

# Preventing and managing cardiovascular diseases in the age of mHealth and global telecommunications

## Lessons from low- and middle-income countries



Presented to  
The Institute of Medicine's Committee on Preventing the Global Epidemic of Cardiovascular Disease

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July 1, 2009

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## A Leveled Playing Field

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During the first decade of the 21<sup>st</sup> century, humans witnessed an intriguing change in the pattern of penetration of information and communication technologies around the world.

Freed by wireless networks from the need to invest time and money in the development of expensive wired infrastructure, so-called ‘developing countries’ started to close the digital gap that had traditionally separated them from their richer counterparts. By 2006, the vast majority of telephone subscribers in Africa (87.1%) had mobile devices, providing some of the strongest signals of the increasing obsolescence, and perhaps impending extinction, of fixed land-based telephone lines. That same year also showed another new phenomenon: hyper-penetration, with countries such as Spain and Italy reporting more active mobile phones in circulation than people<sup>1</sup>.

By the end of 2008, it was estimated that there were over 4 billion mobile phones in the world, and that at least two thirds of them were in the hands of people in low- to middle-income countries<sup>2</sup>. At that point, Africa had already surpassed North America in terms of the total number of mobile phone subscribers<sup>3</sup>. This phenomenal level of penetration of a new technology was also evident in other regions of the world. By mid-2008, for instance, 84% of Colombians had mobile devices<sup>4</sup>, which placed this country between Canada and the United States, where the penetration that year was 74% and 90%, respectively<sup>5</sup>.

Increased access to digital mobile telecommunication devices brought with it unprecedented opportunities for traditionally disadvantaged communities to transcend distance and compress time. Using mobile phones, farmers could check the prices of their products in different potential markets, being able to choose the best location and timing to sell them. These powerful tools also started to shift the balance of power away

from repressive or corrupt governments. In the Philippines, for instance, text messaging was used to topple the government of President Estrada in 2001<sup>6</sup>. Thanks to user-friendly cameras, the world learned about human rights abuses at the Abu Ghraib prison in 2004 or on the streets of Teheran following the 2009 presidential elections, hinting at the futility of efforts by rulers to keep them secret.

Very soon, examples illustrating the transformative effect that these little powerful tools could have on the health system started to emerge, in all regions of the world. This global explosion of mobile health applications and services, known as ‘mHealth’<sup>7</sup>, has now created a special sub-category of eHealth with unique opportunities for mutual learning across traditional boundaries, and for reaching the level of collaborative efforts that are required to reduce staggering numbers of premature deaths or to cope with the onslaught of complex chronic conditions throughout the world.

By the end of the decade, the strong convergence of mobile telecommunication devices and the World Wide Web was ushering the era of the ‘Mobile Web’<sup>8</sup>, promising even more revolutionary changes in the way in which humans access information, communicate with each other, learn and think.

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## The Task

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In 2008, the Institute of Medicine’s Committee on Preventing the Global Epidemic of Cardiovascular Disease<sup>9</sup> was charged with offering conclusions and recommendations on the control of cardiovascular disease targeted to a wide range of stakeholders involved with global health and development. As part of the process, the committee members expressed strong interest in improving their level of awareness and understanding of the potential role of emerging digital health approaches in addressing cardiovascular disease.

This document was commissioned in June of 2009. Its overall objective was to provide a

brief discussion, based on expert opinion that could assist Committee members in assessing the potential value of innovations in digital health to advance the prevention and sustained management of cardiovascular disease.

According to the expressed needs of the Committee, this document should achieve the following specific objectives:

- Describe a framework of digital health approaches;
- Illustrate promising approaches within this framework using specific examples that have been developed and tested in the developing world (or through collaboration with individuals or organizations in the developing world) and could be applied to the prevention and management of cardiovascular disease. These examples may include both innovations that address cardiovascular disease and those developed to address other diseases that have strong potential to be adapted to address cardiovascular disease;
- Briefly comment on the potential for future innovations developed and tested anywhere in the world to contribute to advances in health and disease management in developed countries;
- Include a short bibliography of suggested reading material that could assist the committee in exploring this topic in greater depth.

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## Methods

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Although conducting a formal systematic review of the literature was beyond the scope of the work, this work was guided by a protocol that included the following explicit elements:

## Search strategy

A search of MEDLINE from 1996 to the third week of June of 2009 was conducted with the following terms:

*(mobile: and (telephone: or phone:)).mp.*

*OR*

*(Internet: or online: or web or digital).mp.*

*AND*

*(cardiac or heart or cardio:).mp.*

On June 22, 2009, this search was adapted and executed through Yahoo! and Google, using all possible combinations of terms. The first 20 ‘hits’ yielded by each iteration was examined.

The yield of these electronic searches was complemented with a scan of the reference lists of the citations of eligible documents, and the personal collections of the author, who has been monitoring this literature constantly as the holder of the Canada Research Chair in eHealth Innovation<sup>10</sup>, Chief Innovation and Founder of the Centre for Global eHealth Innovation<sup>11</sup>, as the Founding President of the Spanish eHealth Network<sup>12</sup>, and as a member of the Global Observatory for eHealth’s Strategic Advisory Group of Experts<sup>13</sup> (SAGE) of the World Health Organization.

## Selection criteria

A document was deemed potentially eligible if it:

- Presented a framework of digital health approaches that could be applicable, directly or indirectly, to the prevention and management of the epidemic of cardiovascular disease (this was the main priority, as it would enable the categorization and selection of specific examples to illustrate);

- Described specific digital (telephone- or Internet-based) interventions or programs created in the developing world (or through collaboration with individuals or organizations in the developing world) that could be applied to the prevention and management of cardiovascular disease, even if they had been developed to address other diseases; and
- Was published in English, at least in part

### Information extraction

From each of the eligible documents, the author extracted the following from at least one exemplar for each relevant category in the selected framework:

- Name of the intervention and URL of the main source of information
- General characteristics (e.g., country where it was developed, technological platform, target audience, sources of financial support)
- Specific relevance to the prevention and management of cardiovascular disease
- A diagram or picture of the main components

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## The Framework

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The report entitled '*mHealth for Development: The Opportunity of Mobile Technology for Health Care in the Developing World*', was chosen as the main source of the framework. This document, which was supported by a public-private partnership between The United Nations Foundation and the UK's Vodafone Foundation, used six 'application areas' to describe 51 projects spanning 26 different countries<sup>14</sup>. These same six areas, which have also been adopted by Wikipedia, will be used in the rest of this document to illustrate promising examples that have been developed and tested in the

developing world (or through collaboration with individuals or organizations in the developing world) and could be of use by the Committee to guide their conclusions and recommendations on the control of cardiovascular disease at the global level.

The six categories used in this framework are the following (the original labels have been preserved, but the descriptions have been modified to fit the broad scope of this report):

- **Education and Awareness:** This category includes interventions designed to provide stakeholders with the information they need to support their decisions, at the right time, at the right place and in the right format.
- **Data Collection:** This includes tools that capture facts and statistics at the community level, enabling policy makers to judge and improve the effectiveness of healthcare programs, allocate resources more efficiently, and adjust programs and services accordingly.
- **Remote Monitoring:** This group refers to resources that allow one- or two-way communications to monitor the evolution of health conditions outside health care facilities, to maintain caregiver appointments, or to ensure adherence to medication regimens.
- **Peer-to-Peer Communication among Health Care Workers:** This category encompasses technologies that connect health professionals with each other, improving their sense of empowerment and their ability to make decisions effectively and self-sufficiently.
- **Disease and Epidemic Outbreak Tracking:** This group includes the use of devices to capture and transmit data on the incidence and geographic distribution of diseases, and to guide prevention and containment efforts.
- **Diagnostic and Treatment Support:** This category includes efforts to use technology to shift diagnostic and therapeutic efforts away from health care facilities to people's homes, workplaces, schools and the community at large, while

averting expensive or unfeasible face-to-face in-person consultations with health professionals or visits to hospitals or clinics.

## Exemplars

This section describes at least one example of innovations within each of the above six categories. Preference was given to interventions designed specifically to address issues related to the prevention and management of cardiovascular diseases, to those that were free, and those that were implemented or evaluated in a low- or middle-income environment.

### Education and Awareness: ProCor<sup>15</sup>

ProCor is a global network that uses low-cost technologies to provide people in clinical, community, advocacy, and policymaking settings with the information they need to promote heart health. It was founded in 1997 and appears to be the only global network promoting prevention of cardiovascular diseases in low- to middle-income countries.

The screenshot displays the ProCor website interface. At the top, there is a navigation bar with links: Home | About Us | Newsroom | Support ProCor | Contact Us. Below this is a header banner with the text "a global community promoting cardiovascular health" and a search bar with "Search by Topic" and "Search by keyword" options. The main content area is titled "Global Dialogue" and includes a description: "An open, global discussion forum for questions, information exchange, and networking to find solutions to shared challenges, moderated by ProCor." It also features a "Participate in discussion" section with a link to the "Discussion Policy" and a "Join ProCor's free email Global Dialogue" link. A sidebar on the left lists various categories under "Knowledge WHAT WE KNOW" (Global CVD, Healthy Behaviors, Risk Factors, Issues, Research Review, Resources), "Action WHAT WE CAN DO" (Clinical Practice, Community Programs, Advocacy & Policy), and "Global Community WORKING TOGETHER" (Global Dialogue, CVD Calendar). At the bottom, there is a table of discussion items.

Date	Author	Subject	Replies
30 June 2009	ProCor	<a href="#">Essential health information for India on the Internet</a>	0
30 June 2009	ProCor	<a href="#">Obesity among US preschool children</a>	0
26 June 2009	Coleman, Catherine	<a href="#">Re: Addressing chronic diseases in developing countries: Summary of email discussions (2)</a>	0
26 June 2009	ProCor	<a href="#">Effect of Hartslag Limburg intervention on lifestyle behaviors</a>	0

Through its Global Dialogue (see image above), ProCor disseminates timely, relevant, unbiased information about affordable, effective prevention strategies, and facilitates

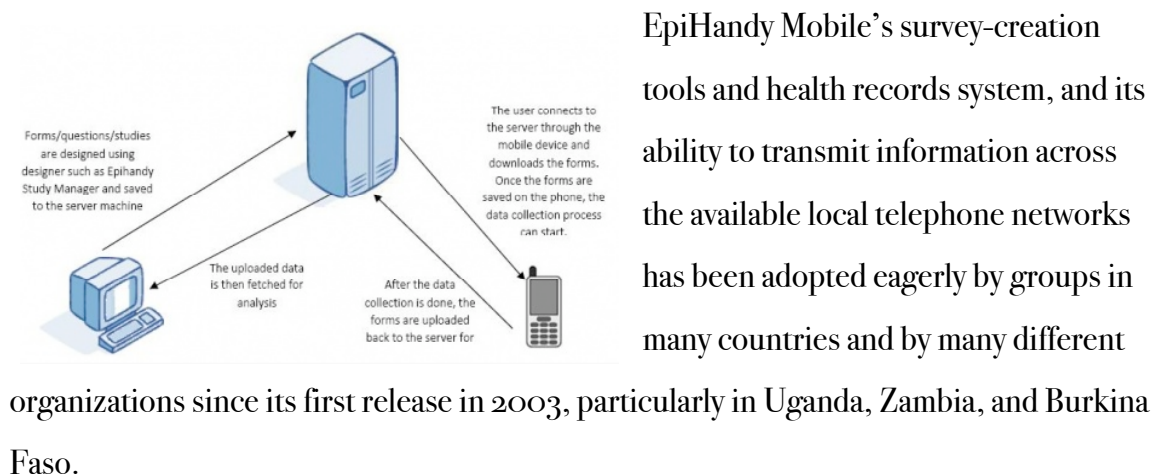


discussion among a global community that is committed to heart health. On a daily basis, members receive free e-mail updates with the latest developments in research, policy, and community interventions. By mid-2008, it was reported that there were more than 1200 people working around the world in clinical, community, research, and policy settings are part of ProCor's e-mail network, and that each message could ultimately reach between 30,000-40,000 people.

### Data Collection: EpiHandy Mobile<sup>16</sup>

This is a survey and data management application for mobile phones developed at the Faculty of Computing and IT, Makerere University, Uganda.

The application draws on support from a variety of sources, including open tools for data storage (e.g. XML, MySQL), for form completion and submission (e.g., JAVA) and for the creation of personal health records (e.g., OpenMRS medical records system<sup>17</sup>) [The source code is available online through Google at <http://code.google.com/p/epihandymobile/>].



## Remote Monitoring: UKIERI's Mobile Disease Management System<sup>18</sup>

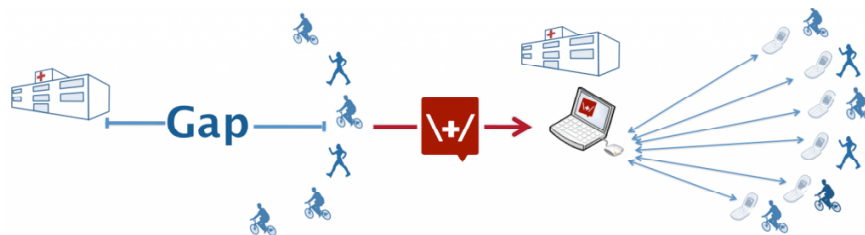
This is a joint effort by engineers at Loughborough University in the United Kingdom the India Institute of Technology Delhi (IIT Delhi), the All India Institute of Medical Sciences, Aligarh Muslim University and London's Kingston University. This collaborative project has led to the development of a mobile health monitoring system, first unveiled in 2005, which uses a mobile phone to collect up to four different physiological signals from a freely moving patient, including ECG, blood pressure, oxygen saturation and blood glucose level. These signals are relayed to health professionals who could then observe them and assess them remotely, anywhere in the world.



## Peer-to-Peer Communication among Health Care Workers: FrontlineSMS: Medic<sup>19</sup>

It is a free open source software application that turns a laptop and a mobile phone into a central communications hub. Once installed, the program enables users to send and receive text messages with large groups of people through mobile phones, without an Internet connection or need for training. Consequently, it enables two-way communication among health professionals, who can support each other easily, in real-enough-time.

FrontlineSMS:Medic can be used anywhere in the world simply by switching the cell phone's SIM card. It works with any existing plan on all GSM



phones, modems and networks, and it is scalable, allowing messages to be sent to individuals or large groups. As it is an open source resource, developers can freely take the source code and add their own features.

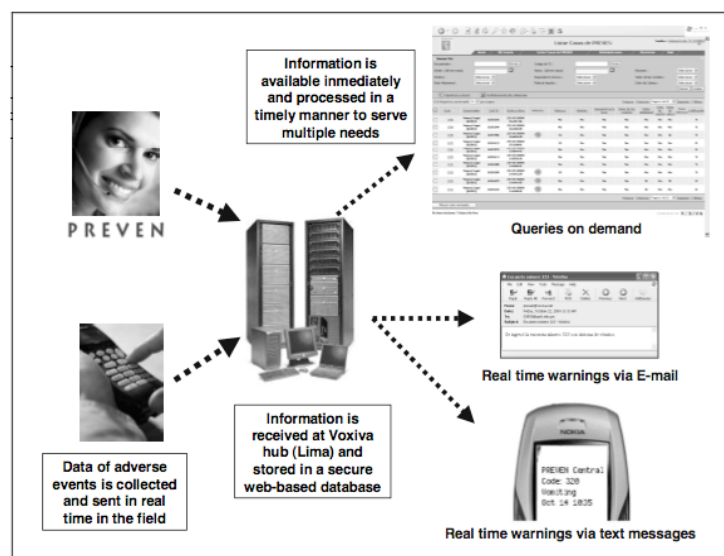
The application has been deployed and tested extensively in Malawi, a country facing major shortages of health professionals. There, health workers working with remote communities have been given a cell phone (bearing the hospital logo), loaded with airtime credit, which allows them to communicate with colleagues at the hospital, reporting on their patients' condition, medication needs and whether follow-up visits are required.

The system has yielded significant clinical and financial benefits, with dramatic reductions in unnecessary referrals and important savings in fuel costs.

Recently, FrontlineSMS:Medic has forged a strong alliance with Hope Phones, a US-based nationwide mobile phone collection campaign supporting mHealth programs at medical clinics in over 30 countries. Funds generated through sales of old cell phones in the US are being used to provide phones for clinics and healthcare workers in low-income countries [<http://hopephones.org/>].

## Disease and Epidemic Outbreak Tracking: Cell Preven<sup>20</sup>

This is a collaborative effort among the Universidad Peruana Cayetano Heredia (Peru), Imperial College (London, United Kingdom) and the University of Washington (Seattle, USA), in collaboration with Peru's



Ministry of Health.

Cell-PREVEN is an interactive system using cell phones and the Internet for real-time collection and transmission of information on drug-related adverse events. It was developed and tested as part of a program that promoted the use of metronidazole for the treatment of vaginosis among female sexual workers in Peru. The system stores data in an online database and generates text messages to mobile devices, alerting key personnel to unusual patterns of selected symptoms.

This project has demonstrated that it is feasible to develop a public health surveillance system based on cell phones, at very low cost and with no need for expensive computer or network infrastructure.

### **Diagnostic and Treatment Support: MDNet<sup>21</sup>**

This initiative creates free mobile phone networks to facilitate communication amongst physicians within countries in Africa.

MDNet Ghana, launched on January 1st, 2008, created the world's first country-wide mobile doctors network in Africa, which has made available the first country-wide directory of physicians in Ghana, and the delivery of bulk text messages to all physicians in Ghana, improving country-wide emergency response capabilities and communication. After only six months, participating physicians made an average of 1 hour and 15 minutes worth of calls per month to colleagues within the network, creating a total of 2,266 hours of clinical discussions within Ghana in the month of June alone.

In August 2008, MDNet Liberia was launched as a partnership among the Liberian Ministry of Health, the Liberian Medical & Dental Association, and the Liberian Medical Board. In less than a year, 100% of physicians in the country were already linked to the free communication network.

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## Emerging Trends: ‘Freeconomics’ and Web 2.0 resources

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While the rapid penetration of mobile devices in the first decade of the 21<sup>st</sup> century was spurring highly innovative mHealth initiatives in low- to middle-income countries, two new major forces emerged in high-income countries that are creating new opportunities to tame the epidemic of cardiovascular disease in high-income countries worldwide. One, known as ‘Freeconomics’, was fuelled by the capacity of the Internet to reduce marginal costs of the production and distribution of digital goods close to zero. As a result, corporations such as Google or Yahoo! could offer free products to users, while hoping that they would acquire other things for a fee or generate revenue through alternative paths (e.g., selling ads to other corporations).

The other force, known as Web 2.0, enables multi-directional interactivity and information sharing, collaborative creation of content, personalization of services and the transfer of power to the end user<sup>22, 23</sup>. This is in marked contrast to the original web, the so-called Web 1.0, which was ruled by Webmasters offering static websites full of text that was broadcasted and distributed uni-directionally to users mostly through hypertext links<sup>22</sup>. Now, the use of Web 2.0 tools in the health sector, such as blogs, podcasts, wikis and social networks is giving rise to the term ‘Medicine 2.0’<sup>24</sup>.

Today, thanks to these two forces, anyone with an Internet connection could access resources with power that could have been considered as science fiction just a couple of decades ago. The following illustrates some of the ways in which highly popular free Web 2.0 resources could promote more effective prevention of the global epidemic of cardiovascular disease, not only by health professionals but also by lay members of the public:

- Wikipedia could become a one-stop shop for anyone interested in the best available knowledge on how to prevent cardiovascular diseases (as of June 30, 2009, however,

Wikipedia did not include an article devoted exclusively to this topic)

- Google could be used to monitor and track the evolution of the epidemic of cardiovascular diseases around the world, just as it was done successfully in relation to the H1N1 outbreak in 2009<sup>25</sup>
- YouTube could act as a powerful tool to increase awareness levels among members of the public and health professional groups (as of June 30, 2009, a search of the contents of this application with the terms “heart”, “disease” and “prevention” identified 13,000 links to potentially relevant videos)
- Social online networking tools such as Facebook or MySpace, or Web-based videoconferencing resources such as Skype could provide a powerful platform to support peer-to-peer communication (as of June 30, there were over 180 different groups in Facebook focused on the prevention of cardiovascular disease)

In addition to these generic resources, tools targeting health professionals (e.g., Medting<sup>26</sup>, Ask Dr. Wiki<sup>27</sup>, Webicina<sup>28</sup>, Sermo<sup>29</sup>, docs2docs<sup>30</sup> or Doctors Hangout<sup>31</sup>) or lay members of the public (e.g., LifeMojo<sup>32</sup>, PatientsLikeMe<sup>33</sup>, Revolution Health<sup>34</sup>, Organized Wisdom<sup>35</sup>, Daily Strength<sup>36</sup>) promise to make important contributions to the control of the global epidemic of cardiovascular disease. Their value, however, remains unclear.

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## Suggested Reading

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Extremely Affordable Health Innovations

<http://www.worldcongress.com/events/HR09000/posters.cfm?confCode=HR09000>

Making the eHealth Connection

<http://ehealth-connection.org/>

The CATER Workshop on Technologies for Development

<http://cater.cs.nyu.edu/wiki/index.php/Workshop09>

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12. Fundacion eSalud [[www.fesalud.org](http://www.fesalud.org)]
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  28. Webicina [<http://www.webicina.com/>]
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  31. Doctors Hangout [<http://doctorshangout.com/>]
  32. LifeMojo [<http://www.lifemojo.com/>]
  33. PatientsLikeMe [<http://www.patientslikeme.com/>]
  34. Revolution Health [<http://www.revolutionhealth.com/community-overview/heart>]
  35. Organized Wisdom [<http://organizedwisdom.com/Home>]
  36. Daily Strength [<http://www.dailystrength.org/>]