

mHealth in the Prevention and Control of Non-Communicable Diseases in India: Current Possibilities and the Way Forward

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ABSTRACT

Mobile health technology has been used effectively for healthcare delivery in many developing countries. India is currently facing an epidemic of Non-Communicable Diseases (NCDs). With greater availability of cheaper phones in the market, the user base of mobile phones in India is increasing rapidly. The present review was thus conducted to explore the current possibilities and future scope of mobile health for NCD prevention and control in India. Literature search was conducted using MEDLINE, EMBASE, and Cochrane Library to collect information regarding mobile health interventions. Two authors extracted the data and included studies if at least the abstract was available. Information from key reports and government websites were also included. We examined information from domains such as need for mobile health in NCDs in India, and the advantages, scope and challenges of mobile health for healthcare delivery in India. Existing mobile health systems in India, current evidence of mobile health use in NCDs, and the recent mobile health related initiatives taken by Government of India were also assessed. Though we found some examples of current mobile phone usage in many health related programmes in India, data from mobile health research is scarce, particularly for NCDs. The current evidence base needs to be strengthened. There is also a need for identifying various opportunities in the recent initiatives taken by Government of India. It can be concluded that though mobile health has many advantages, there are numerous challenges which need to be addressed before scaling it up at the national level.

Keywords: eHealth, Mobile Health, Non-Communicable Disease, Telehealth, Telemedicine

INTRODUCTION

Non-Communicable Diseases (NCDs) are a major cause of global morbidity and mortality, contributing globally to 65 % of all deaths [1]. What is more alarming is that more than 80% of deaths due to NCDs occur in low and middle income countries, where control of communicable diseases and nutritional disorders still need a lot of attention.

In India, NCDs accounted for 40% of all hospital stays (with longer stays than for any other type of health condition), and 35% of all outpatient visits in 2004 [2]. The Global Burden of Disease study found that out of the top 25 causes of Years of Life Lost (YLLs) due to premature mortality in India, Ischemic Heart Disease (IHD) and stroke have moved from 8th and 13th rank in 1990 to 4th and 10th rank in 2010 respectively [3]. The overall prevalence of hypertension, IHD and Stroke in India have been estimated to be 159, 37 and 1.5 respectively per 1000 population [4]. 45% of deaths due to all causes in 30-59 y age group (which are also the most productive life years) were due to these four conditions alone [5].

Simultaneously, Mental Health Disorders (MHDs) are being recognized as among the leading causes of disabilities. NCDs and MHDs, have strong links with environmental and behavioural risk factors, often have protracted course with long latent periods, have a significant burden of undiagnosed and untreated illness in the community, require treatment that go beyond medicines, and the treatment is long-term, often lifelong. Thus, emergence of NCDs and MHDs has presented unique challenges to the healthcare system. In this regard, it is imperative for India to explore newer and more efficient models of healthcare delivery, including use of cost effective and easy to use technology, which is also widely acceptable and easily available to people. The present review will address MHDs as a part of NCDs.

With the rapid rise and adoption of Information Technology (IT) and mobile based technologies across various sectors such as banking,

communications, and governance, there has been an interest in putting these technologies to use in health-systems as well. Mobile health (mHealth) is the medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices [6]. The testing and piloting of mHealth interventions are already underway in various parts of the world. The International Telecommunication Union (ITU) and World Health Organisation (WHO) are jointly testing mHealth interventions for smoking cessation, increasing physical activity, maintaining a healthy diet and enabling patients for better management of NCDs [7].

Certain key questions need to be answered to justify the use of mHealth for NCDs in India:

1. Is there enough evidence of successful use of mHealth for NCDs from developing countries like India?
2. Are mHealth interventions already being used in other health related conditions in India?
3. What are the direct/indirect initiatives taken by Gol related to mHealth?
4. How can mHealth complement the national health programmes for NCDs?
5. What are the barriers and challenges, and how prepared is the healthcare system of India to take up mHealth for NCDs?

MATERIALS AND METHODS

The present narrative review is an attempt to answer the key questions posed above. A thorough literature search was conducted using MEDLINE, EMBASE, and Cochrane Library to collect information regarding mobile Health interventions from various peer-reviewed journals. Two authors extracted the data. Studies were included if at least the abstract was available. Related information from key reports and various governmental and non-governmental websites

were also included. Search was made keeping in mind the need for mHealth in NCDs in India, and the advantages, scope and challenges of mHealth for healthcare delivery in India. We also looked critically at the existing mobile health systems in India, current evidence of mobile health use in Non-Communicable Diseases, and the recent mobile health related initiatives taken by Government of India.

Scope of Mobile Phones as a Platform for Delivery of Health in India

India has the second-largest mobile phone user base in the world with over 900 million users [8]. In 2011 alone, 142 million mobile-cellular subscriptions were added in India [8]. Moreover, the mobile companies have been marketing low-priced phones. The mobile tariffs in India have become among the lowest in the world [8]. There has been a steady increase in the geographical coverage of mobile-phone networks. As a result, people residing in remote rural areas of India have access to a mobile phone, and many of its capabilities.

Primary capabilities of all mobile-phones include voice calling and Short-Messaging Service (SMS). Technological advancements have also resulted in phones with increasing computing powers. These modern smartphones can share as well as analyse digital data (videos, photographs, databases etc). Smartphones have intuitive touch based user interfaces with icons for applications, and thus, even the illiterate can derive benefits out of this technology. Further, extensive localization has resulted in availability of phones which can display not just English but also regional language fonts (such as Hindi, Bengali, Tamil, Kannada etc). According to a recent British Broadcasting Corporation (BBC) news report in August 2013, Indians are switching to smartphones faster than ever, which is pushing India ahead of Japan, helping it become the world's third largest smartphone market [9]. Smartphones are getting cheaper as well in India (now being manufactured locally by many companies).

Where Does mHealth Fit in within the Health System and What Role is It Expected to Play?

The mHealth system can be conceptualized as having three major actors: (a) consumers of the health-care system (b) health-care providers (c) program managers. The potential benefits of any mHealth system too can be classified as per these actors.

From the consumer's perspective, it allows the intervention to get noticed by the consumer at the most crucial time, when it might be actually needed. It is also far easier and reliable for patients to enter information through mobile technology than manually doing so. mHealth technology can also enable patients to gain more control of their Electronic Medical Records (EMRs). Voice calling and SMS capabilities of mobile phones are particularly important for consumers in developing countries. Consumers can utilise the voice call feature of mobile phones for availing ambulance services, and services provided by healthcare call centres during acute emergencies of chronic NCDs. SMS is particularly popular among young adults.

From the provider's perspective also, mHealth is cost-effective because of the utilization of wireless services. Wireless infrastructure is less expensive and faster to deploy, as there are reduced needs for cable installation and maintenance. It is also less susceptible to theft or damage. In India, due to saturation in urban areas, telecom service providers are now investing in rural areas as well. The share of private telecom sector is increasing. For instance, the share of private sector in total telephone connections in India was 86.09% in 2011, as against 5.35% in 1999, and this competition has driven down the costs of telecom services [10]. Artificial intelligence in telemedicine using medical-decision support systems and medical monitoring devices attached to mobile phones are other the uses of mHealth technology [11].

From the health program manager's perspective, the direct benefits for healthcare consumers and healthcare providers yield overall

program benefits such as early case identification, better quality of health care and improved compliance to treatment. In addition, mHealth system can support program management. Performance indicators like number of health related SMS sent to beneficiaries in a month can be used to incentivize peripheral health workers. By integrating mHealth technology with the Global Positioning System (GPS), and thus by monitoring the location of field workers for real time data entry in the field, a check can be put on fraudulent data entry. In addition, targeted mHealth systems can be used to improve supply-chain systems for medical supplies, providing training and self-education avenues to health staff, send announcements etc, all of which can improve program management.

mHealth is Not a New Concept in India

Worldwide, mobile phones are being commonly used in Human Immunodeficiency Virus (HIV)/Acquired Immuno Deficiency Syndrome (AIDS), maternal and newborn health, malaria and tuberculosis control [12-15].

mHealth is being used in many forms in health related programs in India as well [12]. Mother and Child Tracking System (MCTS) is arguably the biggest such program in India, operational since 2009 [16]. Its objective is to track each pregnant woman from the time of registration up to delivery, including postnatal care, and the child from the time of its birth to the end of the immunisation period [17]. Sending mobile based SMS to beneficiaries to alert them regarding services due to them, or services which have become overdue, generating work plans for the grass root level workers regarding the services to beneficiaries in their areas in advance, and communicating with other health care service providers, as well as health and family welfare policy makers, health managers and health administrators at different tiers of the health care delivery system are some examples of how the mHealth system is being utilized in MCTS. More than 25 million pregnant women and 18 million children have been registered in MCTS since its inception in 2010 [18]. Findings of the 6th Common Review Mission show that despite states having hurdles like poor internet connectivity, insufficient staff, lack of clarity, system design issues and weak supervision, they are making sincere efforts to improve the MCTS data entry and output [19].

In Odisha, mobile handheld units are being used for data harvesting at the grass root level. Details of the Anganwadi worker and the children under her care are sent to a central server which can then be accessed online. Another example of effective use of mobile technology in India is using SMS to communicate with the 3.2 million Central Government Health Services (CGHS) beneficiaries spread across India [20]. These and other pilot projects on mHealth in India are instant sources of inspiration and programmes from which lessons have to be learnt before introducing mHealth for NCD prevention and control.

Advantages and Scope of Using mHealth for NCDs

SMS based interventions have seemed to provide some benefit in the self-management of long-term illnesses [21]. Automated system generated SMS can be used to communicate with people for dissemination of health messages like promotion of healthy behaviour and also for surveillance, management and treatment compliance of NCDs. Because of the common risk factor pool of many NCD's and the high prevalence of these risk factors in the community, health messages need to be provided to large populations. One of the major advantages of mHealth interventions in this case is the fact that it can be delivered to a large number of individuals in a relatively shorter time. It also helps in decreasing the time required for analysing large amount of data generated which is difficult with a paper based data collection system. This can be especially helpful in case of NCDs because of the numerous follow-ups required, thereby generating large amount of data.

Existing Evidence Regarding Role of mHealth in the Context of NCDs

Several studies across globe have documented the usefulness of mHealth in management of diabetes and hypertension [22-24]. According to a review conducted, "...mHealth for diabetes is making rapid strides and is expected to be a transforming technology that will be the next big thing" [25]. A trial assessing the usefulness of SMS for management of diabetes showed that SMS can be a simple, fast and efficient tool serving as an adjunct to diabetes management [26]. Santosh Krishna et al., examined the use of mobile calls and SMS and found "significant improvements in compliance with medication taking, Glycosylated Haemoglobin (HbA1C), stress levels, smoking quit rates, and self-efficacy [27]. Mobile phone based surveillance for physical activity was found to be relatively reliable and valid [28].

Similar evidence is available regarding mHealth for cancers as well. One study done among 97 cancer patients to see the utility of a mobile phone based questionnaire for monitoring quality of life found that more than 50% participants filled the questionnaire, indicating thereby the usefulness of mHealth for cancer patients [29]. Mobile phone applications have been developed to help cancer patients acquire health related information from anywhere and also share information with their physicians during clinic visits [30]. When the smoking-related resources of the National Cancer Institute's Cancer Information Service (CIS) of United States of America were integrated into the workflow of nurses using a mHealth Decision Support System, 86% nurses used it and more than 60% nurses perceived it to be useful or somewhat useful [31].

Identifying Opportunities in the Recent Initiatives Taken by Gol and the Role of Intersectoral Collaboration

Increasing Rural Connectivity through Mobile Phone Networks and Internet

The rural tele-density in India (which is an important indicator of telecom penetration in the country) has increased from 5.89% in 2007 to 37.52% in 2011 [32]. Similarly the urban tele-density has increased from 48.10% to 167.46% during the same period [32]. The penetration of internet and broadband has also improved with 20.99 million internet subscribers and 13.30 million broadband subscribers across the country as of 2011 [32]. These are significant initiatives which can drive the development of mHealth systems in the country.

Initiatives Related to Telemedicine

Gol has recently approved a project for the National Optical Fiber Network in 2011 for providing Broadband connectivity to all 2.5 lac Gram Panchayats to provide a highway for transmission of voice services, data and video in rural areas [32]. As a part of this, it has been planned to provide connectivity to Primary Health Centres (PHCs) in rural areas [32]. Under the National Rural Telemedicine Network of Gol, various pilot projects have been funded in all states for tele-consultation, and tele follow-up, which are now being scaled up under assistance from NRHM [33]. Under this initiative, three sites are under pilot project of telemedicine. In 12th Five-year plan of Gol, Rs. 122 cr have been allocated for e-Health including Telemedicine [33].

Gol has also initiated a project called OncoNET to facilitate early detection of cancer patients across the country through peripheral centres, delivery of telemedicine services to them, creation of cancer patient's registry etc, by tele-linking regional cancer centres to peripheral cancer centres present at the district level [34].

Electronic Health Record (EMR) standards for India have been set and by Gol [35]. This includes a proposed mobile health record as well. Gol has also plans to integrate Unique Identification number of

each individual (popularly known as Adhaar in India) with EMRs to help sharing of patient's health related data across hospitals [36].

National Program for Prevention and Control of Cancer, Diabetes, Cardiovascular Disease and Stroke (NPCDCS) [37] and District Mental Health Programme (DMHP)

mHealth system can be directly linked to the objectives of NPCDCS. For example, the operational guidelines under NPCDCS for sub-centres (most peripheral healthcare institutions in India) envisage health promotion for behaviour change, opportunistic screening for diabetes and hypertension by the health worker, and referral of suspected cases to the Community Health Centers (CHCs), where dedicated NCD clinics function. mHealth can be utilized for promoting health through SMS, for reminding patients about appointments with their physicians and about medications, along with sending reports of laboratory investigations to patients (as part of early diagnosis) and management of common NCDs [38]. mHealth can be used to provide home-based care which is also proposed under NPCDCS at the CHC level. In the 12th Five Year Plan, the Gol also proposes to ramp up the DMHP to the whole country.

Challenges

Limited Evidence Base

Despite the widespread use of mobile phones, the evidence base for mHealth, including text messaging in healthcare delivery remains weak [39,40]. Little is known about the practice, effectiveness and acceptability of mHealth applications for disease control in developing countries [40]. This scarcity of literature extends to NCDs as well. A review published in 2006 reported that "there is almost no literature on using mobile telephones as a healthcare intervention for chronic conditions in developing countries" [41]. There has been very little research on the economic aspects of mHealth as well. One study concluded that "while mHealth has the potential to overcome traditional obstacles to the delivery of health services to the poor in lower and middle-income countries.....there is little evidence as to whether the expected benefits and savings can be actualized on a large scale"[42]. Similarly Kaplan W A found that in developing countries, "convincing evidence regarding the overall cost-effectiveness of mobile phone "telemedicine" is still limited and good-quality studies are rare"[42].

It has also been realized that outcomes of mHealth interventions need to be measurable in terms of a much more accepted measure of health intervention performance such as cost per disability-adjusted life year (DALY) averted [43,44]. Some issues which need further research include the types of communication to be used in mHealth interventions, outcomes of such interventions, uptake of mHealth by the consumers, extent of willingness to personal share information, additional yield of mHealth based information to the current mode of health information generation, and the amount of behavioural change mHealth can bring in.

Operational Issues in Implementing mHealth

Simultaneous scaling up of numerous mHealth pilot studies to the national level in developing countries and properly engaging health workers and communities in the process remains a big challenge [45]. Implementing a universally acceptable system in a culturally diverse country like India, with different levels of technical competency, different languages, and different levels of social, economic, and scientific development is mind-boggling. [Table/Fig-1] summarizes the operational issues according to different contexts.

CONCLUSION

The increasing morbidity and mortality of NCDs in India, and the continuity of care required for them mandate the need for

Operational issues in mHealth system in general	Operational issues in scaling up of mHealth system at the national level	Operational issues in mHealth system (India specific)
<p>i. Data management</p> <p>Issues related to quality, security and back up of data sent over mobile networks.</p> <p>ii. Text messaging</p> <p>Usually have a limit on character count, thus constraining the content of the message. Poorly designed or implemented messaging carries with them the risk of antagonizing, desensitizing, or confusing the public.</p> <p>iii. Supervisory and management systems</p> <p>Often lacking or weak for mHealth related interventions [46].</p>	<p>i. Public Private Partnership</p> <p>In case multiple cellular operators (private sector involvement) are chosen for scaling up of services :-</p> <p>They may not join hands or may have different outlooks. Issues related to billing is a challenge faced by all telemedicine systems [47]. Issues related to regulation of the private sector.</p> <p>ii. Technical demands</p> <p>With different brands of mobile phones, and different operating software systems, it will be a tough task to develop applications working across multiple platforms.</p> <p>iii. Manpower shortage</p> <p>Shortage of mHealth experts having the necessary in-depth knowledge and skills</p>	<p>i. Cellular networks</p> <p>Limited and fluctuant bandwidth of the wireless link and poor network signals especially in rural India.</p> <p>ii. mHealth Pilot projects in India</p> <p>No proper documentation and reporting of various ongoing pilot projects using mHealth for NCDs in India.</p> <p>iii. Illiteracy and language</p> <p>Well known issues in the use of mHealth[48]. India having a diverse culture and several languages seems to have a major hurdle in this area.</p>

[Table/Fig-1]: Operational issues in using mHealth

introduction of newer innovative technology. With the ever growing user base of mobile phones in India, mHealth looks to be a viable option. We found that some form of mHealth is already being utilized by the Govt in other health related sectors. We also found that there are numerous capabilities of mobile phones, but mostly voice call and SMS features have so far been explored in developing countries. Though there are many advantages of mHealth, it is not free from barriers and challenges. There is currently a lack of evidence regarding the use of mHealth for NCDs, especially from developing countries. Continued political commitment and support by the private stakeholders will be the key for advancement of mHealth research and services in India. It can be said that appropriate technology is part of the Alma Ata Declaration of Primary Health Care, and mHealth is the current appropriate technology.

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