature on Admission 2nd	_____
Newborn Temperature on Admission 3rd	_____
Newborn Pulse Rate on Admission 1st	_____ (beats per minute)
Newborn Pulse Rate on Admission 2nd	_____
Newborn Pulse Rate on Admission 3rd	_____

Oxygen Saturation on Admission 1st	_____
Oxygen Saturation on Admission 2nd	_____
Oxygen saturation on Admission 3rd	_____
Newborn Treatment Modalities 1st	☐ Oxygen therapy ☐ Surfactant ☐ CPAP ☐ BT ☐ Phototherapy ☐ Warmth & Care (Multiple answers are applicable)
Newborn Treatment Modalities 2nd	☐ Oxygen therapy ☐ Surfactant ☐ CPAP ☐ BT ☐ Phototherapy ☐ Warmth & Care
Newborn Treatment Modalities 3rd	☐ Oxygen therapy ☐ Surfactant ☐ CPAP ☐ BT ☐ Phototherapy ☐ Warmth & Care
How Many Times Received CPAP	_____
How Many Times Received CPAP 2nd	_____
How Many Times Received CPAP 3rd	_____
Newborn Feeding Method 1st	☐ Tube feeding ☐ Cup feeding ☐ Breastfeeding ☐ IV Fluids
Newborn Feeding Method 2nd	◯ Tube feeding ◯ Cup feeding ◯ Breastfeeding ◯ IV Fluids
Newborn Feeding Method 3rd	◯ Tube feeding ◯ Cup feeding ◯ Breastfeeding ◯ IV Fluids
Were Antibiotics Given 1st	◯ Yes ◯ No

Were Antibiotics Given 2nd	◯ Yes ◯ No
Were Antibiotics Given 3rd	◯ Yes ◯ No
Type of Antibiotics 1st	☐ Ampiclox ☐ Gentamycin ☐ Ceftriaxone ☐ Ciprofloxacin ☐ Meropenem ☐ Amoxyclav ☐ Combination
Type of Antibiotics 2nd	☐ Ampiclox ☐ Gentamycin ☐ Ceftriaxone ☐ Ciprofloxacin ☐ Meropenem ☐ Amoxyclav ☐ Combination
Type of Antibiotics 3rd	☐ Ampiclox ☐ Gentamycin ☐ Ceftriaxone ☐ Ciprofloxacin ☐ Meropenem ☐ Amoxyclav ☐ Combination
Newborn Complications During Treatment/Care 1st	☐ Convulsions ☐ Hypothermia ☐ Fever ☐ Neonatal Jaundice ☐ Milk Aspiration/Milk intolerance ☐ Hypoglycemia ☐ Bleeding/DIC ☐ Others ☐ None
Newborn Complication During Treatment/Care 2nd	☐ Convulsions ☐ Hypothermia ☐ Fever ☐ Neonatal Jaundice ☐ Milk Aspiration/Milk intolerance ☐ Hypoglycemia ☐ Bleeding/DIC ☐ Others ☐ None
Newborn Complications During Treatment/Care 3rd	☐ Convulsions ☐ Hypothermia ☐ Fever ☐ Neonatal Jaundice ☐ Milk Aspiration/Milk intolerance ☐ Hypoglycemia ☐ Bleeding/DIC ☐ Others ☐ None

Newborn ARV Prophylaxis 1st	◯ Yes ◯ No
Newborn ARV Prophylaxis 2nd	◯ Yes ◯ No
Newborn ARV Prophylaxis 3rd	◯ Yes ◯ No
Newborn Feeding Options 1st	◯ Exclusive breast feeding ◯ Artificial feeding
Newborn Feeding Options 2nd	◯ Exclusive breast feeding ◯ Artificial feeding
Newborn Feeding Options 3rd	◯ Exclusive breast feeding ◯ Artificial feeding
Newborn Outcome 1st	◯ Alive ◯ Death ◯ KMC ◯ Unknown
Newborn Outcomes 2nd	◯ Alive ◯ Death ◯ KMC ◯ Unknown
Newborn Outcome 3rd	◯ Alive ◯ Death ◯ KMC ◯ Unknown
Date of Newborn Death 1st	_____
Date of Newborn Death 2nd	_____
Date of Newborn Death 3rd	_____
Reason for Newborn Death 1st	☐ Severe HIE ☐ Prematurity ☐ Sepsis ☐ Pneumonia ☐ Neonatal jaundice ☐ Aspiration ☐ Multiple congenital abnormality ☐ Hypothemia ☐ Hypoglycemia ☐ Others
Specify type of abnormality	

Reason for Newborn Death 2nd	☐ Severe HIE ☐ Prematurity ☐ Sepsis ☐ Pneumonia ☐ Neonatal jaundice ☐ Aspiration ☐ Multiple congenital abnormality ☐ Hypothemia ☐ Hypoglycemia ☐ Others
Reason for Newborn Death 3rd	☐ Severe HIE ☐ Prematurity ☐ Sepsis ☐ Pneumonia ☐ Neonatal jaundice ☐ Aspiration ☐ Multiple congenital abnormality ☐ Hypothemia ☐ Hypoglycemia ☐ Others
Final Diagnosis at Discharge 1st	☐ Prematurity ☐ NEC ☐ RDS ☐ sepsis ☐ IVH ☐ Pulmonary hemorrahge ☐ pneumonia ☐ Congenital Heart disease ☐ Congenital Pulmonary disease ☐ Neural tube defect ☐ Multile congental anomilies ☐ Trisomies ☐ HIE ☐ Others ☐ Normal newborn
Final Diagnosis at Discharge 2nd	☐ Prematurity ☐ NEC ☐ RDS ☐ sepsis ☐ IVH ☐ Pulmonary hemorrahge ☐ pneumonia ☐ Congenital Heart disease ☐ Congenital Pulmonary disease ☐ Neural tube defect ☐ Multile congental anomilies ☐ Trisomies ☐ HIE ☐ Others ☐ Normal newborn

Final Diagnosis at Discharge 3rd	☐ Prematurity ☐ NEC ☐ RDS ☐ sepsis ☐ IVH ☐ Pulmonary hemorrahge ☐ pneumonia ☐ Congenital Heart disease ☐ Congenital Pulmonary disease ☐ Neural tube defect ☐ Multile congental anomilies ☐ Trisomies ☐ HIE ☐ Others ☐ Normal newborn

Newborn Outborn Data

Baby's Name

_____

IP Registration No:

_____

Address

_____

Date of Admission

_____

Date of delivery.

_____

Born by

◯ SVD
◯ CS
◯ LCVE
◯ ABD

Gestational Age

_____
(in weeks)

Sex

◯ Male
◯ Female
◯ Ambiguous

Birthweight

_____
(in grams)

Newborn Care In The Neonatal Ward Outborn

Place of Delivery	◯ Inborn ◯ Outborn
Date of Newborn Admission	_____
Time of Newborn Admitted	_____
How Many Babies Admitted in Neonatal Ward	_____
Reason for Newborn Admission	☐ For Care/observation ☐ Birth Asphyxia/Difficult in breathing ☐ Congenital abnormality ☐ Fever ☐ Neonatal jaundice ☐ Prematurity ☐ Persistent Hypoglycemia ☐ Hypothermia ☐ RDS ☐ Meconium aspiration ☐ Infant of diabetic mother ☐ Other
Newborn HIE Score on Admission 1st	_____
Newborn HIE Score on Admission 2nd	_____
Newborn HIE Score on Admission 3rd	_____
Newborn Temperature on Admission 1st	_____ (in centrigrade)
Newborn Temperature on Admission 2nd	_____
Newborn Temperature on Admission 3rd	_____
Newborn Pulse Rate on Admission 1st	_____ (beats per minute)
Newborn Pulse Rate on Admission 2nd	_____
Newborn Pulse Rate on Admission 3rd	_____

Oxygen Saturation on Admission 1st	_____
Oxygen Saturation on Admission 2nd	_____
Oxygen saturation on Admission 3rd	_____
Newborn Treatment Modalities 1st	☐ Oxygen therapy ☐ Surfactant ☐ CPAP ☐ BT ☐ Phototherapy ☐ Warmth & Care (Multiple answers are applicable)
Newborn Treatment Modalities 2nd	☐ Oxygen therapy ☐ Surfactant ☐ CPAP ☐ BT ☐ Phototherapy ☐ Warmth & Care
Newborn Treatment Modalities 3rd	☐ Oxygen therapy ☐ Surfactant ☐ CPAP ☐ BT ☐ Phototherapy ☐ Warmth & Care
How Many Times Received CPAP	_____
How Many Times Received CPAP 2nd	_____
How Many Times Received CPAP 3rd	_____
Newborn Feeding Method 1st	☐ Tube feeding ☐ Cup feeding ☐ Breastfeeding ☐ IV Fluids
Newborn Feeding Method 2nd	◯ Tube feeding ◯ Cup feeding ◯ Breastfeeding ◯ IV Fluids
Newborn Feeding Method 3rd	◯ Tube feeding ◯ Cup feeding ◯ Breastfeeding ◯ IV Fluids
Were Antibiotics Given 1st	◯ Yes ◯ No

Were Antibiotics Given 2nd	◯ Yes ◯ No
Were Antibiotics Given 3rd	◯ Yes ◯ No
Type of Antibiotics 1st	☐ Ampiclox ☐ Gentamycin ☐ Ceftriaxone ☐ Ciprofloxacin ☐ Meropenem ☐ Amoxyclav ☐ Combination
Type of Antibiotics 2nd	☐ Ampiclox ☐ Gentamycin ☐ Ceftriaxone ☐ Ciprofloxacin ☐ Meropenem ☐ Amoxyclav ☐ Combination
Type of Antibiotics 3rd	☐ Ampiclox ☐ Gentamycin ☐ Ceftriaxone ☐ Ciprofloxacin ☐ Meropenem ☐ Amoxyclav ☐ Combination
Newborn Complications During Treatment/Care 1st	☐ Convulsions ☐ Hypothermia ☐ Fever ☐ Neonatal Jaundice ☐ Milk Aspiration/Milk intolerance ☐ Hypoglycemia ☐ Bleeding/DIC ☐ Others ☐ None
Newborn Complication During Treatment/Care 2nd	☐ Convulsions ☐ Hypothermia ☐ Fever ☐ Neonatal Jaundice ☐ Milk Aspiration/Milk intolerance ☐ Hypoglycemia ☐ Bleeding/DIC ☐ Others ☐ None
Newborn Complications During Treatment/Care 3rd	☐ Convulsions ☐ Hypothermia ☐ Fever ☐ Neonatal Jaundice ☐ Milk Aspiration/Milk intolerance ☐ Hypoglycemia ☐ Bleeding/DIC ☐ Others ☐ None

Newborn ARV Prophylaxis 1st	◯ Yes ◯ No
Newborn ARV Prophylaxis 2nd	◯ Yes ◯ No
Newborn ARV Prophylaxis 3rd	◯ Yes ◯ No
Newborn Feeding Options 1st	◯ Exclusive breast feeding ◯ Artificial feeding
Newborn Feeding Options 2nd	◯ Exclusive breast feeding ◯ Artificial feeding
Newborn Feeding Options 3rd	◯ Exclusive breast feeding ◯ Artificial feeding
Newborn Outcome 1st	◯ Alive ◯ Death ◯ KMC ◯ Unknown
Newborn Outcomes 2nd	◯ Alive ◯ Death ◯ KMC ◯ Unknown
Newborn Outcome 3rd	◯ Alive ◯ Death ◯ KMC ◯ Unknown
Date of Newborn Death 1st	_____
Date of Newborn Death 2nd	_____
Date of Newborn Death 3rd	_____
Reason for Newborn Death 1st	☐ Severe HIE ☐ Prematurity ☐ Sepsis ☐ Pneumonia ☐ Neonatal jaundice ☐ Aspiration ☐ Multiple congenital abnormality ☐ Hypothemia ☐ Hypoglycemia ☐ Others
Specify type of abnormality	

Reason for Newborn Death 2nd	☐ Severe HIE ☐ Prematurity ☐ Sepsis ☐ Pneumonia ☐ Neonatal jaundice ☐ Aspiration ☐ Multiple congenital abnormality ☐ Hypothemia ☐ Hypoglycemia ☐ Others
Reason for Newborn Death 3rd	☐ Severe HIE ☐ Prematurity ☐ Sepsis ☐ Pneumonia ☐ Neonatal jaundice ☐ Aspiration ☐ Multiple congenital abnormality ☐ Hypothemia ☐ Hypoglycemia ☐ Others
Final Diagnosis at Discharge 1st	☐ Prematurity ☐ NEC ☐ RDS ☐ sepsis ☐ IVH ☐ Pulmonary hemorrahge ☐ pneumonia ☐ Congenital Heart disease ☐ Congenital Pulmonary disease ☐ Neural tube defect ☐ Multile congental anomilies ☐ Trisomies ☐ HIE ☐ Others ☐ Normal newborn
Final Diagnosis at Discharge 2nd	☐ Prematurity ☐ NEC ☐ RDS ☐ sepsis ☐ IVH ☐ Pulmonary hemorrahge ☐ pneumonia ☐ Congenital Heart disease ☐ Congenital Pulmonary disease ☐ Neural tube defect ☐ Multile congental anomilies ☐ Trisomies ☐ HIE ☐ Others ☐ Normal newborn

Final Diagnosis at Discharge 3rd	☐ Prematurity ☐ NEC ☐ RDS ☐ sepsis ☐ IVH ☐ Pulmonary hemorrahge ☐ pneumonia ☐ Congenital Heart disease ☐ Congenital Pulmonary disease ☐ Neural tube defect ☐ Multile congental anomilies ☐ Trisomies ☐ HIE ☐ Others ☐ Normal newborn