Journal of Midwifery & Women's Health www.jmwh.org

Original Review

mHealth for Midwives: A Call to Action

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The use of mobile phones has grown exponentially in the last decade including in some of the most remote and low-resource regions of the world. With the geographic expansion of mobile phone use, information and communication technology for development (ICT4D) was born, and innovative uses for mobile technologies in various fields including health care have emerged. This use of mobile technology in health care is known as mHealth. mHealth interventions are being used internationally to improve maternal and child health. Be it the use of a mobile phone to call for emergency transport, remote consultation, or large-scale short message service (SMS)-based community education programs, mHealth is demonstrating its utility in reproductive health programs throughout the world. This article describes the evolution and challenges of mHealth, discusses the role of mHealth in achieving Millennium Development Goals 4 and 5, and addresses the potential impact of mHealth for midwives. mHealth represents a new area of global health that warrants the attention of midwifery advocates. Midwifery leadership in the field of mHealth at this early stage of its development will ensure future health programming that is relevant to the needs of women and the midwives who care for them.

J Midwifery Womens Health 2013;58:76–82

Keywords: cellular phones, mHealth, global health, international health, midwifery education, midwifery workforce, patient education, preventive health care, public health, telemedicine, vulnerable populations

INTRODUCTION

Mobile phones are in the hands of increasingly more women and midwives, including those in some of the poorest and most difficult to reach areas of the world. These phones are creating unprecedented opportunities for improving maternal and child health outcomes. The evolution of mobile technology and the role it will play in the future of health care delivery will have a great impact on the midwifery profession, especially in lesser developed countries. Unfortunately, there are very few midwifery voices helping to shape this new approach to health care delivery. This article aims to describe the evolution, current applications, and future challenges of mobile technology in reproductive health, focusing primarily on resource-poor settings, and makes the case for greater midwifery involvement in this exciting new field.

EVOLUTION OF mHEALTH

The dawn of the new millennium saw the emergence of "e-Everything": eCommerce, eBusiness, and eHealth. eHealth is "the use of information and communication technology such as computers, mobile phones, and satellite communications for health services and information."[1] In the late 1990s and early 2000s, many hoped that eHealth would revolutionize health care information systems. In many ways, eHealth did transform the way health information is managed, but it remains a fragmented system in the United States with much work to be done to create interoperability, efficiency, and universality of systems. Unfortunately, eHealth initiation is a costly process, and developing countries can rarely afford to implement such systems. Paradoxically, in these same countries, mobile phones have gone from being a luxury item owned by a selected few to a basic good possessed by the masses. Wireless technologies spread in developing countries at unprecedented rates, leapfrogging the time lag previously observed with other technologies.[2] According to the International Telecommunication Union, there are now more than 5 billion wireless subscribers, and more than 70% of them reside in low-income and middle-income countries.[3,4]

With the explosion of mobile communication, a separate branch of eHealth was born, known as mHealth. While a standardized definition of mHealth has not yet been established, the World Health Organization (WHO) uses the following definition: "mHealth or mobile health is medical and public health practice, supported by mobile devices such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices. mHealth capitalizes on mobile phones' core utility of voice and short message service (SMS, commonly referred to as text messages) as well as more complex functions including general packet radio service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), global positioning systems (GPS), and Bluetooth technology."[5] Definitions for terms and acronyms relevant to mHealth can be found in Table 1.

mHealth serves a multitude of functions, and its utility differs depending on the environment in which it is used. In the United States, the mHealth concept was initially linked to remote monitoring, such as heart rate evaluation. Its functionality then grew to mirror that of general eHealth, encompassing medical records, pharmaceutical data, and insurance information. Instead of using a computer terminal, people could instantaneously obtain this information via mobile phones.[6] The potential of mHealth is vast, particularly in lesser-developed countries where cell phone accessibility and use far surpasses that of computers. The gross diffusion of mobile phones and the relatively low cost of mHealth programs make it an adaptable and portable health care tool, not only for health professionals but also as a population-based

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 1526-9523/09/$36.00 doi:10.1111/j.1542-2011.2012.00243.x

Quick Points

- Mobile health or mHealth is the use of mobile devices, such as mobile phones and personal digital assistants, for a variety of health-related applications including education, remote data collection, monitoring, and consultation.
- A variety of reproductive health projects in developing and developed countries are using mHealth.
- In low resource areas, mHealth can extend the reach of reproductive health services to medically underserved populations.
- The field of mHealth is reaching a critical point and is poised to transition from disparate pioneering projects to full integration into health care systems and is becoming a formal part of health care delivery throughout the world.
- Midwives are encouraged to take the opportunity to be involved in the mHealth revolution, including helping to develop mHealth initiatives that are relevant and functional for our profession and the women and families we serve.

Table 1. Definitions of Common mHealth Terms

Term	Abbreviation	Definition
Bluetooth technology	Not applicable	A technology standard used to enable short-range wireless communication between electronic devices.
Electronic health record/Electronic medical record	EHR/EMR	A systematic collection of health information on individuals or populations in an electronic format. It allows for global connection to massive amounts of health care data for research and patient care.
General Packet Radio Service	GPRS	This is used by GSM mobile phones to transmit Internet protocol packets.
Global Positioning Service	GPS	Global navigation satellite system that provides positioning, navigation, and timing information.
Global Systems for Mobile Communications	GSM	This system is the world's most popular mobile phone technology, largely in Europe and Asia. It allows for international roaming arrangements between mobile carriers and enables phone usage around the world.
Information and communication technology	ICT	A set of technological tools and resources used to communicate, create, disseminate, store, and manage information.
International Telecommunications Union	ITU	This is the United Nations agency for information and communication technology issues.
Internet protocol	IP	Standard Internet communications protocols allow digital computers to communicate over long distances. The Internet is a packet-switched network, in which information is broken down into small packets, sent individually over many different routes at the same time, and then reassembled at the receiving end.
Personal digital assistant	PDA	A handheld computer for managing contacts, appointments, and tasks. PDAs typically include a name and address database, calendar, to-do list, and note taker, which are the functions in a personal information manager application. Wireless PDAs may also offer e-mail and Web browsing. Data are synchronized between the PDA and desktop computer via a cable or wireless connection. PDAs mostly evolved from stand-alone devices to some of the applications in a smart phone, which can also perform countless other tasks.
Short message service	SMS	Text message communication via mobile phones. It allows the exchange of short (less than 160 characters) messages between mobile devices.
Third and fourth generation cellular telecommunication standards	3G, 4G	1G began the 1980s, 2G was introduced in the 1990s, and 3G was launched in early 2001. The 4G promises to provide a secure all-IP solution that is much faster than previous generations.

Source: WHO,[5] mHIMSS,[31] Britannica,[32] PC Magazine.[30]

Box 1. Categories of mHealth
Education and awareness
Remote data collection
Remote monitoring
Communication and training for health care workers
Disease and epidemic outbreak tracking
Diagnostic and treatment support

Source: Vital Wave Consulting.[1]

tool for community health education and research data collection. The uses of mHealth can be categorized as illustrated in Box 1.

Within the international reproductive health community, mHealth is beginning to serve as a tool for the improvement of maternal and child health. From basic distribution of mobile phones to facilitate emergency transport and consultation to the use of more complex programs for remote diagnosis, mHealth is being incorporated into reproductive health programs across the globe.[7] mHealth offers creative solutions to the challenges that midwives face in caring for women, and our voices are important in shaping its future. The midwifery community must seize the opportunity to engage with these emerging technologies.

mHEALTH IN REPRODUCTIVE HEALTH

Benefits are already being seen with the use of mHealth as it relates to midwives and reproductive health, including increased access to emergency obstetric services, increased consultation and information sharing between midwives and other health professionals, improved data collection, and increased support structure for midwives and women, including increased social connectivity.[8,9] While little outcome data are currently available regarding mobile health use in reproductive health programs, several projects have targeted midwives and community health workers as agents of mHealth programs with documented positive impacts. This section describes selected programs that are well established, committed to making their outcomes data available, and particularly relevant to midwives.

In the remote Aceh province of Indonesia, a midwifery-focused pilot program was launched to find out how mobile technologies could serve as a support for midwives working in rural areas after the 2004 tsunami.[8] Midwives from this area receive limited education and generally have poor access to capacity-building activities. This pilot program gave mobile phones to midwives, midwife coordinators, and physicians within the health system. The project aimed to use mobile technology to improve the quality of rural health services and reduce maternal and infant mortality. It also sought to facilitate communication between midwives and physicians and assess the feasibility of mobile data collection.[10] Mobile phone technology allowed midwives to remotely access clinical information, collect patient data and critical health indicators, track patients, and actively participate in this information-sharing system. Additionally, midwives could access information that would enhance their clinical practices through the use of educational SMS messages.

At the end of the pilot project, midwife interviews revealed that the use of mobile phones improved work efficiency, enhanced ability and confidence, created more efficient patient data collection systems, enhanced relationships with community members, facilitated relationships among both other midwives and physician consultants, and facilitated emergency referral and transport. The midwives felt their medical knowledge increased through the use of mobile technologies.[10] One of the greatest benefits of the project was the sense of empowerment enjoyed by the Aceh midwives. In qualitative interviews, midwives expressed feeling more competent and confident in their practices as well as receiving greater respect from the community.[8] The results of the studies conducted with these midwives were published in 3 separate articles addressing different aspects of use of mobile technologies in midwifery care, and they represent the only data available on midwives and mHealth currently published in peer-reviewed journals. The authors paid particular attention to the impact of gender roles as well as other sociocultural factors on the midwives' ability to integrate mobile phones into their practices.

Another midwife-focused project that is calling the attention of many is Mobile Technology for Community Health (MoTeCH). Implemented through the Millennium Villages Project in partnership with the Grameen Foundation and Ghana Health Service, it is a mobile phone-based service being piloted in Ghana to close knowledge and information-sharing gaps in the current maternal health system. The MoTeCH service addresses maternal health on 2 fronts: strengthening the maternal health system and educating mothers and families. Each woman's data are entered into mobile phones during prenatal visits by nurses and midwives, creating a mobile electronic medical record (EMR). Her information is then sent to MoTeCH servers and checked against the recommended care schedule.[11] Both the woman and the provider are then sent messages in the case of missed appointments or points of care. Women also are sent educational messages relevant to their gestational age and their particular needs (eg, missed tetanus shot, preterm birth). The MoTeCH service addresses low rates of female literacy by providing mobile phone-based education, not only via SMS but also through prerecorded messages in the local dialect that can be retrieved at the woman's convenience. The service also generates monthly reports that are sent to health officials so that national databases easily can be updated and maintained. A recent evaluation found MoTeCH programming to be a strong foundation from which to grow in meeting challenges in Ghana's maternal health system. Of note, researchers found a high demand for the phone-based health information service by the communities served.[11]

Many regions of the world lack reliable health data, presenting an important obstacle to health service planning. Accurate maternal mortality and morbidity estimates are an integral part of maternal health programming, but in many regions of the world, the lack of vital statistics infrastructure impedes effective data collection.[12] Several pilot projects are employing mHealth technologies to register births and deaths as they occur, utilizing simple SMS technology. In Uganda, it is estimated that as few as 21% of births are registered, prompting the creation of a pilot mHealth vital statistic registration

project in Kiboga District. This joint effort between the United Nations Children's Fund and Uganda Telecom focuses on reducing the number of births and deaths that escape registration.[13] This project, called MobileVRS, utilizes a technology that allows members of each community's village health team to register vital statistics (eg, births and maternal deaths) via mobile phones. The program requires no software installation and can be used from any kind of mobile phone. Costs related to data transfer are negligible, and it is expected that this project will greatly reduce the amount of time required to report vital statistic events. If this pilot project is successful, the use of mobile phones for vital statistic registration will be introduced throughout Uganda in 2014.[13]

Beyond vital statistics, mHealth data collection can be used to identify gaps in maternal health care. In Senegal, the Ministry of Health began a pilot project aimed at improving maternal health and reducing mortality. This project was a joint effort between the Ministry of Health, WHO, and Datadyne, a social enterprise based in Africa that has created an mHealth data collection software called Episurveyor. This software is free for most users and is being implemented in mHealth programs across the globe.[14,15] In the Senegal pilot program, maternal health data were collected via mobile phones during routine postpartum visits to community health posts. Community health workers completed survey interviews with postpartum women utilizing their mobile phones as data collection devices. In the first 6-month pilot, the data showed that partograms were not being adequately used during births. On receiving this information, the Ministry of Health began a partogram distribution campaign. Participants in the pilot program stated that the greatest advantage to using mHealth data collection was the reduction in time needed to collect the maternal health data. The overall response to the project was positive, and the Senegalese Ministry of Health was supportive of possible expansion of the pilot.[16]

The use of mobile phones for interactive patient education is another exciting mHealth application, as mobile phones provide a whole new level of access to the public. Organizations such as Text to Change capitalize on the wide diffusion of mobile phones, using them as a platform to spread health education information. Text to Change created an HIV education program that rewards mobile phone users with prepaid phone minutes in exchange for correctly answering SMS health questions. They also provide maternal health education to pregnant women via text messages, incorporating the use of prerecorded voice messages for women who are illiterate. This program seeks to increase the number of women who complete the WHO's recommended 4 prenatal visits per pregnancy and increase the number of women who seek skilled attendants for their births and utilize postpartum care.[17] Another program, CycleTel, is being used in India to assist women using the Standard Days Method of family planning. After registering the first day of their menstrual period via SMS, women receive daily messages advising them of their fertility status.[18]

While the potential of mHealth is particularly notable in the developing world, it is also expected to play an important role in maternal health projects in developed countries. Health education-focused SMS programs were first used in Africa, but the model has recently been introduced in the United States.[19] Text4Baby, which was founded by National Healthy Mothers, Healthy Babies Coalition; Johnson & Johnson; and Voxiva in collaboration with the US Department of Health and Human Services, among other government agencies and private partners, is a prenatal education initiative that provides gestational age-relevant pregnancy and infant care information via text messages. According to Andrea Schwartz Goodman, MSW, MPH, of the National Healthy Mothers, Healthy Babies Coalition (written communication, April 2012), Text4Baby has enrolled more than 320,000 users since its launch in February 2010 and is striving to reach one million users by the end of 2012. An evaluation of Text4Baby in San Diego revealed that 63% of study participants remembered an appointment or immunization that their child needed due to Text4Baby messages. Similarly, 75% of participants reported learning medical warning signs they did not know, and 71% reported talking to their physicians about a topic that they read on a Text4Baby message. Finally, 39% of all participants and 53% of uninsured participants reported contacting a service or phone number that they received from a Text4Baby message. The evaluators concluded that underinsured participants are improving their access to health services as a result of Text4Baby messages (A. S. Goodman, MSW, MPH, written communication, June 2012).

Recently, a comprehensive review of outcomes in mHealth maternal and newborn health programs was released. Tamrat and Kachnowski conducted a comprehensive review of literature published between 2000 and 2010, identifying 1538 articles addressing mHealth in reproductive health.[22] Of these, only 34 articles met selection criteria including English language, peer review, and explicitly addressing mobile technologies and maternal and newborn health or the Millennium Development Goals. The review concluded that mHealth made a positive impact on several areas of maternal-child health such as emergency obstetric referral, community health worker function, and preventive services through dissemination of education.[22] Despite these promising results, a comprehensive review on mHealth released in 2010 by the Earth Institute of Columbia University did not find sufficient evidence to conclude that mHealth has had "actual and wide-scale health impacts."[23] Tamrat and Kachnowski also cited a lack of project evaluation and a general paucity of policy and management frameworks for the integration of mHealth services into the broader health care system.[22] The lack of emphasis on monitoring and evaluation may be partially due to the fact that mHealth is a relatively new field and has been pioneered primarily through small-scale pilot projects conducted by independent nonprofit organizations.

THE FUTURE OF mHEALTH

The field of mHealth is reaching a critical point and is poised to transition from disparate pioneering projects to full integration into health care systems and becoming a formal part of health care delivery in both the developing and developed worlds. mHealth projects around the world are seeing results such as increased access to health care and health-related information; increased efficiency and lower cost of service delivery; improved ability to diagnose, track, and treat disease;

more timely, actionable public health information; and expanded access to health education.[23]

There is a great need for improved data collection within mHealth projects to understand the specific impacts of mHealth applications and interventions across diverse cultural and situational contexts. One initiative that seeks to address impact evaluation and create greater cohesiveness and information sharing in the mHealth sphere is the mHealth Alliance. The Mobile Alliance for Maternal Action is the reproductive health arm of the initiative, which aims to build the evidence base on the effective application of mobile technology to improve maternal health.[24] This program currently focuses on Bangladesh, India, and South Africa and provides resources and technical assistance to promising new business models.

Challenges to the implementation of mHealth applications in the area of women and children's health are surfacing as lessons learned in the field are being shared. Cultural considerations that limit the use of information and communication technologies for health include gender issues such as women having less access to mobile phones than men and the traditional role of women in certain societies being in conflict with the independence and professional responsibility that mobile phones can provide.[8,23] High rates of illiteracy steepen the learning curve for using mobile phones for data collection and transmission and could be a significant barrier.[23] However, mobile phone use also has been cited as a tool for literacy improvement in low-literacy populations.[25]

Logistic and usage issues also contribute to the difficulty of wide-scale implementation of mHealth. The fact that some mHealth programs require sophisticated or costly phones poses a barrier. In some areas, issues of consistent access to electricity must be addressed before mHealth technologies can be implemented.[26] Methods of ensuring confidentiality of health information must be developed when mobile phones that are shared among family members or groups of people are used to transmit patient health data.[23] The overarching challenge in the years to come is that of establishing national and global mHealth infrastructure.

mHEALTH AND MIDWIVES

In June 2011, the WHO released its first definitive document assessing the field of mHealth and formulating a global mHealth strategy. Recognizing the necessity of creating a global standard to maximize the impact of mHealth programs, the WHO proposes that "if implemented strategically and systematically, mHealth can revolutionize health outcomes, providing virtually anyone with a mobile phone with medical expertise and knowledge in real time."[5] The document outlines specific steps, including the development of an international framework for the evaluation of these programs, that will provide governments with the evidence needed to allocate funds and create policies that promote strategic mHealth implementation.

A few months later, the United Nations Population Fund and collaborating organizations released *The State of World's Midwifery Report 2011: Delivering Health, Saving Lives,*[27] signaling a monumental recommitment to strengthening the role of the midwife globally. The report calls attention to the key role that midwives play toward the achievement of Millennium Development Goals 4 and 5 that seek to reduce under-5 child mortality and decrease maternal deaths. Additionally, this document gives country-specific recommendations centered around raising the profile of midwifery as a profession, increasing and enhancing the midwifery workforce, and empowering midwives to form stronger collaborative ties with other members of the health care system and within their communities.[27]

The relationship between mHealth and midwives can be mutually beneficial. As evident from the results of the projects previously cited, mHealth has the potential to play a significant role in achieving the goals set forward in *The State of World's Midwifery Report*.[27] Based on existing evidence, mHealth applications can be used to achieve the goals of increasing public awareness of midwifery care, midwifery workforce recruitment and retention, and access to high-quality training and continuing education for midwives.

As providers on the front lines of health care delivery, midwives have a great stake in how the field of mHealth develops. Experts are calling for a more health sector–driven and user-driven approach to adoption of mHealth, stating that mHealth programs must be strategically planned with the specific target group (providers or population) in mind rather than being technology-driven, as were many of the first mHealth projects.[28] Midwives can play an instrumental role in ensuring that mHealth initiatives are implemented in a way that is relevant and optimally functional for midwifery and for the women and families who are served within their particular context.[23] The midwifery model of care emphasizes a holistic approach centered on understanding the woman within the context of her family, her community, her cultural beliefs, and her physical settings.[29] Midwives have the insight and knowledge to translate mHealth applications into health services that address the needs of the communities where they work.

Because mHealth is a relatively new field, and perhaps also due to the high-touch, low-tech midwifery approach to care, there has not been great midwifery interest and involvement in mHealth to date. Very little midwifery-led and midwifery-focused mHealth research has been published. It is critical that midwives stay abreast of the latest developments in mHealth and make use of opportunities to engage in mHealth programming and research. Conferences such as the mHealth Summit, International Conference on Information and Communication Technologies and Development (ICTD), and International Congress on Nursing and Informatics are good sources of information and networking opportunities. A recently formed organization called TechChange offers month-long online courses on use of mobile technology for development. Social media such as Facebook and Twitter also can be used to stay updated by following projects and people that are innovating in the mHealth space.

There is a growing need for leadership and technical assistance to international maternal and child health projects employing mHealth tools. Midwives interested in global health should take advantage of these opportunities. Midwives already working on global health projects should provide leadership in incorporating mHealth tools into programming and ensure built-in evaluation mechanisms. They should also

strive to publish outcomes data in the scientific literature. Additionally, midwifery leaders should investigate ways in which midwives in less-developed countries can be better connected to each other for professional consultation and networking through mobile technologies. This can help strengthen national midwifery associations and advance the profession of midwifery globally. Current training programs for midwives in less-developed countries, such as the American College of Nurse-Midwives' Life-Saving Skills Curriculum, should look for ways that mobile technologies can be incorporated into training. Finally, as the mobile EMR comes into greater use in less-developed countries, midwifery leaders must advocate for EMR systems that are interoperable, efficient, and confidential.

CONCLUSION

We are living in truly extraordinary times: the exponential growth of mobile communications is connecting people in a way previously not imagined and creating opportunities to make unique health impacts. Simultaneously, the global community has turned its attention to midwifery in recognition of the unique role that midwives play in delivery of health care in vulnerable communities worldwide. Integrating the strengths of midwifery care and mHealth technology into the strategy for achieving the critical Millennium Development Goals related to maternal and child health is a powerful way forward. Midwifery involvement in the mHealth revolution, particularly at this critical point in its development, could benefit midwifery education and access to midwifery care, creating the shift needed to make real strides in decreasing maternal mortality globally.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

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