USING MOBILE PHONES TO STRENGTHEN HEALTH SYSTEMS, WITH A FOCUS ON MATERNAL AND NEWBORN HEALTH

Camielle Noordam

The Netherlands

Master in International Health (MIH)
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ROYAL TROPICAL INSTITUTE (KIT)
Development Policy and Practice
In cooperation with the Free University of Amsterdam (VU)

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A thesis submitted in partial achievement of the requirement for the degree of Master in International Health.

By

Camielle Noordam

The Netherlands

Declaration:
The work of others used for this thesis, either from printed sources, Internet or from discussions, has been carefully acknowledged and referenced to according to the requirements. The thesis "Using mobile phones to strengthen health systems, with a focus on maternal and newborn health" is my own work".

The thesis contains 13.907 words.

Signature and date:

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(Aaltje) Camielle Noordam
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Royal Tropical Institute (KIT)

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Amsterdam, the Netherlands

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CONTENTS

ABSTRACT

Every minute, at least one woman dies of complications related to pregnancy and childbirth, resulting in more than half a million deaths a year. In addition, around four million newborns die within the first month. These deaths take place in developing countries, especially in rural and isolated areas, revealing the greatest gap between rich and poor.

The poor status of women in many developing countries, in addition to a low quality of maternal health services, limit women from accessing appropriate health services and health education.

The quick penetration of mobile phones in Africa and other parts of the developing world offers a potential to improve health services. This thesis examines the potential of mobile phones in improving accessibility and quality of maternal and newborn health services.

The literature search revealed several projects in developing countries, linking mobile phone technology with health: mHealth. Most of the projects are pilot projects, which are externally funded. Furthermore, literature research shows no strong evidence on the effectiveness and efficiency of these interventions. The value of these projects is mainly of pioneering nature and advocacy for utilising this new technology.

Mobile phones have hardly been used to improve maternal and newborn health. Four projects were identified and they indicate improved communication between traditional, frontline and higher levels of health care providers and more timely referrals in emergency situations. However, no strong evidence is yet available regarding its effectiveness and efficiency.

Further development of mHealth requires governments to take a more leading role, by ensuring the use of free and high quality software programs, establishment of partnership with the private sector and designing and implementing policies.

Word count: 13.907
Key words: eHealth, mHealth, mobile phones, Information and Communication Technology, Health, Developing Countries and Maternal and newborn health, - deaths and services.

LIST OF ABBREVIATIONS

AIDS	Acquired Immuno-Deficiency Syndrome
ANC	Ante Natal Care
ART	Antiretroviral treatment
ARV	Antiretroviral
CMR	Child Mortality Rate
EHealth	Using ICT to improve health systems
HIV	Human Immunodeficiency Virus
ICPD	International Conference on Population and Development
ICT	Information and Communication Technology
IMCI	Integrated Management of Childhood Illnesses
KIT	Dutch: Koninklijk Instituut van de Tropen, translated: Royal Tropical Institute
LHW	Lady Health Workers
MDG	Millennium Development Goals
MHealth	Using mobile communication to improve health systems
MMR	Maternal Mortality Ratio
MPH	Master of Public Health
NGO	Non Governmental Organisation
OSS	Open Source Software
PDA	Personal Digital Assistant
PHC	Primary Health Care
PMTCT	Prevent Mother To Child Transmission
PPP	Private Public Partnership
SMS	Short Message Service
SRH	Sexual and Reproductive Health
STI	Sexual Transmitted Infections
TBA	Traditional Birth Attendant
TSF	Télécoms Sans Frontières
TTC	Text To Change
UN	United Nations
UNICEF	United Nations Children's Fund
WFP	World Food Program
WHO	World Health Organisation

CHAPTER 1: INTRODUCTION

Every minute, at least one woman dies of complications related to pregnancy and childbirth, resulting in more than half a million deaths a year [4]. In addition, around four million newborns die within the first month [46]. Over ninety percent of these deaths take place in developing countries.

Despite the efforts to reduce deaths and complications, maternal and newborn deaths reveal the greatest gap of any health indicator between the rich and poor. Very little progress is being made in resource-poor countries. It is evident that insufficient attention and funding is paid on this problem at all levels, from the global to the local.

Evidence shows that relatively simple interventions, such as adequate nutrition and hygiene, skilled attendance during birth, access to emergency and post-natal care of mother and child can reduce maternal and newborn deaths tremendously. However, the position of women and poor quality of services prevent women from utilizing health care services. The disadvantaged position of women in society is frequently reflected in low levels of education, limited involvement in decision making and poor access to sufficient nutrition. In addition, the services are frequently of poor quality, with low-skilled health workers required to perform complicated interventions.

Information and Communication Technology (ICT) is quickly being accepted in Africa, as shown by the extreme quick penetration of mobile phones [59][60]. Since communication is the key to improving services, mobile phones can have great potential.

The literature search reveals that several projects in developing countries have been set up to link mobile phone technology with health; this is referred to as mHealth. The projects are small, standalone projects that improve adherence to treatment, promote HIV testing and collect health information and data on diseases.

Realizing the potential of mobile phones to improve a severe health problem resulted in the problem statement of this thesis: how can mobile phones improve maternal and newborn health. The study design addresses three issues: 1) maternal and newborn health, 2) mobile phone applications for health and 3) linking maternal health and mobile phones.

CHAPTER 2: STATEMENT OF THE PROBLEM, OBJECTIVES AND METHODS OF THE STUDY

2.1 Statement of the problem

Pregnancy and childbirth should be one of the best times in a woman's life, yet it is the most serious health risk a woman living in a resource poor country may have. Interventions to reduce maternal deaths are well-known; nevertheless women still die in giving birth. Despite of the issue being put on the global agenda, there has been only a very slow decline in maternal and newborn deaths with some countries showing no progress at all. Hence, there is a need to analyse the situation and its causes and search for new potential solutions.

Modern Information and Communication Technologies (ICT) are increasingly used in the developing countries. In relation to health, computers and mobile phones have been used to create awareness concerning HIV and AIDS, drug adherence and collecting epidemiological data on diseases. Mobile phones are penetrating developing countries fast; therefore this thesis focuses within the field of ICT on the use of mobile phones. There are a growing number of organisations and projects that focus on applying mobile phones on health related services. Despite the weak evidence on the effectiveness of the use of mobile phones in health care, especially in developing country settings, the advocates are enthusiastic. "The use of mobile technology is evolving within health care and although it is too early to tell from published evaluation how successful it will be, the potential is clear" a report on developing countries by the UN Foundation concludes [39].

Linking the persistent problem of poor maternal health and the newly available technology in a developing country is a new innovation. Literature review is the first step to examine this innovation. However, the preliminary search showed the literature to be limited, indicating a lack of information on this issue. Therefore, the literature search needs to be expanded from including only maternal and newborn health, to health in general including maternal and newborn health.

2.2 Objectives of the thesis

Overall objective

The objective is to provide an analysis on the potential of use of mobile phones to improve maternal and newborn health in developing countries, based on the available evidence.

Study questions

To achieve the overall objective the study aims to provide responses to the following research questions:

In developing countries,

a) How serious is the problem of poor maternal and newborn health?
b) What are the key factors that determine maternal and newborn health?
c) What are the key interventions that can improve maternal and newborn health?
d) What is the current role of mobile phone technology in developing countries?
e) How are mobile phones being used to improve health and health care?

f) How are mobile phones being used to improve maternal and newborn health and health services?

2.3 Methods of the study

2.3.1 Literature search
Two different topics, maternal and newborn health and mobile phones are discussed in the study. Also, two sectors are covered, implying two different literature searches and analyses. The information retrieval started with searching for research reports that combined maternal and newborn health with mobile phones. Next, a literature search took place on maternal and newborn health and finally a review on mobile phones and its potential in improving health in developing countries.

2.3.1.1 Maternal and newborn health and mobile technology
The literature search started with looking for studies that combined maternal health with the use of mobile phones. The search was conducted in cooperation with the KIT (Royal Tropical Institute, Amsterdam) library. Searching different databases, Cochrane Library, PubMed and Scopus, seven reports were identified. The use of these reports was unfortunately limited, because they applied high technology, which is not the focus of this thesis. The search continued using Google, WebPages of organizations and discussions seeking for any information on mobile phones in enhancing health. This information contained meeting summaries, opinions, comments, editorials and non-scientific reports including descriptions of projects and general overviews.

Due to the rapidly growing interest in the topic of mobiles and health, new information appeared continuously during the analysing process- even in the last weeks a report was published on a study conducted in Indonesia relevant to this analysis.

2.3.1.2 Maternal and newborn health
The databases were indeed useful for gathering information on maternal and newborn health. Besides PubMed and Scopus much information was collected from the Lancet, WHO, UNICEF and other UN reports.

2.3.1.3 Information and Communication Technology – Mobile phones
In order to understand more about mobile phone technology; its use in developing countries and its potential to improve health services delivery, a search was conducted mainly using Google. The WebPages of organizations such as UN and ITU (International Telecommunications Union) gave an overview.

2.3.2 Discussions and meetings
To get a better understanding of the potential of mobile phones and its use to improve health care and reduce maternal and newborn deaths in developing countries, discussions took place with Master in Public Health (MPH) students. They were from various developing countries and are studying in the field of health. Discussions addressed the penetration of

mobile phones in their society and its use even in remote areas and by poor population groups.

A structured meeting was organized with three MPH students and three senior health advisors of the Royal Tropical Institute, Amsterdam. The meeting was to brainstorm on if and how mobile phones could be used to improve maternal and newborn health. The aim was to assess if it was feasible to start a project in a developing country to improve maternal and newborn health and if applying mobiles phones into the health services is relevant. Topics as cost-effectiveness, public-private partnership, use of text messages, and cost of call-time and use of beeping system were addressed.

Meetings took also place with individuals working in the field of mHealth. H. van Beijma from the NGO Text to Change and J. van Esch from the CommCare gave a clear picture on how projects using modern technology can be successful in developing countries.

2.4   Outline of the thesis

This thesis covers two sectors, health and Information and Communication Technology (ICT). The main focus is on maternal and newborn health and mobile phones in developing countries. In order to respond to the question on if and how mobile phones could improve health of pregnant mothers and newborn children, the thesis is divided into three parts.

Chapter 3 covers the first three questions:

- How serious is the problem of poor maternal and newborn health?
- What are the key factors that determine maternal and newborn health?
- What are the key interventions that can improve maternal and newborn health?

Chapter 4 covers the following three research questions:

- What is the current role of mobile phone technology in developing countries?
- How are mobile phones being used to improve health and health care?
- How are mobile phones being used to improve maternal and newborn health and health services?

Chapter 5 covers the discussion and recommendations for mHealth in general and specially linked to maternal and newborn health.

The study does not only include published reports on finalised projects on use of mobile phones for health but provides information also on several ongoing projects.

CHAPTER 3: FACTORS CONTRIBUTING TO POOR MATERNAL AND NEWBORN HEALTH

3.1 Problem of poor maternal and newborn health in developing countries

3.1.1 Maternal and newborn deaths

Every minute, at least one woman dies of complications related to pregnancy and childbirth. Ninety-nine percent of maternal deaths take place in developing countries (Figure 1) [4]. It is estimated that for every women who dies due to causes related to pregnancy 20-30 other women suffer from pregnancy-related illness or experience other severe consequences such as infertility, fistula and incontinence [12][15]. Every child who loses her or his mother during or shortly after birth is ten times more likely to die before the age of two [2].

Beside high maternal mortality developing countries struggle with high Child Mortality Rate (CMR). Around 9.2 million children died under the age of 5, in 2007. Ninety-two percent of these deaths took place in Africa and Asia; and 40% took place before the first 28 days of life

Figure 1: Maternal Deaths per 100,000 live births in 2005, showing high Maternal Mortality Ratio (MMR) in Africa and Asia. Source: UN, The Millenium Development Goals Report 2008 [43].
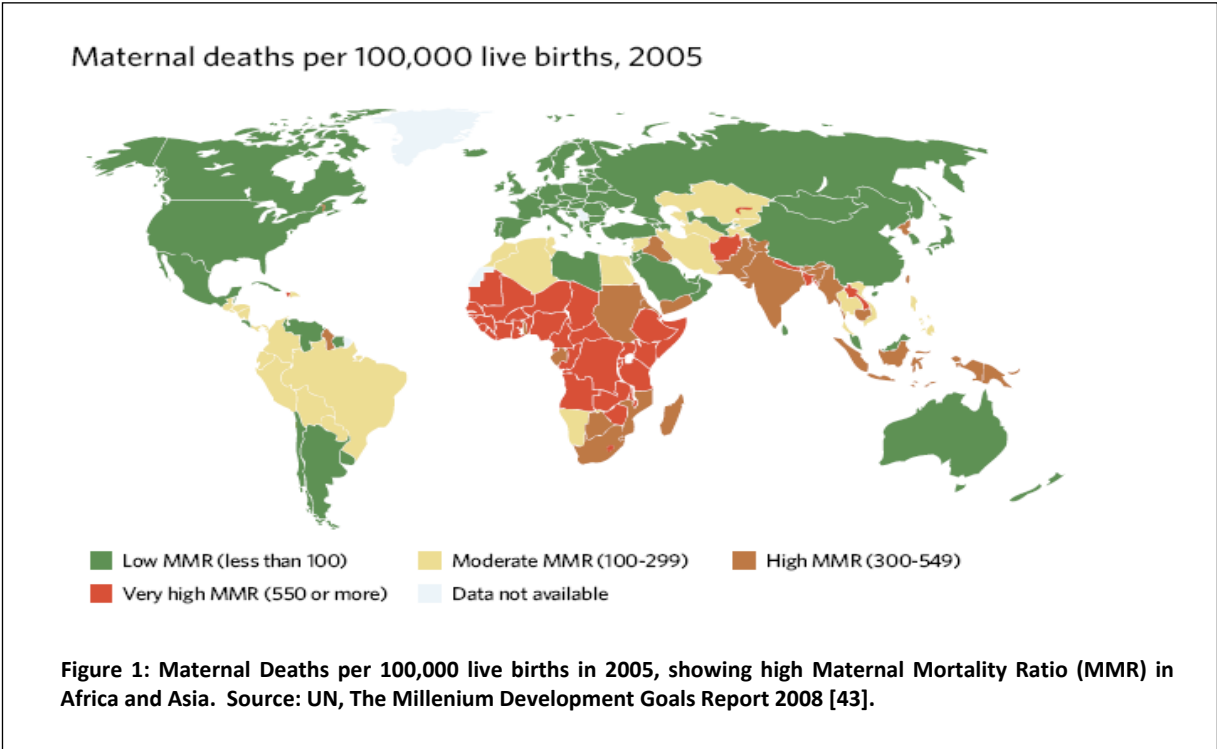
[12]. Maternal mortality reveals the greatest gap between rich and poor, within countries as well as between countries. In Africa the lifetime risk of dying in pregnancy and childbirth is 1 in 22, in Asia it is 1 in 120 and in developed countries 1 in 7 300 [42]. An important reason for these differences is that developing countries lack qualified and adequately equipped health care providers and services [43]. Africa has 24% of the global burden of disease but only 3% of the world's health care providers [15].

The following cases illustrate the difference: In the Netherlands the maximum timeframe for an ambulance to reach a woman in need of emergency care is 15 minutes. The ambulance is highly equipped and the personnel are well trained. Communication and coordination

between the ambulance personnel and hospital is fast and efficient. The woman is stabilized by the ambulance personnel and referred to the appropriate hospital. The cost of care is covered by her insurance. For a woman in a developing country the prognosis in case of requiring emergency care is completely different. Her need for emergency care needs to be correctly diagnosed. She needs to receive proper advice to travel to the health centre or hospital. She may a need permission of her mother-in-law or her husband. The transport system may not be available or affordable to her family. Once having reached the hospital she may need to wait and if treated the right interventions - blood transfusion, caesarean section may not be available or it may be simply too late to do anything to save her life.

3.1.2 Millennium Development Goals

To address a global partnership to reduce extreme poverty the international community agreed on goals that guide governments, international communities, private sectors and the civil society. These goals are formulated in eight Millennium Development Goals (MDGs) [42]. The fifth MDG aims to improve maternal health, by reducing maternal mortality by three quarters between 1990 and 2015 and by achieving universal access to reproductive health by 2015 [4]. Despite these efforts, limited improvements have been made worldwide. The global Maternal Mortality Ratio (MMR) is currently estimated to be 400 maternal deaths per 100.000 live births, while it was estimated to be 430 in 1990 [4]. To achieve the MDG 5, a decline of 5.5% annually is needed, whereas until now data show a decline of less than 1% [4][5]. In the past 20 years a decline in maternal mortality has only been observed in some regions, especially in middle-income countries in Latin America and Northern Africa. The reduction in low-income countries remains drastically low (Figure 2) [20]. Child mortality - deaths of children under the age of five - remains high. Sub-Saharan Africa has made the slightest progress and in some countries no progress towards reaching MDG 5 [43].

Since the progress on MDG 5 has been very slow; there is an evident need for stronger advocacy and a shift from intentions to actions [22]. In many countries HIV and AIDS in addition to other health needs have been prioritised and maternal health has been left aside. As around 80% of the maternal deaths can be prevented if a woman has access to essential maternal and basic health-care services [12], it is clear that a lot can and needs to be done. At global level maternal health

Figure 2 Maternal deaths by region. Source: UN, The Millennium Development Goals Report 2008 [43].
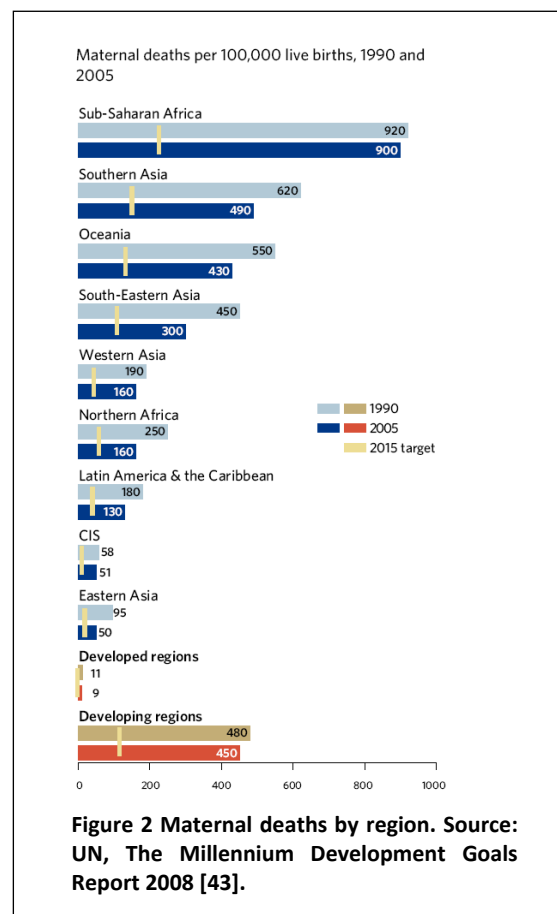
and women's rights slowly receive more attention and this now needs to be filtered to country level [22].

3.1.3 Direct causes of poor maternal and newborn health

To improve health of mother and newborns, factors that influence their health must be understood and taken into account. There are three stages in which social, cultural, economic, behavioural and biological factors influence maternal health. The first stage is before pregnancy and relates to preventing unwanted pregnancies. In many developing countries women have very limited access to family planning services. Religious and cultural factors frequently prevent women from using family planning methods, especially teenagers face difficulties in this stage as they may be forbidden to be sexually active [23]. The second stage is during pregnancy. The major contributor to high maternal mortality during this stage is unsafe abortion. It causes about 13% of the maternal deaths, implying a need for awareness and availability of contraceptives, safe abortion and post abortion care [44]. Additional constrains during pregnancy are insufficient nutrition and poor general health, which endanger the further development of pregnancy and have effect on health of the newborn. Major contributors to death during childbirth, the third stage, are haemorrhage (bleeding) (25 %), infection (15%) and hypertension (12%). The importance of different causes differs by country [12]. For example Latin America and the Caribbean have hypertensive disorder as main cause of maternal death and a much higher rate of deaths due to unsafe abortion [56]. In Africa the highest rate of deaths is due to severe bleeding [45]. Other difference between and within countries is the proportion of maternal and neonatal deaths due to tetanus. Globally neonatal tetanus still accounts for 7% of the neonatal deaths [46] and 47 countries still need to eliminate maternal and neonatal tetanus [12].

The main reasons for deaths due to these causes are lack of attendance of the skilled and qualified personnel during delivery and poor access to emergency obstetric care when in need. Tradition and culture frequently require women to deliver at home. Due to their economical and cultural status they often reach the referral level too late.

Globally, newborns die from three main causes: severe infection (36%) - including sepsis, pneumonia, tetanus and diarrhoea-, 23% die from asphyxia (difficulty in breathing) and 28% are born preterm [12][46]. Interventions that can reduce these deaths are skilled attendance during and after birth, as to prevent death skilled and rapid action is needed, besides improving mother's health [12]. The stages and interventions are discussed later in this chapter.

3.2   Key determinants of maternal and newborn health

In the previous sub-chapter, the complexity of maternal and newborn health and the direct causes of deaths were presented. To add another dimension to the complexity, the underlying factors for poor maternal health are discussed in the following.

According to a report by UNICEF (2009) the root cause of poor maternal health lays in the disadvantaged position a woman has in many developing countries and the lack of *attention to and accountability for* her rights [12]. This section addresses aspects that manifest the disadvantaged position of many women and hence endanger their reproductive life. Especially MDG 1, 2 and 3 - poverty, education and gender - are interlinked and have impact on maternal and newborn health. Also, violence, female genital mutilation/ cutting (FGM/C) and the limited - or no - involvement in decision making processes have an impact on maternal health [12].

3.2.1 Poverty

People living in poverty have a disadvantage in accessing basic needs such as health, education and other aspects that influence their individual well being [43]. A poor woman is more likely than a better off woman, to die during pregnancy and childbirth. Her newborn is more likely to be malnourished and hence more likely to die due to childhood illnesses. If the child survives the first five years of life; she or he is less likely to attend school [43].
Once living in poverty, it is hard to break the vicious circle. A result of lack of education and knowledge, the fight for basic needs limit women from developing independency, making them more vulnerable for gender-inequalities [43].

3.2.2 Education

An educated woman will have more power to negotiate; a research conducted in Uganda showed that the use of condoms was considerably higher among the girls in school compared to the girls out-of-schools. The in-school adolescents had fewer sexual partners in the previous years and started their sexual activities at a later age compared with the out-of-school adolescents. The in-school adolescence used modern contraceptive more frequently [24]. Educated women are more likely to delay a marriage, which has a positive impact on the health status of both the mother and the child [12].
It has been estimated that a woman under the age of sixteen is four times more likely to die than a woman above twenty, and neonatal deaths increase with 50% [5]. Early pregnancies have a negative impact on poverty, by complicating young mothers to attend school and improving their economical status [5]. Additional constrains for adolescent pregnancies is the increased chances of developing complications such as fistulas, due to limited access to health services and biological aspects, isolating women even more [5].

3.2.3 Involvement in decision making

A woman is often excluded from making decisions regarding household and health. In the State of the World's Children of 2007, UNICEF reported that in a number of developing countries, more than one third of the women don't have a say in decisions made regarding their health. Studies show that if a woman has full participation in key decisions, she is more likely to ensure that her children receive enough food and appropriate health care [12].
There is increasing evidence, that the lives of many women can be saved if the financial barrier of health care is removed. A report by Merlin (an Non-Governmental Organization

(NGO) specialized in health) states that free maternal health services would help overcome cost as well as gender inequality, as women would not have to ask their husband or relatives for funding to seek care [2].

3.2.4 Nutrition and hygiene

People living in poverty often have a poor nutritional status. This has a negative influence on a mother's health status and in its turn has a negative impact on babies, resulting in low birth weight. A mother's poor health and nutritional status, as well as inadequate care and nutrition during and after pregnancy, are reason for most of the neonatal deaths [12]. South Asia is the region with the highest rates of under-nutrition amongst women and girls as well as among children under five [12].

Interventions that aim to improve the nutritional status need to address improvements during all stages of an individual's life, starting before birth. Improving the health status of a newborn starts with a good nutritional status of and expecting mother. Interventions such as increasing food intake and supplying folic acid, iron, vitamin A, using iodised salt and timely treatment of worms, malaria as well as other diseases can clearly improve maternal and newborn health [12].

Hygiene, access to safe water and sanitation, is important to prevent diseases, which influence the nutritional and health status of both mother and child.

3.2.5 Violence

Violence against women is widely spread and often neglected. It often includes unsafe and unwanted sex resulting in unwanted pregnancies. Violence can lead to complications such as unsafe abortions, depression, stress, anxiety disorders and others [12].

Domestic violence

In a multi-country study on women's health and domestic violence against women, it was found - in 11 out of the 15 countries studied - that 5% of the ever-pregnant women were physically abused during at least one pregnancy. Some of the factors influencing the risk of violence were: education, financial dependency, empowerment, social support, gender inequality as well as a history of violence. The study also showed that the age of a woman influences the risk of physical and/or sexual violence; in most settings women between the ages of 15 to 19 years were at higher risk of experiencing violence within past 12 months. The report showed that a variation of 13 to 50% of the women said they were beaten for the first time during their pregnancy and that violence contributes to the number of miscarriages and induced abortions [3].

Violence in conflict areas

Beside domestic violence there is violence caused by conflict. In some conflict countries, sexual violence, especially rape is used as a weapon. Recently, there have been such reports from Congo and Darfur, and in the past numerous examples in Bosnia and Herzegovina and Rwanda. Also within stable countries, sexual violence can be used as a form of power. Unwanted pregnancies as well as children born from unwanted pregnancies are at a greater

risk to poor maternal and neonatal health. Additionally, violence during pregnancies can lead to multiple health risks for both the mother and the unborn child [12].

Female genital mutilation/ cutting

One of the fundamental violations of the rights of young girls and women is female genital mutilation/ cutting (FGM/C) [53]. FGM/C has direct negative impacts on the health of young girls as well as negative long-term impacts. FGM/C can increase the risk of maternal mortality and morbidity, by increasing the chances of obstructed labour and post-partum haemorrhage (bleeding after giving birth). It can cause severe pain, prolong bleeding and increase the risk of infection [12].

3.3   Key health care interventions to enhance maternal and newborn health

3.3.1   *Continuum of care*

Eighty percent of the maternal deaths can be prevented if women have access to essential maternal and basic health-care services [12]. However, women often lack the means and the permission to travel to services and services lack the resources to provide quality care. The previous paragraphs addressed the underlying causes of maternal deaths; this section discusses the health care services that women need during their lifecycle to improve maternal and newborn health.

Health care services need to address the following aspects: sexual and reproductive health care, skilled attendance during pregnancy and childbirth - including access to emergency obstetric care and postnatal care for both the mother and the child. Postnatal care is a reasonably new service, aiming to improve care during the fragile days after delivery [12][20]. New developments aim to address them in a comprehensive way: the continuum of care.

Continuum of care is a comprehensive approach that embraces every stage of maternal, newborn and child health promoting the delivery of integrated health services during a life cycle (Figure 3) [12]. The review by Kerber (et al) defines

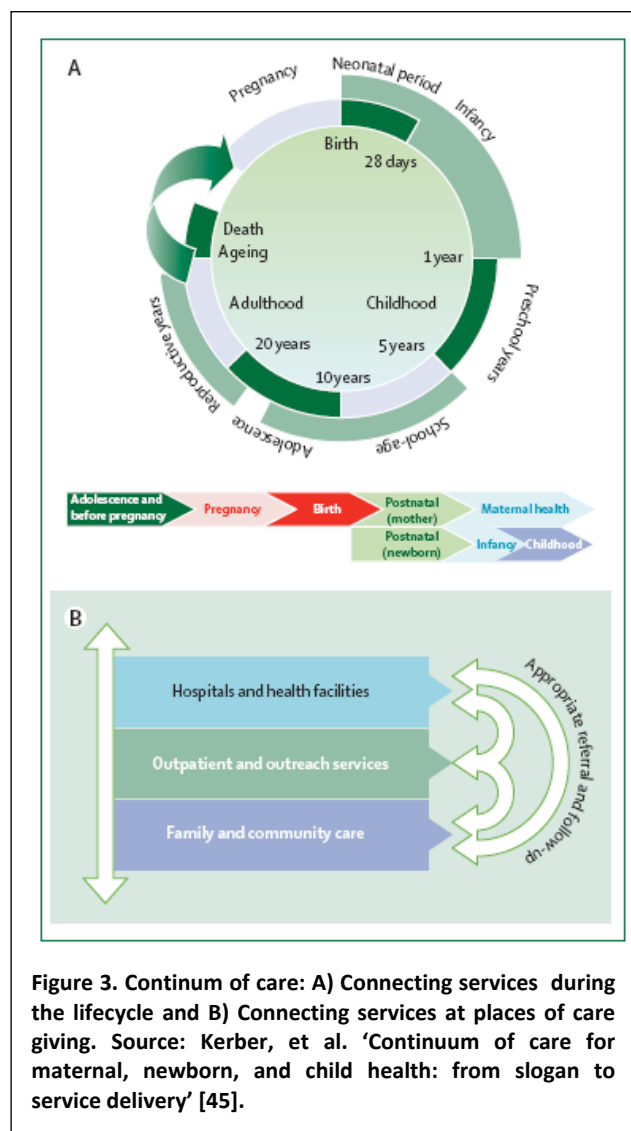
Figure 3. Continum of care: A) Connecting services during the lifecycle and B) Connecting services at places of care giving. Source: Kerber, et al. 'Continuum of care for maternal, newborn, and child health: from slogan to service delivery' [45].

continuum of care as followed:

> "The continuum of care for maternal, neonatal, and child health requires access to care provided by families and communities, by outpatient and outreach services, and by clinical services throughout the lifecycle, including adolescence, pregnancy, childbirth, the postnatal period, and childhood. Saving lives depends on high coverage and quality of integrated service-delivery packages throughout the continuum, with functional linkages between levels of care in the health system and between service-delivery packages, so that the care provided at each time and place contributes to the effectiveness of all the lined packages" [45].

The services are discussed below, the Table 1 compiles interventions that need to be delivered at specific points of time during the reproductive cycle of a women's life.

3.3.2 Sexual and Reproductive Health

The integrated approach starts with Sexual and Reproductive Health (SRH). The definition of reproductive health is "the state of complete physical, mental and social well-being and not merely the absence of disease or infirmity, in all matters relating to the reproductive system" according to the International Conference on Population and Development (ICPD), Cairo 1994 [33]. After the ICPD, the Fourth World Conference on Women called states to review laws, which punished women for illegal abortions. Also, sexual health was included to reproductive health rights. Sexual health rights include the right to have control over and decide freely and responsibly on matters related to sexuality. SRH includes the right for education, family planning, prevention and treatment of Sexually Transmitted Infections (STIs) including HIV and AIDS. The aim is to reduce STIs and unwanted pregnancies, as well as delaying early marriages [12]. Improving sexual and reproductive health requires political, religious and cultural commitment for legislating abortion (or treatment of unsafe abortions) and promoting sexual and reproductive rights of all individuals [25].

In a review by Prata (et al) [15] it is stated that: "Two hundred and five million pregnancies occur annually worldwide, 35% of which are unintended and 22% of which end in an induced abortion". There is an extreme gap between the proportion of women who desire contraception and those receiving it. In countries with high birth-rates family planning can reduce poverty, hunger and prevent around 32% of all maternal deaths and nearly 10% of childhood deaths [21][23][26]. Early and frequent pregnancies also contribute to women's empowerment, education and long-term environmental sustainability [26].

Especially rural and poor areas lack sufficient health care services and teenagers face the extreme difficulties due to cultural and religious factors [23]. To reduce maternal deaths, the impact of family planning is the highest among women below 20, as well as women who have frequently given birth and have short birth intervals [15]. They are most vulnerable to develop complications during pregnancy and childbirth, mainly due to biological aspects.

### 3.3.3 Care during pregnancy and child birth

Care during pregnancy

Ante-Natal Care (ANC), care provided during pregnancy, is an important service that provides education to women on safe birth and emergencies. It identifies women who may face risks of developing complications during pregnancy and birth. ANC addresses the importance of a good nutritional status and micronutrients supplements: Vitamin A, Iron, zinc and iodised salt. In areas with high malaria prevalence women are to be treated with malaria prophylaxis and in some areas de-worming may be necessary. In addition women are counselled, diagnosed and - if possible - treated for STI's (including HIV and AIDS). If a mother is diagnosed with HIV or AIDS, measures should take place to Prevent Mother to Child Transmission (PMTCT) by counselling and antiretroviral treatment (ART). Additionally, to prevent a mother from bacterial infection, ANC services educate mothers on the importance of clean and safe delivery as well as Tetanus immunization [12].

WHO recommends at least four ANC visits during a pregnancy cycle. In The Countdown to 2015 report [1] data collected from 39 countries show that less than 50% of the mothers visit ANC services at least 4 times during their pregnancy. The percentage of women visiting ANC services at least once is much higher, 75%; this is an estimate from 68 countries.

Figure 4: Causes of Maternal Deaths. Source: WHO 2005 [61].

Skilled care during delivery

Making estimations concerning Maternal Mortality Ratio (MMR) is difficult; women often deliver and die at home. Their deaths are often not reported and data that is available concerning MMR is often collected from hospitals and do not represent the overall population [12][19]. The MMR is the lowest in those countries where most of the deliveries are attended by Skilled Birth Attendant (SBA), backed up by emergency obstetric care and high use of contraceptives [15][21]. However, in most developing countries women deliver at home, without skilled attendant and no access to emergency obstetric care. In sub-Saharan Africa and South and Southeast Asia, about a third of the births are attended by a doctor, nurse or midwife [14]. Worldwide 65% of the births are attended by skilled health personnel, with a country variation of skills and quality of a 'skilled' birth attendant, availability of equipment and treatment as well as the possibility for adequate referral [19]. Obaid [21] has estimated that skilled attendance at birth in addition to access to emergency obstetric care could reduce maternal deaths by about 75%, while the estimation of UNICEF is 80% [12].

Most women die due to severe bleeding, followed by infection, high blood pressure, obstructed labour, unsafe abortion or indirect causes (Figure 4). To prevent these deaths, interventions such as timely referral, treatment (oxytocin, antibiotics, ARVs, Magnesium
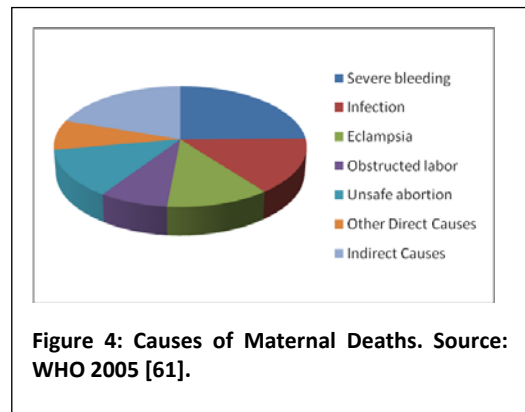
Table 1 Information on interventions that need to be in place at specific points during the reproductive cycle of a woman's life. Compiled by Camielle Noordam from the The state of the world's children 2009, UNICEF [12].

Adolescence (before pregnancy)	Pregnancy	Birth	Post-natal Mother	Safe motherhood
Sexual and Reproductive health	Ante-natal Care (ANC) (at least 4 visits)	Skilled birth Attendance	Post Ante-natal Care Mother	Motherhood and maternal health
• Sexual and reproductive health education • Improve negotiation skills • Delay sexual intercourse (and marriage) • Access to **Family planning** and contraceptives • Prevent unwanted pregnancy • Prevent and treat STI's • Access to VCT's (voluntary counseling and Testing)	• Educate women on Safe birth and emergencies • Identify health condition and risks of developing complication • Strengthen referral systems • Prevent and treat anemia, malaria and iodine deficiency • Treat STI • PMTCT (availability of antiretroviral) • Tetanus Immunization • Prevent unsafe abortions, prove post-abortion care and counsel and provide family planning	• Clean delivery • Access to Emergency Obstetric Care (Care for post-partum hemorrhage, infections, high blood pressure, prolonged or obstructed labor and complications of abortion) • Access to Caesarean section	•Exclusive Breastfeeding •Treat complications; fistula, uterine prolapse, anemia, infertility, chronic infection, depression and incontinence •Educate mother on child care	• Educate on Birth spacing • Back to Sexual and Reproductive health
			Post-natal Child	**Child Health**
			Post Ante-natal Care Child	Manage childhood illnesses and immunize
			•Exclusive Breastfeeding Warmth provision and prevent direct bathing (first 24 hours) •Extra care for small babies •Immunize Rapidly identify and treat (severe) infections, asphyxia and preterm births	• IMCI • Good Nutritional status • Early learning and good development
Nutrition, hygiene, decision making, education, violence				

Sulphate and others) and equipment (clean delivery), Tetanus immunization and access to family planning are needed.

3.3.4 Postnatal mother and child care

Around 40% of the child deaths occur within the first 28 days - most within the first week – an estimated total of 4 million babies a year. Almost all these deaths take place in low-income countries [46]. Complications during delivery are a high risk for neonatal death. Most deaths are due to infection, asphyxia and preterm, and also mothers frequently die due to infection. Many neonatal deaths can be prevented, if mother and newborn receive post-natal care and have access to correct doses of antibiotics. Other easily implemented activities, which reduce newborn and maternal deaths, are proper attention to warmth and feeding practices [46].

3.3.5 Constrains in service delivery

Access to sexual and reproductive health, care during pregnancy and child birth in addition to postnatal care for mother and child reduce deaths, by providing life saving services. However, appropriate and quality maternal health services are often not accessible to

pregnant women due to long distances, high cost, poor communication and transport systems, weak referral links and often low-quality of care in health facilities [45]. The low quality of services is linked to the health system structure and a critical shortage of health workers [19]. The shortage of health workers results in less highly qualified staff and more low-skilled community based health workers. The low-skilled health workers, also referred to as frontline health workers, are frequently not qualified to make decisions which they have to make due to lack of higher qualified staff.

In addition to low skilled staff, frequent out-of-stock of drugs, consumables and equipment prevent basic health care services from providing appropriate care. Improving the status of health services, by ensuring continues and sufficient supply-deliveries and enabling low-skilled health workers to consult can improve the utilization of services.

3.4 New approaches to reduce maternal and newborn deaths

3.4.1 International and national policies

The underlying factors and the direct causes of poor maternal health - resulting in deaths - are known. The need of quality services and of women to access them is evident. Nevertheless, the MDG 5, reduction in maternal deaths, is far from being achieved. One of the key reasons is lack of involvement and commitment of governments, donors and the global community to tackle maternal and newborn health and improve the rights of women. Political dialogue at global, national, district and community levels is required to put MDG 5 on the agenda and to take concrete action. Sexual and Reproductive health must be addressed in national health policies and plans. Programmes should inform and involve the community, ensuring high-quality services, which are accessible to all, including the poor and marginalized [20][21][22]. Services at all levels - community, district, regional and national - need to be strengthened. Avoiding disease-specific vertical programmes and ensuring effective use of health providers is essential [22]. Policies, plans and finance should filter to all levels ensuring sustainable action and strengthening local and national capacity [22]. Additionally, less restrictive abortion laws need to be discussed with religious and political leaders.

Eventually improving maternal health and reducing maternal deaths is important for all levels of society - families, communities and nations - as it improves social and economical status. Investing in interventions costs only a third the income a woman provides when and if she is in good health [20].

3.4.2 Comprehensive approach

Governments, donors and international community need to work together in achieving the Millennium Development Goals that remain behind. The Millennium Development Report of 2008 [43] shows - amongst many improvements - a decline in the number of people newly infected by HIV and the amount of deaths due to measles. Nevertheless, targets as poverty, nutrition, education, gender and sanitation - remain behind. The MDGs that stay behind are also the underlying causes of poor maternal and newborn heath as discussed the in the

section 3.2. Besides improving commitment and resources it is important to seek for new solutions that can strengthen health systems and utilization of health services.

3.4.3 Including men in maternal health

Over the past years, adolescent boys and men have been excluded from reproductive, sexual, maternal and newborn health. Programs such as Preventing Mother to Child Transmission (PMTCT) and Ante Natal Care (ANC) are focusing on women, leaving the father aside. Educating expecting mothers as well as their partners can lead to greater involvement - of both - in important decision- making processes [12]. In addition to including adolescent boys and men, it is important to involve grandmothers and mothers-in-law, as in many countries they have an influential role regarding pregnancy and care of the newborns. Beyond the family, a community with its religious leaders influence the role of women, her status and consequently her health status. All the above mentioned, requires a switch from the so called 'women's responsibilities' to 'everyone's responsibilities'.

3.4.4 Including technology

In addition to involving men in maternal health, improving the use of technology can influence the quality and utilization of services. There is limited evidence of the impact of Information and Communication Technology (ICT) on health especially in developing countries. In Chapter 4, the role of ICT is discussed in more depth.

Krasovec [48] reports that improving communication and transport, if health services are available, can significantly reduce maternal deaths. Strengthening communication systems is especially important to reduce delays in recognizing problems and seeking for the appropriate care. Additionally communication is needed to coordinate transport, as proper transport is essential to reduce time in reaching the service. Communication can also improve logistical aspects by improving the coordination between regional and rural level, ensuring timely delivery of drugs and equipment.

Strengthening communication systems can also inform individuals on laws and services. Knowing that there are services that provide family planning information and methods can motivate individuals to access those programs. Contraceptive pill was invented in 1960 and 50 years later still 120 million couples face an unmet need for contraceptives [25]. Informing individuals on possibilities increases the demand and this in relation to family planning prevents deaths.

Haddad et al [44] have stated that "less restrictive abortion laws don't guarantee safe abortion for those in need; it also requires better education and access to health care". They mentioned India as an example; after removing legal hindrances to terminating pregnancies, women in rural areas still turned to unqualified providers for abortion. The reason was that the knowledge on the law never reached the population that most needed to rely on it. In Sudan I experienced the same: female genital mutilation/ cutting is against the law; however this is not filtered to the communities. Technology such as radio and mobile phones can improve the filtration of laws to frontline health workers and community leaders.

3.5   Summary of the Chapter

More than half a million women die each year from pregnancy and even more develop pregnancy-related illnesses. In addition to the deaths of women, millions of newborns die within the first month of life. Women in developing countries are extremely vulnerable during their pregnancies, this due to their limited access to life-saving care. Simple interventions that can save their lives are linked to health services; however these are often not available or accessible.

There are two interlinked reasons for the inaccessibility and unavailability of health services. The first reason is linked to the position of women in many societies in developing countries. Women in developing countries living in rural and isolated areas are frequently less educated, have little to no involvement in decisions that need to be made and suffer from an insufficient nutritional status. The lack of knowledge, poverty and limitation in making decisions concerning her health, limit her from accessing health care services. In addition to her limited rights, the quality of health care services is frequently poor. This is mainly due to lack of governments and other influential decision-makers to advocate for the rights of women. In addition, developing countries face a shortage of qualified health care providers.

Improving the rights of women, their nutritional status and their access to quality health care services can save their lives, however until now there is limited to no progress.

New approaches need to be advocated to improve the status of women and their accessibility to health care services. One of the approaches is involving men in maternal and newborn health. The second is to strengthen communication systems within the field of health. Strengthening communication can improve the quality of services by, linking health care providers to higher levels of care and care providers and by ensuring timely delivery of equipment (including drugs).

The next Chapter looks into new possibilities to improve the quality of health services and mobilize communities to improve the status of women.

CHAPTER 4: ANALYSIS OF MOBILE PHONES IN STRENGTHENING HEALTH SYSTEMS

In the previous chapter maternal health, one of the eight Millennium Development Goals (MDGs) was discussed. This chapter addresses another MDG, namely the MDG 8. It sets targets for the development of a global partnership. One of its targets is "In cooperation with the private sector, making available the benefits of new technologies, especially information and communication" [43].

4.1   Introduction

A constrain in public health services is that knowledge and health information are not always available where they should be. Shortage of well- educated health professionals results often in low-trained health workers being the only health providers in emergency situations. Working in isolated areas with limited access to information increases the risk to poor management of severe cases. The lack of awareness among the decision-makers regarding the needs of isolated areas due to poor communication also leads to poor policies and inappropriate allocation of resources.

This chapter discusses if and how a relatively new innovation and fast-growing technology, namely mobile phones, could improve health services. Mobile phones are one aspect of Information and Communication Technology (ICT). ICT offers an enormous variation of possibilities to respond to health-care challenges. Over the years, ICT has been used to improve care; building bridges to isolated areas, providing and collecting health information and improving access to scientific information [32]. A number of reports claim that ICT can offer unique opportunities to improve public health globally [10][32]. Nevertheless, the information is limited and scattered, resulting in the development of a Platform for mHealth in Development by the Royal Tropical Institute, for more information see Table 2 on page 1.

In order to understand the possibilities that ICT provides for health and health care, it is important to understand more of the ICT itself.

4.2   Mobile phone technology and part of ICT

4.2.1   What is ICT

According to Tutor2U [27] - a leading publisher of e-learning resources - there is no universal definition of ICT, because the concept, method and application involved in ICT develop almost daily. The abbreviation ICT stands for Information and Communication Technology. ICT is related to storing, improving and manipulating digital data, as well as communicating and receiving digital data using one or more different technologies and linking technologies together. A well- known ICT product is the computer. Over the years the computer has extended its use to link individuals and organizations together in sharing information digitally. Information can be shared trough different networks: local area networks (linking hardware items such as printers, scanners, etc) and wide- area networks (the most used is internet) [27].

Table 2   The development of a Platform for mHealth, a collaborative initiative coordinate by the Royal Tropical Institute.

The ePlatform on mHealth for Development

The idea

There is a lack of information regarding the use of mobile phones in health care, in developing countries. The lack of information, in addition to a meeting the thesis advisor attended, raised a discussion regarding the development of a platform on issues related to mHealth in developing countries.

Partnership

The first step was to form a team of people who are interested in designing this platform regarding mHealth. A team was designed including individuals from KIT (Royal Tropical Institute), a NGO called Text to Change (TTC) and myself (a Master student). The individuals from KIT are the thesis advisor and a person from the Information and Library Services Department (ILS).

Contents and design

The ePlatform is planned to be a collaborative web-based platform designed to identify, select, publish, share and discuss information resources on mHealth, particularly related to developing countries. Some information is gathered through contact with collaborators, individuals and institutions, as not all the information is open for publication. The Platform is a way to build knowledge and share best practices, using Open Source.

There are three components to this platform:

The first component includes news, interviews and information from meetings.

The second component provides mHealth resources and links to selected published documents as well as unpublished documents submitted by collaborators.

The third component links individuals to the wider web of information; enabling visitors to access discussions and surf within the wider ranges on the internet.

Upgrading to a platform

Currently we are still at the level of designing the Platform, collecting information and connecting with individuals and organizations working in the field of mHealth.
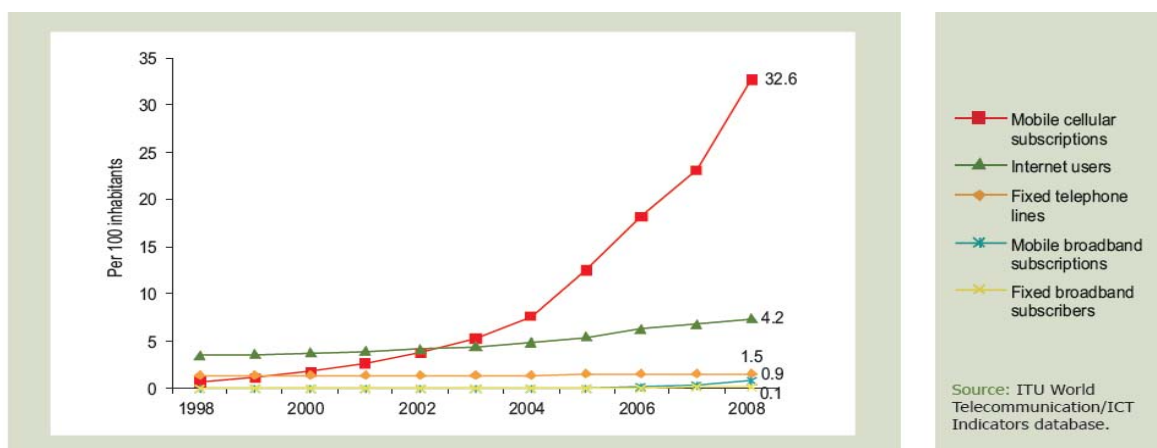
Figure 5: ICT Developments in Africa, 1998-2008 penetration rate. Source: ITU, Information Society Statistical Profiles 2009 – Africa [49].

4.2.2 Mobile phone technology in developing countries

In developing countries the two technologies with the greatest potential are the mobile phones and PDAs. A PDA or Personal Digital Assistant is a small, handheld computer that can store, access and organize large volumes of information. In some cases a PDA additionally has phone capability, called a 'smart' phone. A PDA is able to electronically exchange data with other services [9].

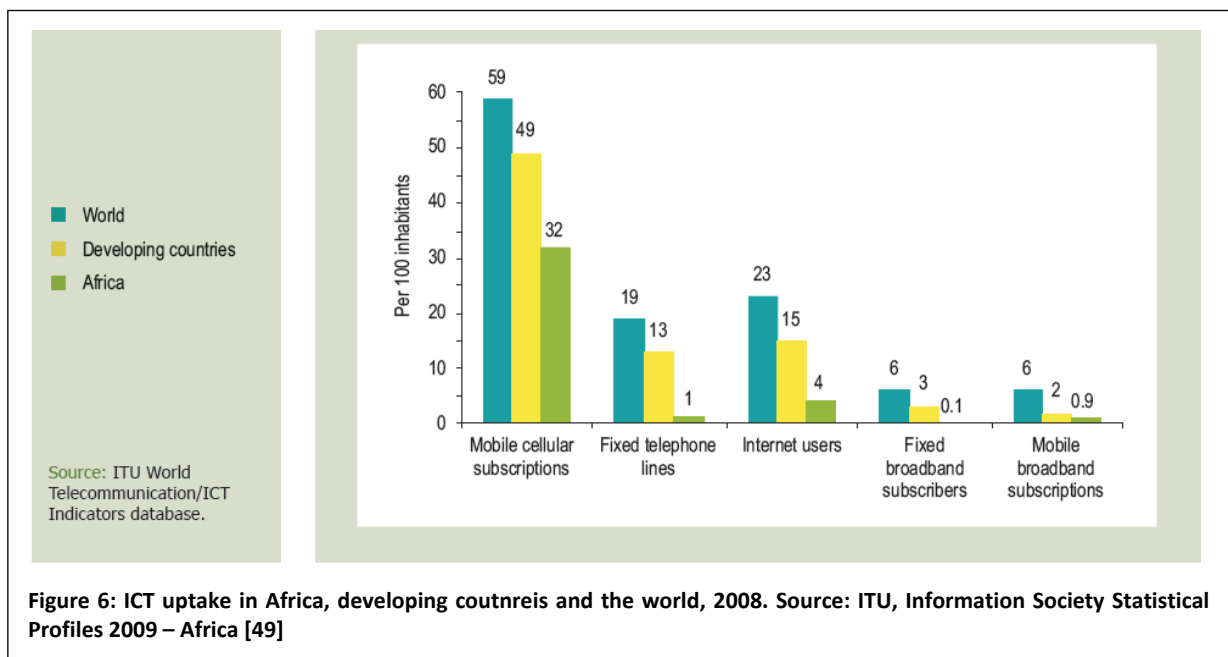The mobile phone is penetrating areas all over the world. Network coverage is increasing and it is predicted that by 2012 around 50% of the people living in remote areas will have a mobile phone [34]. Mobile phones are increasing especially in Africa. The number of mobile phone subscribers grew from 32 million in 2000 to 246 million by the end of 2008 [49]. Mobiles phones are particularly used by adolescent and young adults [16][49].Figure 5 shows the fast penetration of mobile phones in Africa.

Despite the fast growing number of mobile users, the number of internet users remains behind, especially in Sub-Saharan Africa - 1 out of 100 use internet - , even if it would be available, it is for many not affordable [43]. Figure 6 gives an overview of the uptake of mobile phones in relation to internet. Despite the low use of internet, the services, such as email, will gradually grow and will have potential in improving health services. Nevertheless, due to its quick penetration, mobile phone technology has, at present, the highest potential. The quick infiltration of mobile phones stimulates creative thinking to utilize its potential to a maximum.

Figure 6: ICT uptake in Africa, developing coutnreis and the world, 2008. Source: ITU, Information Society Statistical Profiles 2009 – Africa [49]

The quick penetration of mobile phones in developing countries, versus other forms of technology, is mainly due to the easy use and low maintenance level. Mobiles can easily be maintained using 'old' pieces, and batteries can be charged using car engines, solar panels or other creative solutions. Mobile phones can be used for voice contact and test messaging. Advanced mobiles can even be used for video, photo messaging and accessing low-bandwidth Internet pages, a more expensive technology [34][39]. The increase of mobile

phones is also due to the extra benefits it provides such as m-banking, m-government and text messaging [49].

4.2.3 Text messages

One of the main communication methods using mobile phone is Short Message Services (SMS), easy and widely used in society [39]. SMS can be sent to many recipients simultaneously and in different languages. Additionally, SMS is cheap, confidential, and accurate and can be stored if the receiver does not give immediate attention [39][34]. Text-messages have several benefits over other communication systems (Table 3). In an informal meeting with MPH students, the SMS system and its acceptability and relation to illiteracy were discussed. They verified that in Africa the mobile phone is not as personal as in developed countries. Hence, illiteracy is not such a big obstacle than one could anticipate: if a pregnant woman cannot read a SMS, she will ask her daughter or grandchild to read it for her.

Despite all the benefits, there are challenges concerning the use of SMS. Some network providers may not be able to handle the demand of mobile phone users, and this is especially an issue in developing settings [7]. SMS is only cheap for short messages; a message in English can use 160 characters and the amount of characters can vary per language [35]. In Arabic language one text message can use only 70 characters. Translating mass-messages into different languages can cause difficulties, as many English abbreviations are not known in local languages. Abbreviations such as ARV and VCT[1] are not easily translated into Kiswahili and how many characters would the translation use? In addition the English language has applied a lot of 'quick talk' in text messages: "txt u" for "text you" and "g2g" for "got to go" are well known. However these are also not easily translated and may lead to miscommunication.

Table 3 Advantage of different communication systems, Source: de Jongh, 2009[55].

Immediacy	Slow	Slow	Immediate	Immediate	Immediate or stored	Immediate or stored
Privacy / Confidentiality	High	High	Moderate	High	High	High
Likelihood of mis-interpretation	Low	Moderate	Low	Low	Moderate	Moderate
Delivery confirmation	N/A	No	N/A	N/A	Yes	Yes
Cost	High	Moderate	Low	Moderate	Low	Low

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[1] VCT : Voluntary Counselling and Testing

Using text messages, Internet or mobile software programs to improve health services, requires software designs and development. The designing and developing process frequently comes with high cost [18]. To limit expenditure and to enable access to software programs, Open Source Software (OSS) [17] have been and increasingly need to be promoted. Free access to software programs enables small projects, with limited funding, to use high quality software and to run their programs effectively. Another way to limit cost is by collaborating with the private sector, Private-Public-Partnership (PPP). Effective collaboration with the private sectors implies a win-win situation for the private as well as the public sector.

4.3   Mobile phones and development

The quick penetration of mobile phones in developing countries has alerted private and public sectors to analyse the potential of using mobile phones to reach their clients. In India use of mobile phones is very common and the network coverage is wide. There a striking example is of LifeLine, a Non-Governmental Organization (NGO). LifeLine helps to improve the field of agriculture enabling tens of thousands of impoverished farmers to get answers on urgent questions related to their crops or livestock. Using phones, farmers are linked to field experts, who in the past were unaffordable and inaccessible [30]. A similar concept of connecting individuals is experimented in Canada, Pakistan, India and some other countries, where individuals are linked to health professionals: providing care by phone, addressing disease and other conditions confidentially, without having to travel to a health care facility [13].

The quick penetration of mobiles has also alerted services in Kenya to use mobile phones to link individuals to essential information. The project Mobile4Good [30] uses mobiles to connect unemployed individuals to jobs using SMS messages. Text messages were also used to prevent violence following the elections in 2007. Text messages were used to send data concerning actual and planned attacks between rival ethnic and political groups. The aim of this project was to effectively mobilize police [9]. An article published this month reported on how mobile phones assisted in data collection on infectious diseases after an earthquake in China [6].

The following section reviews how the quick penetration of mobiles and ICT can and has filled gaps within health care.

4.4   Mobile phones and health care

4.4.1   E-Health and mHealth
Related to health and technology in developing countries, two 'new' approaches are being used; eHealth and mHealth [10].

E-Health is described as the use of Information and Communication Technology (ICT), like computers, mobile phones, and satellite communications for health services and health information [34]. In the report 'Building foundations for eHealth by WHO' [32] it is stated

that eHealth represents "a commitment for networked, global thinking, to improve health care locally, regionally and worldwide by using ICT". Industrialized countries have extended the use and development of eHealth broadly, while developing countries are still at the beginning of applying ICT [32].

UN Foundation and Vodafone Foundation refer to mHealth as being a part of eHealth, with mHealth specifically referring to mobile communication, such as PDAs and mobile phones to improve health services and health information [11]. There is a lot of enthusiasm concerning mHealth and the expectations are very high as demonstrated in the following quotations. "Mobile technology represents a high-reach, cost-efficient method for making health care more accessible, affordable and effective across the developing world" (UN Foundation and Vodafone Foundation) [10]. "…the use of mobile technology is evolving within health care and although it is too early to tell from published evaluations how successful it will be, the potential is clear" [39]. It is a new development in which the public and private sector are linked to improve the health status of individuals (UN Foundation).

4.4.2 Projects and organizations working on mHealth

In the field of health, mobiles and software programs have been designed to remind, inform and connect individuals to providers as well as collecting data. Some of the projects that use mobiles and software programs are listed in Table 4.

In a pilot project of Cell-Life [52] in South Africa, daily SMS reminders were sent to participants reminding them to take their Anti-Retroviral Drugs (ARVs). Additionally HIV and AIDS related information, such as side effects, nutrition and tuberculosis was send to the participants. A benefit that the Cell-life project reports was that SMS is a common technology, easy to make free for users and can be sent at an exact time, which is important for Anti-Retroviral Treatment (ART). Cell-Life also used mobile phones to connect home-care providers to health care providers working at a coordinating level, ensuring data collection. In addition, the mobile phones are used to strengthen the capacity and knowledge of home-care workers enabling them to contact the supervisor for advice and feedback [31].

In the United States, in San Francisco a mobile program called SexInfo is used as a way to improve sexual education and access to health care for the youth. SexInfo was developed as a tool to provide answers to specific questions that sexually active youth have by text messaging and informing young people on where they can get free and confidential access to health services. SexInfo has shown to have a great impact for difficult to reach youth in accessing health care and information on sensitive topics [41].

Table 4 Examples of mHealth projects around the world, gathered from UN [36] and UNICEF [57].

	Examples of mHealth projects around the world	
Country	Health area – objective	Project name
Africa		
Rwanda	Improve effectiveness and scaling-up ART treatment. Using ICT; mobile, computers and paper record systems, to link policy makers and care providers, in order to improve adherence, avoid stock-outs and drug resistance.	Rwanda TRACnet HIV/AIDS Solution
Burkina Faso, Kenya, Zambia	Improve data collection in remote areas, by; enabling data to be collected from the field, on mobile devices and transferring this in the office to a computer for analyzing.	EpiSurveyor
South Africa	Support management of monitoring HIV and AIDS, by improve the quality. **Aftercare**; enables counsellors to send and receive data and information during home visits. **Remote Booking for VCT** enables large organizations to manage bookings for VCT sessions.	Aftercare and Remote booking for VCT by Cell-Life
Kenya, Malawi, M'bique, Namibia, T'zania, Uganda, India	Educating individuals using mobile devices (games). Games such as; Aids fighter Pilot and AIDS penalty Shoot Out inform individuals on HIV and AIDS, the program will extended in India to target TB, Malaria, dengue and others common diseases.	Freedom HIV Aids - A social initiative of ZMQ Software Systems in India and Africa
Asia		
Sri Lanka	Improve data collection by ensuring coordination between remote areas and district experts, to ensure effective distribution of resources and timely data analyze.	Tamil Nadu Health Watch
Europe		
Luxemburg, Belgium, Italy and Germany	Sending text reminders to users concerning medication uptake and health related messages, by physicians and pharmaceutical companies; additionally M-Pill collects health related information and runs clinical trials.	M-Pill
Latin America		
Peru	Enabling real-time reporting of disease outbreaks and ordering of medicines and supplies. Using mobiles or internet, improvement is also made in communication between health care professionals at different levels.	Alerta DISAMAR: An Innovative Disease Surveillance System in Peru
North America		
USA	Provides required information to sexually active youth and informs them concerning where they can get free and confidential access to health services, using text messages. Example; txt 1 if ur condom broke, answer: U may be at risk 4 STDs + pregnancy. S.E clinic, Keith at Armstrong St, 41-671-7000.	Sextext - SEXINFO

A project in Tanzania focuses on covering health services in rural areas. The project provides treatment protocols on mobile phones. One of the examples is IMCI (Integrated Management of Childhood Illnesses). IMCI helps health workers in Primary Health Care (PHC) settings to improve their diagnostic skills concerning childhood illnesses and to understand which treatment to prescribe and when to refer. Mobile IMCI is a system for administering the IMCI protocol. The protocols are provided on mobile phones, previously they were provided on PDA's. The protocol is downloaded on mobile phones, enabling health workers to access the protocol easily. Health workers, working with eIMCI report that the project improved speed, flexibility and adherence to the protocol. They mentioned benefits as not having to turn pages and that the software protocol provided more flexibility for them in relation to the prescription of drugs. E-IMCI is easy to implement as most of the health workers were used to mobile phones and have used the IMCI protocol for years [8]. In a discussion with J. van Esch working for e-IMCI [54] mentioned that currently his team is designing new protocols, in cooperation with the government and field-experts. Protocols

designed help the health worker to keep track of patients' records and improve health care provision for specific diseases and conditions.

4.4.3 Organizations that improve communication

Télécoms sans Frontières

In and for developing countries there are some Non-Governmental Organizations (NGOs) that aim to improve the use of technology. One of the pioneering ones is Télécoms sans Frontières (TSF). Their mandate is to maintain the destroyed or seriously damaged communication infrastructure in areas that suffer from natural disasters or conflict. The founders of TSF realized that after a disaster, besides to food and medication aid, civilians needed reliable emergency telecommunication service. Individuals were often displaced and separated from their families and desperately in need to be re-connected. In setting up communication systems, TSF additionally aims to improve communication between UN, government and NGO's in order to improve coordination - during and shortly after - disaster and hence to improve interventions. TSF was created in 1998 and until now has provided emergency telecommunication services in 55 countries [28].

Kiwanja.net

Kiwanja.net has been helping to empower local, national and international non-profit organizations in making better use of ICT in their work. Ken Banks established it in 2003, and so far forty countries have benefited from a variety of initiatives. Kiwanja.net believes that "all non-profits, whatever their size and wherever they operate, should be given the opportunity to implement the latest mobile technologies in their work, and Kiwanja.net actively seeks to provide the tools and the environment to enable them to do so". FrontlineSMS is one of the initiatives of Kiwanja.net providing a database that helps NGO's to set up a two-way communication system enabling text messages to be sent to large groups of people at any place where there is mobile network coverage, to anyone having a mobile phone [29].

Text to Change

Text to Change (TTC) is an NGO that in cooperation with governments, mobile providers, private companies, academia and local NGO's provides mobile- based solutions to address HIV and AIDS and other health related issues in developing countries [47]. By providing interactive mobile SMS quizzes, general information is sent to the general population, aiming to prevent the further development of HIV and creating awareness concerning treatment. TTC works in contacting individuals and sends questions and information (Figure 7).

The fact that mobile phones have a potential to provide effective solutions is also represented in the enormously fast growing interest in mHealth. Organizations such as Voxive, Inveneo and CommCare are working also in the field of mHealth. Within the UN, The World Food Program (WFP) used text messages to inform individuals on food distribution and other organizations such as the WHO, the International Telecommunication Union (ITU)

and UNICEF are also working on strengthening services, policies and providing information regarding the use of mobiles.
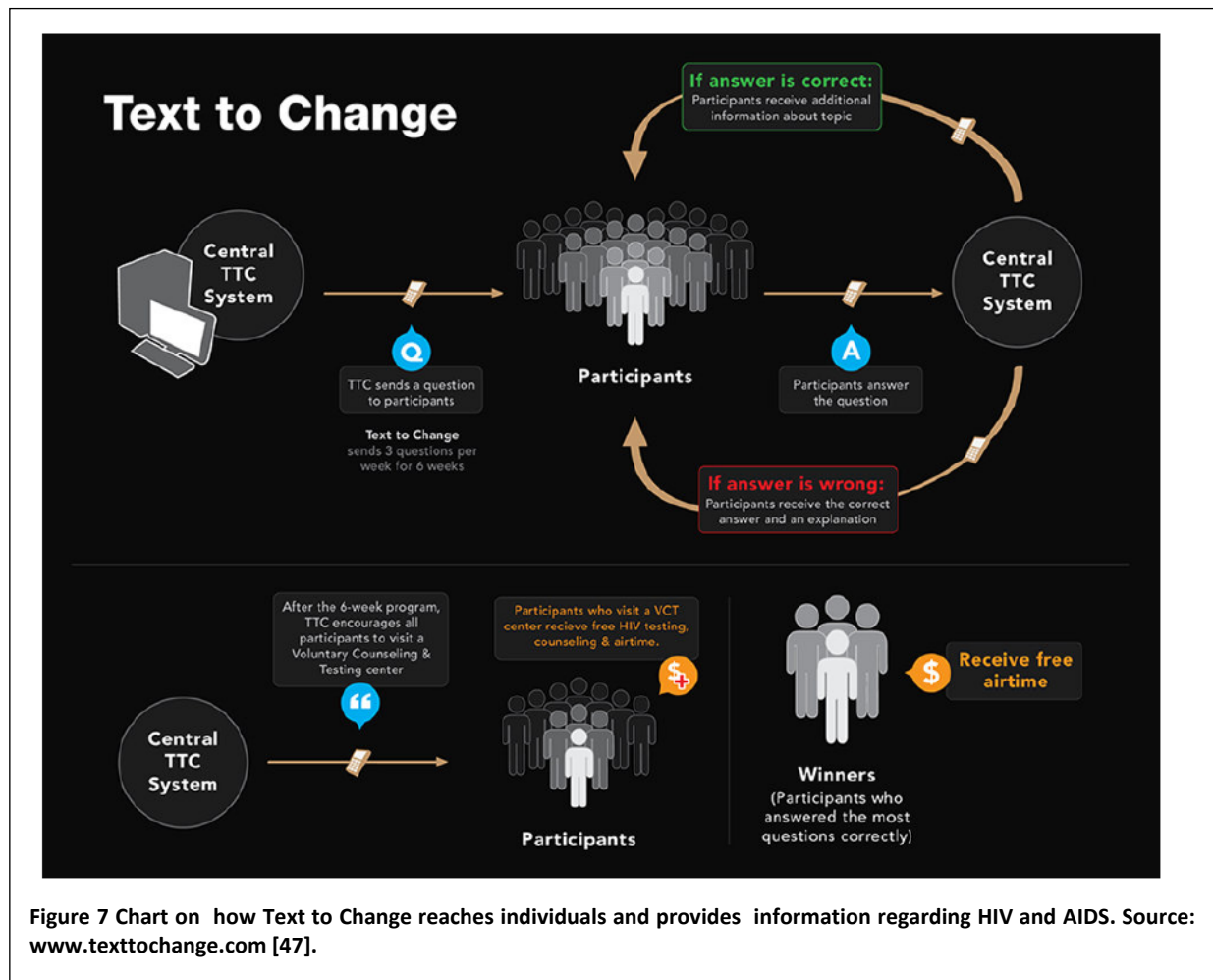
Figure 7 Chart on how Text to Change reaches individuals and provides information regarding HIV and AIDS. Source: www.texttochange.com [47].

4.5 Mobile phones in improving maternal and newborn health

In Chapter 3 it is concluded that increased attendance of skilled professionals during birth and essential obstetric care can improve maternal health and prevents maternal and newborn deaths. However, the availability and accessibility of services may be insufficient and often social and cultural norms prevent women form utilizing them.

There are a few reports that present how communication has strengthened maternal and newborn health. These projects are discussed in the next paragraph. The key questions are: how communication could improve the utilization of health services and how the quality of services can be improved.

4.5.1 Mobile phones and maternal and newborn health
In a comprehensive literature search, only a few reports were identified on strengthening communication technology (mobile phones) and referral systems for pregnant women and their unborn children. The projects are from Pakistan [50], Uganda - Iganga District [38], Peru - Ucayali [37], and Indonesia – Aceh Besar [51].

Pakistan

To improve health care delivery in remote areas in Pakistan, the Pakistani Government trained Lady Health Workers (LHWs). They provide preventive, curative and rehabilitation services [51]. These LHWs did not have resources to communicate with their supervisors, for example to refer serious cases. In a pilot project, LHWs received a mobile phone in order to contact different sources - including district coordinators, supervisors, hospitals and ambulances.

The outcomes of this project are not reported. Nevertheless it can be assumed that by providing communication means for the LHW her capacity to correctly treat and timely refer severe cases may have improved. As described in the Chapter 3, frequently the decisions to refer are made too late, which have negative impacts on maternal and newborn health. By providing a mobile phone, a LHW has the possibility to make a more informed decision and she can coordinate a referral when needed. Additionally, the capacity to communicate also improves the image of a LHW, giving her status. Improving status and the quality of care can gradually reduce social and cultural constrains in utilizing services.

Uganda

A program in Uganda reports "a notable impact on the maternal mortality", a decline of more than 50 percent over three years [38]. It aimed to improve communication and transport systems in order to increase referrals and make them in time. The project was designed to bridge the distance between traditional healers and the public health services. Traditional Birth Attendants (TBAs) received walkie-talkies to communicate with public health services. Improving communication resulted in more timely referrals, reduction of panic situations and uncertain management, more time to prepare for emergencies and improved connections between traditional healers and public health providers. The report emphasises the need for a comprehensive approach; ensuring quality improvements of health care services, equipment and knowledge, in addition to strengthening communication systems.

The project aimed to bridge traditional health with bio-medical services, by providing communication means. Further research can indicate how important communication devices can be in improving the gap between traditional health and bio-medical services.

Peru

In Peru [37] the thick Amazon rainforests and lack of roads mean that most of the transportation takes place via the rivers. Journeys from isolated areas to emergency obstetric care can take as long as two to seven days. A phone- and web- based information and communication system was set up to enable health professionals to exchange critical health information between themselves, medical experts and regional hospitals. They use Internet, and if it is not available, satellite, fixed-line, mobile or community phones in order to discuss and analyse the cases. The program is used to improve patient monitoring, referral, follow-up, and tracking of supply as well as improving disease surveillance.

Communication devices can improve the contact between hospitals and frontline health workers. An interesting question for further research can be how communication strengthening follow-up can improve correct post-natal care and how this can reduce maternal and mainly neonatal deaths.

Indonesia

A project in Aceh Besar - Indonesia - provided midwives with mobile phones. The aim of the project was to improve coordination and exchange of information between community and district levels. The report [51], states that the "introduction of ICT, such as mobile phones to basic health service providers in rural areas can help bridge lacunae in the medical infrastructures, resulting from under-capacitated resources, constrained access to information and delayed interventions". The introduction of mobile phones was reported to result in more effective and efficient communication, and allowing faster emergency responses [51].

4.5.2 Strengths and weaknesses of the studies

The studies indicate that mobile phones can improve maternal health care and the coordination between different levels of health care. The main role of mobile phones and walkie-talkies is to improve timely referrals and provide the possibility for frontline health care workers to easily access information and back-up from specialists.

The projects in Pakistan and Peru do not include studying any outcomes or impacts. It can be assumed that connecting health care providers can improve and strengthen services; however there is no evidence on the effectiveness within these projects. The referral time in Peru varies between two to seven days; the study did not mention how communication improved the time of referral. The report from Peru gives no clear explanation on how the communication between regional and isolated areas might improve maternal and newborn health and how it prevents deaths.

The project in Uganda reports a maternal mortality decline of more than 50 percent over three years. Unfortunately, there was no control group and hence we do not know if the improvement was due to other issues than use of communication. It is surprising that if the improved communication between traditional healers and biomedical health care providers declined maternal mortality by 50 percent, that no further studies are made. This intervention would need to be further analyzed and evidence should provide a proper study design, i.e. trial.

The project in Indonesia did not include baseline data and hence the evidence is only indicative. The researchers mentioned the lack of data in general regarding health indicators of maternal and infant mortality [51].

The four projects demonstrate how very limited the information is concerning the impact of mobile phones on reducing maternal deaths. The limitation of evidence can only result in one conclusion; there is an urgent need for research, providing evidence regarding the effectiveness of mobile phones in improving the care for mother and child.

4.6   Summary of the Chapter

One of the targets within the eighth Millennium Development Goal addresses the need to make new technologies, especially related to information and communication, available. The fastest growing new technology is the mobile phone. Estimations are made that by the end of 2012 half of all the people living in remote areas will have a mobile phone. The penetration of the mobile phone is the fastest in Africa. The penetration of Internet currently stays much behind compared to the mobile phone. Mobile phones are used for communication, and the most frequently used form of communication is the Short Message Service (SMS).

In developing countries, mobile phones have been used to improve services by alerting individuals on job opportunities and coordinating police forces during conflict situations. Within the field of health, mobile phones are considered as an innovation that can drastically improve the use and quality of health services. Despite the high expectations, there is limited to no evidence on its cost or effectiveness. Projects that use mobile phones to promote services mainly focus on HIV and AIDS and are gradually extending to other fields within health. There are some organizations that focus on designing projects that use mobile phones for voice communication, some are specialized in the use of text-messages and other organizations strengthen communication in general.

There is very limited information regarding how mobile phones can strengthen maternal and newborn health. An extensive literature research covered use of mobile phones for health. Regarding the use of mobile devices to improve maternal and newborn health, only four projects were identified. The projects mainly focus on rural and isolated areas, linking them to hospitals and other health care providers. All four projects focused on strengthening the capacity of the least trained health care provider, by ensuring better collaboration with higher levels of care.

The limited information reveals the urgent need for evidence. The studies should be designed to be able to provide evidence if strengthening communication reduces maternal and newborn deaths.

CHAPTER 5: DISCUSSION AND RECOMMENDATION

The thesis studies the potential of linking mobile phones to improve maternal health in developing countries.

5.1   Discussion

The study is an analysis of literature available on three issues: 1) maternal and newborn health, 2) mobile phone applications for health and 3) linking maternal health and mobile phones. Literature on maternal and newborn health in developing countries was widely available, sketching a sufficient and reliable picture of the problem, its causes and determinants as well as interventions in health care. The available literature on mobile phones applications for health in developed and developing countries is more limited. The topic is new and evidence on its effectiveness is not yet available. For example, even in the developed country setting there is only weak evidence on effectiveness of health education via mobile phones compared to other methods. Additionally, within the field of health, literature in developed countries focuses mainly on applying high technology innovations that use mobile phones only as one part of the technology (mobile phones are often linked with use of Internet or special sensors). In developing countries the focus is more on the use of simple mobile phone technology for health. Scientific reports regarding maternal health and the use of technology were almost non-existent.

Introduction
The first three study questions are answered in Chapter 3. Explaining how serious the problem of poor maternal and newborn health is, in developing countries. The two interlinked reasons for poor access and availability of health services are explained to be the position of women and poor quality of health services.

The next three study questions are linked to mobile phones and its potential to improve health, explained in Chapter 4. Reflecting these questions to maternal health it can be concluded that key areas in which mobile phones can improve health are by strengthening the health systems, ensuring equity, connecting health care providers and empowering community health workers. In addition it is important to look at the role of governments and the cost-effectiveness and efficiency, the high expectations of mHealth and the potential of using text messages.

5.1.1   The importance of strengthening health systems

Regardless of the valuable work done by Non-Governmental Organizations and governments, most of the projects reviewed addressed individual aspects within health care. Research needs to provide evidence on how mHealth functions within a health system, as a part of it, and on how the activities could be scaled up to strengthen health systems. Within a country, mHealth activities should gradually expand to a comprehensive approach, strengthening health and health systems rather than supporting a vertical approach (HIV and

AIDS, tuberculosis, malaria) as is frequently the case. In addition, it makes more sense to ensure the use of one mobile phone for several tasks of a health worker than wasting funding on providing a mobile phone for each vertical function of the health worker

It seems, on the basis of the literature and discussions [54] that experts in ICT largely drive the eHealth and mHealth development and projects. Governments should stimulate the involvement of health system experts. Gradually, in addition to research, health experts can advice governments in developing and planning initiatives that can be scaled up.

Introducing mobile phones into the health systems should be viewed as just one of the many solutions and interventions that need to be considered to reduce avoidable deaths and improve the quality of life of women and newborns.

5.1.2 Ensuring equity

Technology, especially high technology has a tendency to serve the better off; mHealth applications should enhance equity in accessibility to health services.

Improving the quality of health care services and ensuring accessibility for all, including the poor and marginalized is the government's responsibility (see 3.4.1). Improving communication between health care providers such as traditional healers, frontline health workers and coordinators strengthens the health care. This way, investments are used for improving services for the poorest of the poor. An example of such an approach is in Sri Lanka where the government supported mHealth project in an isolated area. In this project Primary Health Centres are linked with district experts and program managers to ensure improved coordination in allocating resources more effectively and efficiently [36].

Research is needed to show how the use of mobile phones within maternal and newborn health influences women's empowerment and how it is influenced by gender inequality.

5.1.3 Connecting health care providers and services

Strengthening capacity

Despite the lack of evidence, the general idea is that mobile phones and improving communication between health services have a positive impact on improving health care and health systems. Providing communication for traditional and other community workers can improve referrals and prevent avoidable deaths. The project in Uganda reported that the "notable impact of the project was that maternal mortality declined by more than 50% over three years" [38]. Providing mobile phones, or radios, enables a two-way communication. Community health workers provide information from the community level concerning constrains they face in their day- to day- work, at grass root level. This information can also contain underlying factors related to maternal health. For example: a coordinator may recognize that frontline health workers frequently report on poor nutritional status of pregnant women. She then can advice the frontline health worker on how to educate women regarding food intake and improve the distribution of micronutrients. A community health worker can also inform a coordinator on issues such as high incidence of malaria or

women suffering from worms. The coordinator in her turn receives more accurate data on mortality and morbidity that can inform management and policy makers at all levels on the actual need and therefore improves the allocation and targeting of resources.

Limited resources enquire efficient use of resources. Improving communication can also help coordinators to identify which frontline health worker needs additional training or enhanced supervision. In my experience, due to limited communication means, supervisors' visits are often poorly planned. A supervisor may arrive at the Primary Health Care unit and realize that the health worker had taken a day off. Or it could be that the health worker had just faced extreme difficulties with a delivery, not knowing that the supervisor was on her way.

Connecting to a wider perspective

Networking is important to learn what is going on and what is available. For example, in Sudan, due to high percentages of female genital mutilation/ cutting and adolescent pregnancies, women frequently suffer from fistulas. Women, at young ages, become isolated as they suffer chronic incontinency of urine after giving birth. De-isolating frontline health care providers and enabling them to contact specialized hospitals provides solutions for these women.

Besides connecting to other health care providers, communication can also strengthen connections that have already been in place but lack sufficient coordination. Health care services in developing countries frequently suffer from out-of-stock. Orders are made but they do not reach for example a drug store in time. An improved communication system improves timely and accurate delivery of drug and equipment.

Strengthening communication implies more than just giving community health care providers a mobile phone. It requires meetings and hands-on supervision. If frontline health workers are not aware of whom they can contact for feedback and referral and if the gap remains, mobile phones will provide only a limited, if any improvement.

5.1.4 Empowerment of community health workers

The critical shortage of health workers, especially doctors and nurses, has made the less trained cadres very important. Frontline health workers, low-skilled birth attendants often are the ones who need to make critical decisions, however they may lack the capacity. Some studies indicate that providing communication tools to them strengthens their capacity and improves their performance. Having a mobile contributes to the status and recognition of an individual, resulting in a higher uptake of Primary Health Care services. Health workers can also use the mobile phones to contact other services, organizations and individuals expanding their network.

5.1.5 The role of governments in applying mHealth

Projects in the field of mHealth are scattered and fragmented. They are mostly one time, self-standing projects initiated by external actors and funded externally. Mobile phones may be given free of charge to the people studied. The NGO in question may have negotiated

free airtime for this one-time activity with a local service provider. Such projects and Public-Private-Partnership (PPP) are important pioneering experiments, yet the financial sustainability of such activities is questionable.

Governments need to develop policies that set priorities for applying Information and Communication Technology (ICT) in health on the basis of the local needs and resources. The government should lead the development of mHealth, giving clear guidance to private organizations ensuring quality and cost-effective solutions. In order to limit budgets governments need to co-operate with the private sector, ensuring collaboration that benefits both. Budgets regarding mHealth are frequently high, limiting long-term planning.

In order to build meaningful PPP and ensure long-term financial sustainability governments need to lead and coordinate eHealth activities and develop guidelines and policies on ICT and eHealth. The WHO is strongly advocating countries on the importance of such policies [32]. Furthermore governments need to consider the use of open source software and encourage software programs to be freely accessible and easy to use. Another reason why governments need to lead the eHealth and mHealth application in health care is to address health system strengthening and equity.

In addition to mHealth services need to be improved
Strengthening communication between health care providers in order to improve decision-making processes is known to be effective. Besides communication infrastructures the health care services also need to be improved [38]. In Chapter 3, the importance for a woman to have access to emergency obstetric care and to have the decision to referral be made rabidly is discussed. However, even if the decision is made in time, but there is no transport, or the health services cannot provide the needed caesarean section, improved communication will have made no difference for her.
Governments and organizations must address the underlying factors that limit women from accessing health services. A reason for women not accessing services, besides delaying referral decisions, is often lack of transport and means to pay for transport. Programs need to be designed that incorporate addressing underlying factors such as poverty, lack of education and violence. One of the ways in which mobile phones can be used to empower women, is to enable them to access micro-financing projects and to start income generating projects.

5.1.6 Cost-effectiveness and efficiency

A review on studies in developed countries indicates the health information technology can improve quality and efficiency health services, for example; sending reminders to patients increases the uptake of services, adherence to treatment guidelines, improves monitoring and evaluation of treatment, reduces medication errors and decreases use of potentially unnecessary or inappropriate care [58]. However research is needed to provide evidence and to give feedback on the impact of ICT in improving health system performance, by

showing its impact on building human capacity, providing access to knowledge, supporting decision-making processes and eventually leading to improved care for patients [32].

The essential analysis of cost-effectiveness of mHealth applications is largely lacking, not to even mention maternal health studies. A review on studies in developed countries on behaviour change interventions, delivered by mobile telephones short-message services, concluded that the interventions had positive impact on short-term behavioural outcomes [16]. Nevertheless, it is unclear if this is the most cost-effective way to improve behaviour compared to some other methods In a project, daily reminders were sent on ART (medication related to AIDS) and the high cost were considered as the main limitation for scaling up [31]. The estimated cost for expanding the project to cover all people in need in South Africa would have been 350.000$ a month. Improving adherence to ARV's is a crucial; however a decision-maker needs to know if the same effectiveness could be achieved using some other method with less cost.

Besides analyzing the cost-effectiveness, it is important to have studies on cost-efficiency of mHealth solutions, i.e. to what extent it makes sense to invest in mHealth applications in improving outputs of services related to the cost involved. For example, in maternal services it would need to be identified if the use of mobile phones would increase the number of referrals (as well as the reasons for the results).

5.1.7   The expectations of mHealth

The surprisingly fast penetration of mobile phones in developing countries has raised a lot of expectations. There are clear and strong improvements for example in the fields of agriculture and commerce, reaching also the poor and disadvantaged. In the field of health, the discussion and application of mobile technology is still very recent. Nevertheless the expectations are high and sometimes they seem to be unrealistic; not based on evidence. Yet, this far, articles, reports, presentations, interviews and discussions deal with fragmented actions in only a few developing countries such as projects that raise awareness on HIV and AIDS using text messages or promote health professionals to use an electronic treatment protocol.

The fragmentation of actions and the newness of mHealth require discussions and extensive research. Issues such as long-term sustainability, Public-Private-Partnership (PPP), cost-effectiveness and efficiency, integration into health systems, policy development, user-friendliness and equity among population groups need to be seriously considered. In relation to maternal health, discussions need to address the continuum of care, strengthening of capacity and improvement of women's rights.

5.1.8   Using text messages

Mobile phones have a potential to improve coordination and efficiency of work. Text messages can be used to mobilize and inform communities. Examples of organizations that use text messages are Text to Change and Cell-Life. The first reports indicate positive results

on for example use of specific services. Nevertheless, issues such as cost and privacy need to be addressed. Regarding maternal health, text messages, especially quizzes, can inform the community on health services, danger signs during pregnancy and family planning. Further, a quiz gives project designers feedback enabling them to adapt questions during the process, minimizing miscommunication.

Random text messaging can be a risk for effectiveness of planning health messages and to privacy. In some developing countries, private organisations frequently send messages to mobile phone users to the extent that it becomes irritating and may even result in not reading any messages except from a known source. Using text messages worthwhile, kiwanja.net as well as SexInfo mentions that community participation is a key element. In the project design SexInfo realized that youth required a program that would only send messages on request of the individual. Governments should develop policies and guidelines to ensure that the messages meet legal and ethnical requirements and support the public policies.

5.1.9 The development of a Platform
The extremely complicated process of finding formal and informal information regarding mHealth, in addition to the outcome of a meeting on eHealth held in Accra this year, resulted in designing a Platform on mHealth. Despite the fact that the Platform is an additional element and is not included as a part of this thesis, it was considered worthwhile as it may make a great impact on the future development of research and projects concerning mHealth. The publication of information regarding mHealth in developing countries is growing very fast since new projects and organizations in addition to evidence are gradually becoming available.

5.2 Recommendations
Most of the issues that need to be discussed in order to improve the utilization of mobile phones in the field of health, including maternal and newborn health, have been discussed. These are the five most important recommendations:
- Research should provide stronger evidence regarding the effectiveness, efficiency and costs of mHealth applications.
- Governments should develop mHealth and eHealth policies and these should be filtrated to all the organizations – private and public – working in the field of ICT and health.
- Governments and organizations need to invest in improved private public partnership relations, ensuring win-win solutions for both.
- Organizations and governments working in the field of mHealth, including maternal health, need to be provided with more information regarding potential, possibilities, constrains, software programs, etc. so that they can make informed choices in utilizing mobile phone technology.

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