SONOMOBILE PROJECT MID-TERM REPORT

SUBMITTED TO: AMICI DEL MONDO- WORLD FRIENDS ONLUS (2020)



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Amici Del Mondo- World Friends Onlus

Amici del Mondo - World Friends Onlus is an Italian Non- Governmental Organization working in collaboration with global partners to combat poverty and inequality and to guarantee fundamental rights to the local communities in Italy, Tanzania, Ethiopia, and Kenya. It continues to engage with and address the needs of the local communities through interventions in social-health and education.

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Acronyms

APHRC	African Population and Health Research Centre
Campus	Universitá Campus Bio Medico di Roma– Ufficio Progetti di Cooperazione Universitaria allo Sviluppo
COC	Clinical Officers' Council of Kenya
CSG	Centro di Salute Globale – Regione Toscana
FGD	Focus Group Discussion
IDEAS	Informed Decisions for Actions to improve maternal and newborn health
KAP	Knowledge Attitude Practice
KAR	Kenya Association of Radiologists
KIs	Key Informants
KMCT	Kenya Medical Training College
KMPDC	Kenya Medical Practitioners' and Dentists' Council
KOGs	Kenya Association of Obstetricians and Gynaecologists
m - POCO USG	Mobile Point-of-Care Obstetric Ultrasonography
NCK	Nursing Council of Kenya
NGO	Non-Governmental Organization
OTE	OTE Medical s.r.l.
PI	Principal Investigator
RUNH	Ruaraka Uhai Neema Hospital
SUERC	Strathmore University Ethics Review Committee
UniTO	Università degli studi di Torino- Scuola di Medicina
WF	Amici del Mondo-World Friends Onlus
WHO	World Health Organization



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Executive Summary

Background

High neonatal and maternal mortality rates continue to be a concern around the world, especially in Sub-Saharan Africa. Evidence demonstrates that quality healthcare care before, during and immediately after birth reduces the number of deaths. Diagnostic medical imaging through ultrasounds is a medical intervention that has been shown to hold great potential in detecting fetal anomalies and ensuring mothers receive appropriate medical intervention. The SonoMobile research investigates the acceptability, viability and efficacy of nurse-led mobile point of care ultrasonography (m-POCOUSG) in Nairobi, Kenya, through the opinions and feedback from medical staff providing the service, regulators of the service and pregnant mothers receiving the scans.

Methods

A sample of two health facilities in low income areas in Nairobi North East were selected and nurse-led mobile ultrasound services were offered. The nurses, sonographer, medical staff, supervisors of the nurses, specialists (obstetricians and radiologists), regulators, and pregnant women involved in this study were then interviewed through e-surveys, telephone interviews and Focus Group Discussions for their opinions and experience. Four key areas of training, task-shifting, teleradiology and scale up & sustainability were explored.

Results

Respondent feedback was positive towards the SonoMobile m-POCOUSG. All respondents agreed on its importance in providing better healthcare to mothers as well as increasing the skill of personnel. The mobile nature of these ultrasound services fit well into the roles and work environment of the medical staff. Better training and regulation of nurse sonographers, as well as clarity on government policies were the improvements emphasized by respondents for successful scale up and sustainability. More involvement from the government and policy makers was recommended to ensure the service costs remained low. Community acceptance of m-POCOUSG was high with pregnant mothers seeing the benefits it offered.

Conclusions

The m-POCOUSG rendered through the SonoMobile project is an intervention that is adaptable and can easily be implemented in low-income areas. Feedback on its utility has mainly been affirmative with its value seen by both medical personnel and the community. Effective adoption and scaling will require more robust training and supervision of the nurses, clarity of regulatory guidelines for the nurse sonographers coupled with more community engagement and sensitization on its value and availability.

01

INTRODUCTION



1.1 Background

Amici del Mondo- World Friends Onlus is an International Non-Governmental Organization (NGO) operating in Kenya since 2004 and is based in Ruaraka Uhai Neema Hospital, Nairobi. World Friends Onlus supports programs that improve health, educational and social conditions in underprivileged areas in line with the principles of the Universal Declaration of Human Rights. Further, World Friends Onlus runs several programs with the aim of bringing healthcare to poverty stricken people in Italy, Kenya, Tanzania and Ethiopia. (1).

1.2 SonoMobile Project

Overview

Under the auspices of the Italian Agency for Development Cooperation (AICS), World Friends Onlus in partnership with Health-E-net (a telemedicine support firm in Kenya keen on strengthening health equity through access to health) conceptualized the three yearlong SonoMobile project with a view to leveraging on new technologies to make the access to services more equitable. This would be tenable through; a) training of midwives through implementation of a new curriculum for nurses specialized in point of care US, in collaboration with KMTC and be duly recognized; b) remote reporting of ultrasound images by qualified sonographers/ radiologists hence provide a mobile ultrasound service in facilities that offer Primary Health Care, with priority given to the marginalized areas of the capital; c) quality control of the newly created mobile service, through the partnership with Italian universities; The project is being implemented in Ruaraka Sub-County in Nairobi County, covering the informal settlements in Ruaraka.

Evaluation

The project's baseline assessment had identified that the limited use of ultrasounds by pregnant mothers in informal settlements was due to limited financial resources,, limited availability of ultrasound services in facilities (only 2.7% of sample), limited awareness and limited capacity to perform the ultrasounds in the respective facilities. Further, it noted that for the few mothers who got the ultrasound service in their previous pregnancies, 36.9% obtained it in their first trimester.
The midterm evaluation thus sought to assess the perceptions of the key stakeholders on the SonoMobile services with a view to refining it for scale and sustainability. These insights would thus be central to designing effective services within SonoMobile to address existing needs cost effectively and in keeping with prescribed standards of quality.

1.3 Objectives

Main Objectives

To understand the long-term sustainability of m-POCOUSG services by exploring the usability, usefulness and acceptability of nurse-led, point-of-care obstetric ultrasound services among stakeholders of the SonoMobile project.

Specific Objectives

1. To explore the knowledge, attitude and practices of nurses trained to perform m-POCOUSG.
2. To explore the knowledge, attitude and practices of sonographers delivering reports for m-POCOUSG.
3. To explore the knowledge, attitude and practices of managers of primary healthcare facilities where m-POCOUSG services are delivered.
4. To explore the knowledge, attitude and practices of Information Technology experts supporting data management for m-POCOUSG.
5. To explore the knowledge, attitude and practices of women receiving m-POCOUSG services.
6. To explore the knowledge, attitude and practices of key health system stakeholders and regulators'

[1] SonoMobile - Measuring the Baseline situation of the ultrasound service's fruition in Ruaraka Sub County- Nairobi, Final Report, 2019

02

LITERATURE REVIEW



2.1 Country Context

Kenya, alongside many countries in Sub-Sahara Africa, records high maternal and neonatal mortality rates at 362/100,000 live births and 22/1,000 live births respectively (2). The neonatal mortality rates account for 56% of the overall infant mortality rate in Kenya. The rates are higher in the rural areas as well as the urban slums (3). In Nairobi the neonatal mortality rate is 39/1,000 born alive (more than half within the first 6 days) -a rate 77% higher than the national average (2). Further, relative to the population of informal settlements in the city, there are 133% higher neonatal and infant mortality rates compared to the same average value of the capital (4; 5) and an almost double maternal mortality compared to the national average (+95%) (3).

Maternal and child health indicators in the informal settlements of Nairobi – primary target of the present research – paint a mixed picture with gains in some aspects and losses in others. Being in the outskirts of the capital opens to several opportunities, like the availability of health centers in the surrounding areas. On the other side, the high population density and poor hygiene conditions bring huge challenges to the health status of slum dwellers.

The informal settlements represent the most disadvantaged areas with regard to health protection and access to health services. Only 57% of pregnant women complete the cycle of prenatal visits and less than 50% participate in an assisted and safe delivery. More than half of the women who have to deal with complications, both during pregnancy as well as at delivery do not receive medical assistance (5).

2.2 Diagnostic Obstetric Ultrasound Scans

The high rates stated above have been partly attributed to limited availability of basic ultrasound services during the perinatal path and the missed opportunity to tap the diagnostic potential of such technology in monitoring pregnancies (6). The cost of ultrasound machines has decreased significantly in the past few years and good-quality imaging can be performed using portable machines that run off batteries and can be charged using solar power. New technologies are exploring rechargeable machines with wireless transmission of data and back up.

Majority of public and private primary health facilities lack this essential diagnostic service, and where available, the costs often are prohibitive hence many expectant mothers fail to access these services. Promoting a wider and more equitable access to obstetric-gynaecological imaging may make it possible to identify, at early stages, a larger number of conditions that put mothers and newborns' survival at risk and mitigate against preventable deaths.

Despite the availability of the equipment, the extreme shortage of sonographers and doctors trained to perform ultrasound is a challenge. This gap is so significant that even urban areas have an acute shortage; on the other side, the number of trained nurses and midwives is far greater. Training healthcare providers in basic POCOUSG applications has the potential to greatly improve patient care in such a setting (7). While ultrasound services are culturally acceptable and have significant demand in Kenya, economic and geographic obstacles to the use of sonography in pregnancy still persist (8).

It is estimated that 97.6% of pregnant women within Ruaraka sub-county have at least one prenatal visit (9) so access to a health facility is not inherently problematic: more often than not, on the occasion of that visit, however, an essential ultrasound examination is not carried out (10). As a result, only 2.7% of future mothers benefit from this service during pregnancy [WF, RUNH, AB Consultants, 2014].

Despite the fact that nurses are more widespread, available and potentially cheaper than are specialist radiologists, trained doctors and sonographers, deploying them into ultrasonography entails task shifting. As such, this would need significant multi-stakeholder engagement, training, quality assurance, inter alia in program design and implementation (7; 10; 11).

2.3 Leveraging on Technology

Advances in technology through the use of telemedicine (tele-radiology) provide an innovative approach to increasing access to scarce, yet specialized skills in healthcare at considerably lower costs. It has the potential of increasing service efficiency, reducing transfers and length of hospital stays for patients (12). However, besides the initial capital investments in establishing the system and the recurrent transmission costs, it requires investment in a quality remote provider compliant to explicit criteria for qualifications and certification (13). Further, most countries do not have sufficient regulatory structures for the oversight of teleradiology as well as control of its commoditization (14).

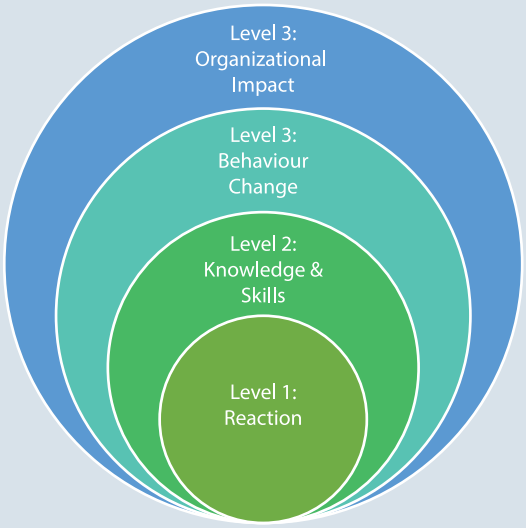
2.4 Conceptual Framework

The aspects under assessment in the SonoMobile project- training, task shifting, teleradiology and scalability- will be evaluated as described below:

2.4.1 Training

The training component of the SonoMobile Project will be evaluated using the Kirkpatrick Framework (15) as outlined in figure 1 below.

Figure 1: Kirkpatrick Model



1. **Level 1: Reactions -** measures what the participants felt about the training.
2. **Level 2: Knowledge and Skills -** measures what knowledge and skills the participants gained from the experience of the training.
3. **Level 3: Behavior change -** measures how the participants changed work activities as a result of attending the training.
4. **Level 4: Organizational impact -** assesses the impacts of the training on the trainees' organizations.

2.4.2 Task Shifting

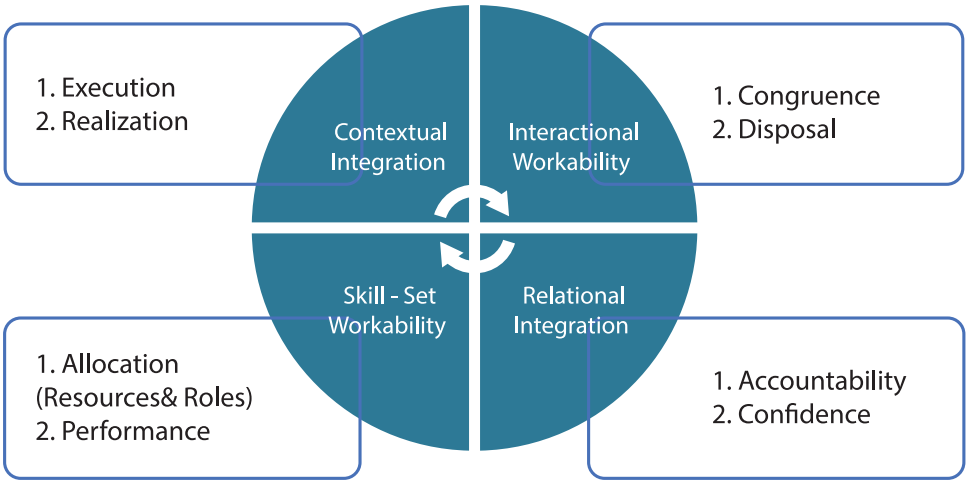
The use of midwives in delivery of ultrasonography in pregnancy, being task shifting, was evaluated in keeping with the WHO implementation guidelines on task shifting as below (11);

1. Role distribution
2. Regulatory environment
3. Stakeholder involvement
4. Training and Supervision
5. Referral systems
6. Supplies
7. Incentives

2.4.3 Tele-Radiology

Evaluation of the teleradiology component of SonoMobile project was based on the Normalization Process Model (16) drawn from the Normalization Process Theory (17). The Normalization Process Theory emphasizes the following as key in intervention adoption: positive links with policy level sponsors, successful structural integration within existing milieu, cohesive groups and integration at the level of professional knowledge and practice.

Figure 2: Normalization Process Model



The model takes as its starting point the points of contact between four domains:

1. The interactional work that professionals and patients do within the clinical encounter and its temporal order, (interactional workability).
2. The embeddedness of trust in professional knowledge and practice, (relational integration).
3. The organizational distribution of work, knowledge and practice across divisions of labor (skill set workability).
4. Its contexts of institutional location and organizational capacity, (contextual integration).

This 'bottom up' approach focuses on human agency reflecting the value of stability, order and practicability at professional and organizational levels in healthcare. This contrasts with models of diffusion of innovation that focus on the efforts of organizations to direct and secure the adoption and diffusion of new techniques and technologies deemed to add to effectiveness.

2.4.4 Scale up and sustainability

The extent to which SonoMobile is aligned for scale up and sustainability will be evaluated using the framework proposed by Informed Decisions for Actions to improve maternal and newborn health- IDEAS (18). The aspects in consideration included the following:

1. Designing innovations for scale
2. Integrating scale-up within programme plans
3. Building organizational capacity
4. Advocating effectively with government decision makers
5. Generating and communicating strong evidence
6. Ensuring government involvement throughout a project
7. Invoking policy champions and networks of allies
8. Aligning with government systems, policies, priorities and targets
9. Harmonizing efforts with other development partners and implementers
10. Supporting and building the capacity of government for scale-up
11. Working with community leaders, media and others to stimulate diffusion of innovations among communities

03

METHODS


AMUA
Family Health Clinic
AMUA
Family Planning Clinic • Jipangie Maisha

This study was conducted at select SonoMobile project sites in the urban informal settlements of Ruaraka Constituency in North East Nairobi including: a) Baba Dogo Health Center (Baba Dogo Ward), a level 3 public health center; and b) Jamii Kipawa Hospital (Kariobangi Ward), a level 3 private health center. It was a qualitative study assessing the knowledge, attitudes and practices of stakeholders in the SonoMobile project including nurses, midwives, sonographers, regulators, trainers, and hospital management representatives.

The study sought insights from thirty-one (31) respondents including the following:

1. Pregnant women receiving m-POCOUSG services (n=10).
2. Nurses delivering m-POCOUSG services (n=2).
3. Sonographers supporting delivery of m-POCOUSG services (n=1).
4. Health facility managers where m-POCOUSG services are delivered (n=2)
5. IT/Teleradiology technicians supporting m-POCOUSG services (n=2)
6. Supervisors for the SonoMobile nurses (n=3)
7. SonoMobile Project administrator (n=1)
8. Institutional stakeholders in m-POCOUSG services:
    - Kenya Medical Training College (KMTC)n=1
    - Kenya Medical Practitioners & Dentists' Council (n=1)
    - Kenya Association of Radiologists (n=2)
    - Kenya Obstetrical & Gynaecological Society (n=4)
    - Kenya Association of Sonographers (n=2)

All participants were recruited purposively in view of their respective roles in the implementation, regulation and utilization of obstetric point of care ultrasonography within the Kenyan system.

Data was collected from the respondents through semi structured interviews, semi-structured electronic surveys, and Focus Group Discussions. The key informant interviews were conducted via phone and skype in view of logistical restrictions occasioned by the COVID-19 containment measures during the period of the evaluation.

All phone interviews and FGDs upon obtaining informed consent, were audio recorded via mobile based Tape-a-Talk application, transcribed, translated as necessary and stored. The duly completed electronic surveys were de-identified for confidentiality.

The qualitative data gathered was analyzed through thematic analysis in keeping with the proposed frameworks i.e. Kirkpatrick framework for training; WHO guidelines for task shifting; Normalization Process Theory for teleradiology; and IDEAS framework for scalability and sustainability. Quantitative data was analyzed using measures of dispersion and presented in tables.

Ethical approval was sought from Strathmore University Ethics Review Committee for the project as it drew insights from the stakeholders within the clinical setting including pregnant women, nurses, sonographers, facility managers, and support agencies outlined above.

04

FINDINGS & ANALYSIS

> The feedback from the SonoMobile respondents was categorized into four sections namely; training, task shifting, tele-radiology and scale up & sustainability.



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4.1 Training

4.1.1 Level 1: Reaction

Based on the Kirkpatrick model, the trainees had a positive response in regard to level 1, reaction. As shown in Table 1 below, both participating nurses strongly agreed that the training was effective, contained clear concepts and met its objectives with none of the topics being a waste of time. Both nurses strongly agreed that they had the opportunity to participate in class and rated the trainer's performance and course's quality highly.

Table 1: Nurses' reactions to SonoMobile training

Components of Training	Nurse 1	Nurse 2
(1=strongly disagree, 5=strongly agree)		
Objectives met	4	5
Clear concepts	4	4
Logical course sequence	4	4
Addressed real need in ANC	4	4
Realistic/ Achievable Goals & Outcomes	4	4
Participation in class	4	5
(1=poor,5=excellent)		
Effectiveness of trainers	4	5
Overall quality of training	4	5
Average	**4**	**4.5**
Group Average	**4.3**	

4.1.2 Level 2: Knowledge and Skills

To the nurses, the training was successful in level 2 of the Kirkpatrick model; knowledge and skills. Both nurses felt very comfortable performing the different ultrasound exams, giving themselves average scores above 4 as shown in table 2 below. However, to the other medical staff, the training did not perform adequately in this level. The trainer and specialists rated the nurses' comfort lower, an average of 3.45. The sonographer, who had the closest contact with the nurses gave the lowest rating of 2.5. Further, the nurses were found to be more comfortable performing scans for fetal presentation and second trimester of pregnancy (average scores of 4.3 and 4.0 respectively; {1=not comfortable, 5=very comfortable}). They were least comfortable performing first trimester scans (rating 2.9), assessing the gestational sac (3.1) and the fetal heart rate (3.1).

Table 2: Interviewees' rating of nurses' comfort levels in performing ultrasound exams

Exam (1=not comfortable, 5=very comfortable)	Nurse 1	Nurse 2	Sonographer	Trainer	Supervisor 1	Supervisor 2	Supervisor 3	AVG
OBS 1st Trimester	2	4	2	2	3	3	4	2.9
OBS 2nd Trimester	5	5	3	4	3	4	4	4.0
OBS 3rd Trimester	5	5	2	4	2	3	4	3.6
Gestational Sac	3	4	2	2	3	4	4	3.1
Foetal Heart Rate	5	5	2	3	2	2	3	3.1
Sagittal Uterus	5	5	2	4	3	4	4	3.9
Fetal Presentation	5	5	3	4	3	5	5	4.3
Placental Location	4	4	3	4	3	4	4	3.7
Head Circumference Measurement	4	5	3	3	2	4	5	3.7
Bi-parietal Diameter Measurement	4	5	3	4	2	3	5	3.7
Average	**4.2**	**4.7**	**2.5**	**3.4**	**2.6**	**3.6**	**4.2**	
Group average	**4.45**		**2.5**		**3.45**			

Interviewees were divided on their views of the training's adequacy. Those who saw it as inadequate, including the sonographer gave the reasons that it did not teach all the necessary skills as "Obs-gyn is wide and needs much training" (sonographer) and "nurses would have to be trained in radiology which is currently not the case" (radiologist 1). The training was too short as "time was limited" (nurse 2). On the other hand, some felt the training was adequate as it was "simple enough to be understood but also complete for what it is needed" (supervisor 3) and because it resulted in nurses being "able to tell apart normal to abnormal findings" (supervisor 2).

Despite the divided view, majority (n=12/16) said they would recommend the training/model. The main reasons for this recommendation were that it adds "more knowledge and skills to their [nurses'] profession" (nurse 1). It also improves healthcare to mothers making the "services better" (Baba Dogo administrator) helping "the needy in the interior or slums who can't afford hospital costs" (sonographer). Thirdly, the training increases capacity and "it's important to spread the capacity of performing obstetric US" (supervisor 1). All three interviewees who wouldn't recommend the training were specialists (two radiologists and one obstetrician gynecologist). Their reasons were that the training was inadequate and "unless the nurses undergo proper training in radiology and understand it, it would lead to a lot of misinterpretation." (specialist 1). There is also "no system to objectively certify competence achieved. Short of that and we will be endangering lives" (specialist 5).

100% of those interviewed agreed that the training of nurses was necessary giving three main reasons. Firstly, the nurses "are the ones in direct contact with the mothers." (Baba Dogo administrator). Secondly, training the nurses can improve the healthcare provided bringing "ultrasounds in the field outside town and slums." (supervisor 3) allowing mothers to "get quick response to their problems [by allowing the clinic to] sort out the emergency that may not wait for a sonographer to be called" (sonographer). Lastly, training nurses would "help have many people at facility level do the scans to reduce workloads" (Jamii Kipawa administrator).

4.1.3 Level 3: Behavior Change

The impact of the training was "greater awareness of obstetrical issues leading to prompt referral to hub center" (supervisor 2). The sonographer also cited that the training "improved my work experience since some complications that are rarely seen have been referred to me by the nurses." This training meant "improved access to ultrasound services because it is free here" (Baba Dogo administrator) and "reduced referrals for scans; better follow-up for mothers" (Jamii Kipawa administrator).

4.2 Nurse-Led Obstetric Sonography (Task Shifting)

In light of the new service being offered through the SonoMobile project, nine interviewees said the nurses' responsibilities after the training were clear (including the sonographer and nurses themselves). The SonoMobile administrator clarified that "in the facilities, their roles are clearly stated through a protocol and a booklet that both the ANC nurse and the team have to fill." However, four of the specialists disagreed saying there are "no clear SOPs for the nurses in this regard. Which nurses do the scans?" (Specialist- Obstetrician Gynaecologist 2) and "no clear guidelines are available on their roles and limitations." (Specialist- Radiologist 2)
Though the trainer said there should be a responsibility change after training "because they are required to go to partner facilities to perform obstetric ultrasound", only one nurse experienced a change: "I now have advanced responsibilities since I can now respond not only to the duties of a nurse but a sonographer as well." (nurse 1). Nurse 2 experienced "no change of responsibilities."

Table 3: Interviewees' rating of adequacy of nurses' supervision post training

Supervision Dimension	Nurse 1	Nurse 2	Supervisor 1 (N1)	Supervisor 2 (N1)	Supervisor 3 (N2)	Project Admin	Trainer	AVG
(1=weak, 5=excellent)								
Supervision Frequency	5	4	3	3	4	4	5	
Supervision Duration	5	4	3	3	4	4	4	
Supervision Mentorship	5	4	3	4	4	3	4	
Average	**5.0**	**4.0**	**3.0**	**3.3**	**4.0**	**3.7**	**4.3**	
Group Average	**4.5**			**3.4**		**3.7**	**4.3**	

Table 3 shows the adequacy of the nurses' supervision. The nurses gave the highest score of 4.5 while the supervisors scored lowest at 3.4.

There was 100% agreement that there were available and clear referral systems for pregnancy imaging cases beyond the nurses' capacity. Apart from the trainer (rating=1, not involved), an ICT technician (rating=2) and supervisor 2 (rating=2), the rest of the interviewees directly involved in the daily operations of the project reported being very involved (rating=3) in providing feedback on the SonoMobile project. The mothers in the focus groups reported not being asked to provide feedback on the ultrasound scan they received in the program.

In the case of a medical misfortune related to cases handled by the trainees in the SonoMobile project, it was unclear who would bear responsibility: "The nurses and the sonographer, I guess" (supervisor 1), "Not clear" (Jamii Kipawa administrator).
There was also limited awareness of the existence of any regulations and policies that guide the practice of nurse sonographers in the SonoMobile project as reflected in responses such as "none" (trainer) as "ultrasound services are not a nursing procedure so there are no laws governing this." (Baba Dogo administrator). In a further interview, the SonoMobile administrator clarified that no guideline or policy is in place to regulate the practice of nurse sonographers in Kenya. The COVID-19 pandemic delayed the implementation of guidelines and nurses academic courses by appropriate regulators, with the role to convene and discuss this.

The benefits of task shifting are that "the costs to the patient would also be less" (Specialist- Obstetrician Gynaecologist 1) and provides better healthcare through "early diagnosis and management of medical emergencies" (Specialist- Radiologist 2). Task shifting also reduces workload "on healthcare workers when tasks of higher cadres are shifted to lower cadres" (Specialist- Obstetrician Gynaecologist 2) giving "a degree of operational effectiveness/capability especially in resource constrained setups" (Specialist- Obstetrician Gynaecologist 2). Lastly, it saves costs as "the expansion of capacity of the existing workers is more economical than training new personnel from scratch." (Specialist- Obstetrician Gynaecologist 2)
The challenges of task-shifting are that there is a "lack of proper training for those who need to perform the task. Lack of proper understanding of clear cut duties among the different cadres in the medical field" (radiologist 1). Additionally, there could be "competence issues and increased error rates" (Specialist- Obstetrician Gynaecologist 2), for example "the reports from most sonographers are deficient and the images are of poor quality" (Specialist- Obstetrician Gynaecologist 3).

4.3 Teleradiology

According to the proposed Normalization Process Theory (NPT) model, the team showed coherence in their embrace and usage of the technology involved though it was new. The nurses were able to perform over 20 scans each over the 3 months preceding this evaluation.
Cognitive participation was reflected in the ability of the medical team to work together in the nurses sending reports to the sonographer, receiving back reports and overall supervision support by other team members. However, both nurses and the sonographer reported problems in sending images and receiving back reports. Nurse 1 experienced these problems for over 4 weeks while nurse 2 and the sonographer reported an average of 1-2 weeks. These technical difficulties were a hinderance to cognitive participation as they disrupted the workflow. Moreover, the lag in resolving these problems, 1-2 weeks for the nurses and no resolution for the sonographer, provided an additional hinderance.

Table 4: Number of weeks during past 3 months that the following problems have been experienced

Problem	Nurse 1	Nurse 2	Sonogra-pher	Supervisor 1 (N1)	Supervisor 2 (N1)	Baba Dogo admin	Jamii Kipawa admin	Project Admin	ICT 1	ICT 2
Machine not functioning properly	>4	1-2	1-2	1-2	1-2	0	0	1-2	0	1-2
Ran out of supplies	0	0		1-2	0	0	0	0	0	
Image quality problems	2-4	1-2	1-2	1-2	1-2	0	0	0		
Problems sending images to sonographer	>4	1-2	1-2	1-2	2-4	0	0	1-2	1-2	1-2
Problems receiving reports from sonographer/ nurses	>4	2-4	1-2	1-2	2-4	0	0	1-2	1-2	1-2

The technology used in the SonoMobile model showed successful collective action with all staff reporting the model fitting well into their current work environment.

Reflexive monitoring was measured by the team rating the quality of support they received. On average, the quality of remote support from the sonographer was 4 (1=Poor, 5=Excellent). The sonographer scored the quality of remote support to the nurses as 4. The SonoMobile administrator scored ICT support as 3 while the ICT team scored themselves as 3 and 4, an average of 3.33.

4.4 Scalability & Sustainability

50% of the mothers in the focus groups had experienced an ultrasound before SonoMobile. Their difficulties in getting an ultrasound in the past included cost, "the service is expensive elsewhere. I paid Ksh.1500 in my previous pregnancy and only Ksh. 250 here" and distance, "the ultrasound center was far from my home." Incorrect information was another deterrent with mothers saying "I did not get any ultrasound in my previous pregnancy because I heard that it would make me get cancer," "I did not get an ultrasound because I heard that they usually give wrong information on the baby's gender" and "I have heard that the scan can cause miscarriages." There was also lack of awareness "I did not know that I needed any ultrasound during my previous pregnancy."

The mothers rated the overall quality of the scan as average.

The feedback on the scale up and sustainability of the SonoMobile project was built around the IDEAS framework.

All interviewees agreed that there was value in the SonoMobile service, falling into five themes:

a) Capacity Development and Knowledge Management

Firstly, it offers increased knowledge for mothers and medical staff as "both the clients and the health workers have been able to gain more knowledge on obstetric scanning." (Nurse 1). "For the women: They are able to understand the importance of ultrasound." (Nurse 2) and "…nurses gain the knowledge of ultrasound and it's daily challenges…" (Sonographer). An ICT technician reported that the program "enabled me to think more like a user or see the solution from a user's point of view."

b) Affordability

Secondly, the SonoMobile services come at a low cost to the mother and clinic. This was summarized by the SonoMobile administrator as "Women= availability of cheap and good quality basic obstetric US, in an environment where there wasn't any before. Clinics= Availability of the service without being forced to buy a machine (usually too expensive for many of them) and hiring a sonographer."

c) Better patient care and access to services

The third value is the improved healthcare and accessibility of services as "it has also helped the health workers in achieving the focused antenatal care" (Nurse 1) providing "better and more accessible ultrasound services" (ICT technician 1). "Accessibility of services might improve" (Specialist- Obstetrician Gynaecologist 3) as "mothers won't have to go and seek for US services elsewhere" (SonoMobile administrator).
The improved healthcare and accessibility led to the ability to "detect emergencies early for timely referral and better follow up of pregnant mothers." (Jamii Kipawa administrator). Now the "women get quick response to their problems" (sonographer) and "faster service delivery at ANC/Labour ward setup…" (Specialist- Obstetrician Gynaecologist 2) whereas before "there are usually long queues to get obstetric ultrasounds and sonographers are often overwhelmed. Scans are delayed and often left out all together due to this problem" (Specialist- Obstetrician Gynaecologist 1).

d) Convenience

Lastly, the service means fewer referrals as "we now don't have to refer many patients" (Baba Dogo Administrator) and "it helps reduce referral of patients out of the health center" (Mother).

These views on the value of the SonoMobile services offer strong evidence in persuading the government and partners to be actively involved in the scale up of the SonoMobile innovation.

Whether the model meets existing requirements was not clear. Only one interviewee agreed that it did (sonographers' regulator), while the obstetrician gynaecologists were unsure, and radiologists felt that it didn't. These sentiments were repeated when asked if there existed policies to regulate this practice in Kenya. The sonographers' regulator said "yes... by Society of Radiography in Kenya...." Two specialist Obstetrician Gynaecologists were "unsure of the policies in place for this" (Specialist- Obstetrician Gynaecologist 1). The third specialist Obstetrician Gynaecologist and both Radiologists said no. "I have not heard of any existing policies" (Radiologist 1). This uncertainty around existing requirements and policies would need to be resolved for the innovation to align with government systems, policies, priorities, and targets, one of the components in the IDEAS framework.

4.5 Current Challenges

The current challenges faced in the implementation of the SonoMobile project were:

1. "Regulation" (trainer) where "tasks need to be perfectly defined" (supervisor 2). "Currently only sonographers are allowed by law to give a report to patients, and that does not include tele-reporting" (ICT technician 2)
2. Technical difficulties & slow network with "images not being found on the patients block. "Technical difficulties. Feedback report not reflecting on the sonographer's report." (Nurse 2). "So far the system network is very slow." (sonographer)
3. Understaffing which hinders "workflow because as a project we don't have enough staff compared to the demand of the service" (nurse 1). "They only take five mothers every Wednesday, yet we have more mothers (15-20)." (facility administrators)
4. Poor quality images due to the "inability to pick more details on scans done with the current machines" (facility administrators)

4.6 Future Challenges

The future challenges expected from implementing the SonoMobile service are as follows.

1. The buying and running of technology. "Technical difficulties" (nurse 2) "could be one of the challenges to be experienced if the project is to be deployed in various parts of the country especially in the regions with poor network coverage" (nurse 1). The "high costs of instrumentation may limit the widening of the service" (supervisor 2).
2. Inadequate training and supervision would be another challenge as "inadequate training" and "lack of supervision may lead to late diagnosis or misdiagnosis" (Radiologist 2).
   The service would cause the additional challenges of "competency, ensuring adequate training" and "coordination of the services" (radiologist 1). Obstetrician Gynaecologist 3 was "not sure how competent they will be." For this reason, "consistency in training will also be important, as well as involving experienced sonographers in the training, to ensure everyone is 'on the same page' with regards to what is required" (Specialist- Obstetrician Gynaecologist 1).
3. Lack of regulations around nurse-led sonography as "lack of guidelines on what the nurses can or cannot do" (Radiologist 1) may deter its acceptability.
4. Poor quality imaging could cause difficulties as "even a second more competent person will have difficulties interpreting them. They may have to recall the patient for a repeat scan" (Specialist- Obstetrician Gynaecologist 3).
5. Finally, the cost of the service. "If the services are made expensive, many people here will not afford them" (mother).

05
DISCUSSION



Potential for acceptance, scalability and sustainability of the SonoMobile Model

a) Training

i. Reactions and Perceptions

The training of the nurses was well regarded by the trainees, trainer and the supervisors. It was deemed to have appropriate trainee involvement and had relevant content delivered by competent trainers. These positive perceptions are key for acceptability, sustainability and scalability of this training.

ii. Skills and Knowledge

Whilst there is new knowledge and skills added to the trainees, the supervisors, sonographers and specialists esteem this as inadequate for quality obstetric care as seen in their lower ratings. The greatest inadequacies appear to be in 1st trimester imaging. This highlights the need for more rigorous training, supervision and quality assurance.

iii. Behavior and Organizational Changes

Limited observations on behavior and organizational changes may be in keeping with the early phase of this project's lifecycle hence may be best observed at later phases of this project.

b) Task Shifting

i. Responsibilities & Regulation

There appears to be clear responsibilities for the nurse sonographers internally (within RUNH) but unclear in the grand medical professional environment due to the lack of specific regulations governing their practice. The lack of clarity within the medical profession poses a significant threat to the model's acceptability, scalability and sustainability.

ii. Stakeholder involvement

There has been involvement of internal (project related) stakeholders in the review and implementation of the SonoMobile project but a lower scale of involvement of external stakeholders including intended beneficiaries (pregnant mothers), trainers, specialists (obstetricians and radiologists), potential partners inter alia. These are essential for the project's acceptability, scalability and sustainability.

iii. Training and Supervision

The project thus far has benefited from rotational supervision of the trainees by visiting specialists. However, the specialists esteem the supervision as inadequate to ensure quality obstetric care. These sentiments align to the insights from specialists on the value of robust, continuous and objective supervision in the setting of task shifting. The weak supervision may further compromise the quality of service rendered hence deter its acceptability, scalability and sustainability.

iv. Referral systems

The existence of clear referral systems within the project bolsters the acceptability of the SonoMobile service as it works towards guaranteeing access to quality obstetric care.

v. Supplies

The undisrupted supply of requisite project utilities as noted by the key stakeholders is essential in ensuring continuity of service delivery as well as acceptability, sustainability and scalability of the SonoMobile project.

vi. Incentives

Incentives (financial and non-financial) are essential for acceptability of the SonoMobile services by the providers (nurses, sonographers). These have been realized in part among the sampled staff. Clarifying the incentives should be carefully considered to ensure that they do not hinder sustainability and scalability but should drive quality of care.

c) Tele-Radiology

i. Contextual Integration.

The teleradiology component of this service alongside the task shifting allow access to care to a population that would otherwise not benefit from such services given the setting of poor informal settlements. This aspect of contextual integration may bolster the acceptability, scalability and sustainability of the SonoMobile services.

ii. Interactional Workability

Effort has been made to ensure linkage of the nurses to the sonographer. However, the delays in transmission of images and reports between the two are a threat to structural integration of the new technology within the existing system. This is further compounded by the limited case context and views available to the reporting sonographer.

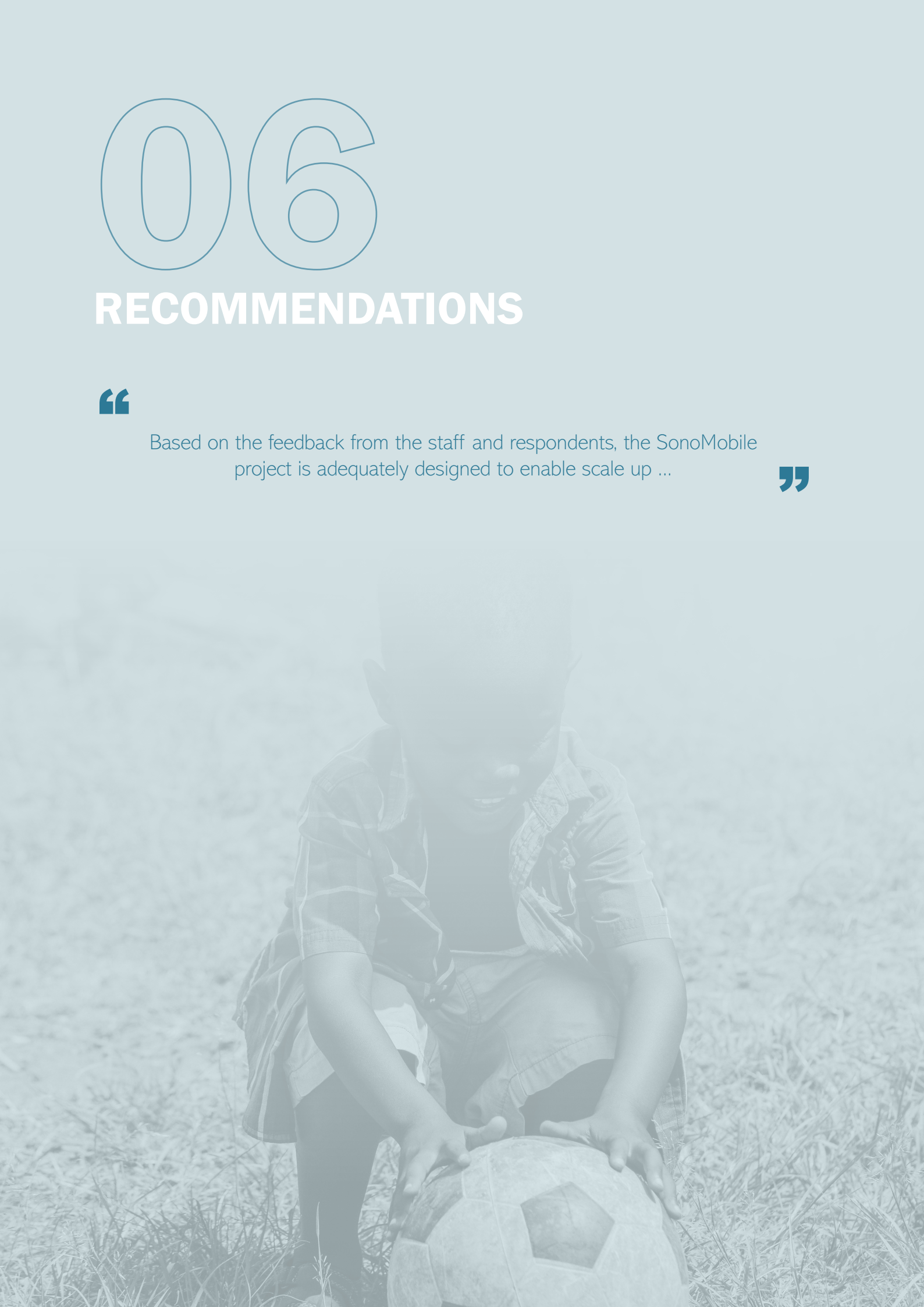
iii. Relational Integration & Skill-set workability

The lack of clarity in roles and regulations for the nurse sonographers weakens the trust within the professional environment and hence threatens acceptability, scalability and sustainability of the SonoMobile project.

06

RECOMMENDATIONS

> Based on the feedback from the staff and respondents, the SonoMobile project is adequately designed to enable scale up ...



Based on the feedback from the staff and respondents, the SonoMobile project is adequately designed to enable scale up if the following suggestions of improvement are implemented:

a) Robust training and Supervision

The suggestion was "quality training" (Obstetrician Gynaecologist 1) where "proper training and guidelines should be put in place" (Radiologist 2). This would involve training "the nurses to be able to do more" (Baba Dogo administrator) such as "in basic radiology" (radiologist 1).

b) Development of clear regulations

The interviewees noted the lack of clear regulations for nurse-led sonography in the country i.e. "lack of guidelines on what the nurses can or cannot do" hence the need for clear guidelines from the regulatory agencies.

c) Capacity Development

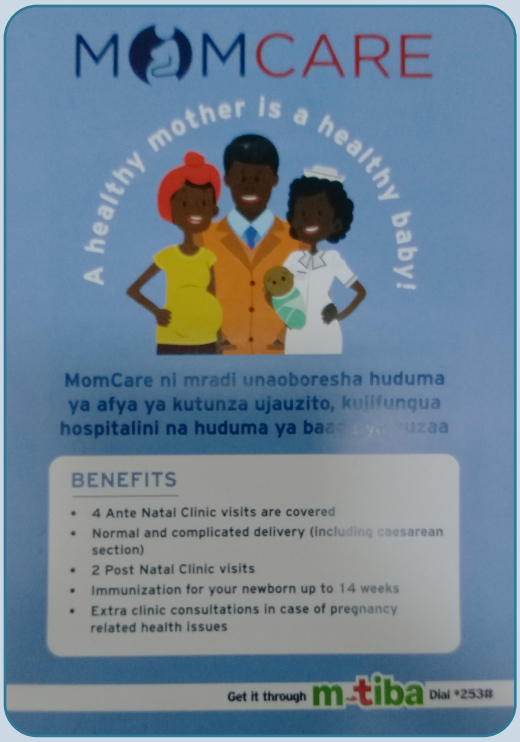
This focused on building capacity with interviewees highlighting the need to "increase facilities" (nurse 2), "increase staff doing the tests" (Baba Dogo administrator) and "increase the number of tests they do" (mother).

d) Improve technology and equipment

The interviewees cited the need to use more and better technology. "Get better quality ultrasound machines" (Jamii Kipawa administrator) because "m-POCOUSG needs modern equipment in order to allow good scan quality with all current requirements in unfavourable situations (doppler US, transvaginal US) "(supervisor 2). Ideas of this improved equipment included "Bluetooth mobile ultrasound devices" (ICT technician 1) and "a printer" (nurse 2).

e) Strategic Partnerships

Staff thought it possible that the government and partners could participate, support, and enable the scale up of the project. They suggested coordinating "with partners/ stakeholders like government.Partner with Linda Mama or other payers/ donors/ government to cover costs." (Baba Dogo administrator) and partnering "with other players like Mum-Care for payment of the services" (Jamii Kipawa administrator). This participation of partners and government could "make the services free for the mothers" (mother). By the IDEAS framework, this is an important activity for the successful scale up of a health program.





f) Community Engagement

Community involvement in the integration of the SonoMobile ultrasound services would require communication by the project team and health facilities to mothers on the services available as well as allowing feedback from the mothers. Two mothers complained of poor communication stating, "we do not know when the services are offered" and "I was not aware that they offer the ultrasound services here." Additionally, mothers were unable to explain how the service was delivered. However, despite these complaints, uptake of the service was positive with mothers seeing the value of the service. One mother said, "it helped my doctor know what complications I had in my last pregnancy." Such acceptance by the community is crucial, by the IDEAS framework, to bring about scale-up.

g) Better Coordination

To improve this service, mothers suggested setting up better systems such as having "a clear schedule for the scans so that patients don't miss the tests just because the team could not come" (mother) and having the tests based at the clinic "so that more patients can access the services without being referred away from the health center" (mother).

07

NEXT STEPS



i. Training and Supervision

- Provide targeted continuous medical education on a weekly basis.
- Pair the trainee nurses to specialists (radiologists and obstetricians) and sonographers for continued practice, learning and mentorship.
- Develop an objective assessment tool such as a logbook for targeted skill acquisition for the nurse trainees. These could focus on areas of identified weakness such as 1st trimester imaging as well as fetal heart rate assessment..

ii. Regulations

- Collaborative development and review of training curriculum and practice guidelines with the respective regulators and training institutions particularly the Ministry of Health, Kenya Medical Practitioners' and Dentists' Council (Including the Kenya Association of Radiologists and Kenya Obstetrical and Gynaecological Society), Nursing Council, Society of Kenyan Radiographers and Kenya Medical Training College.

iii. Technology & Equipment

- Invest in infrastructure that will help speed up transmission of data between the nurse and the sonographer.
- Facilitate the inclusion of motion images/ videos during imaging for better interpretation by the remote sonographer.
- Provide options for printing images for clients at the point of care.

iv. Strategic Partnerships

- Seek out for more collaborations with the government (county and national at MOH), development partners in reproductive health programs, imaging devise and IT companies, insurance companies etc.

v. Community Engagement

- Develop publicity and health promotion campaigns to educate the community on the service as well as demystify inaccurate perceptions around the role of imaging in pregnancy.
- Create avenues to actively draw feedback from the stakeholders including pregnant mothers. This could include surveys.

vi. Service Coordination

- Develop clear schedule for SonoMobile services in the partner sites.

vii. Capacity Development

- Train and recruit more staff to support the current team.

08

CONCLUSION

The m-POCOUSG rendered through the SonoMobile project is an intervention that is adaptable and can be easily implemented even in low-income areas. Feedback on its utility has mainly been affirmative with its value seen by both medical personnel and the community. Effective adoption and scaling will require more robust training and supervision of the nurses, clarity of regulatory guidelines for the sonographer nurses as well as more community engagement and sensitization on its value and availability.



09

LIMITATIONS

The study did not assess the clinical effectiveness and outcomes of the SonoMobile project as that would be subject to influence by extrinsic factors beyond the scope of the project such as previous training of nurses. The study thus did not measure outcomes at a patient level, the ultimate measure of improved quality of care. Clinical effectiveness would be studied in a larger follow up prospective study.

The study was a preliminary effort to examine the effect of an intervention that addresses multiple limitations to delivering good quality ultrasound services. It lacked the capacity to 'close the loop' by addressing gaps identified to limit adherence to guidelines. The success of the intervention will be measured by the support for scaling its use in a greater number of healthcare organizations, alongside a larger, controlled trial to measure its impact on maternal and newborn health.

The scope of this assessment did not allow for in-depth analysis of training as follows; a) Level 1 assessment would best be done during and immediately upon conclusion of the training, hence this evaluation came in after a significant time lapse; b) Level 2 assessment would be best assessed with pre and post-tests during the training. This evaluation attempted to assess some of the knowledge and skills gained albeit partially; c) Level 3 and 4 assessments are best done after longer periods of time of observing the impact of the trainees implementing learnt skills. End-term assessment may best capture the impact of these levels of training.

The prevailing COVID-19 global pandemic and the resultant restrictions on movement as well as social distancing measures limited the options available for data collection to remote/ virtual means such as phone interviews and electronic surveys.



10

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SonoMobile Project Mid-Term Report

