

mHealth: Meaning, Purpose and Outcomes

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Abstract— Health assumes prime importance around the globe and the most significant indicator of a nation's growth and development. Health is probably the best measure to define a person's state of well-being. With the advent of time, the Health Care industry has also been effected by the role of ICT (Information and Communication Technology); which is slowly replacing the time-worn methods of recording patient details manually by faster and technical methods like "mHealth". Even the consensus suggests that the impact of ICT in Health Care could be substantial or even revolutionary. Although it is difficult as of now to predict the precise nature of impact, but it definitely seems that the health sector will benefit from advances in mobile telephony and Internet services. The concept of mHealth is specifically relevant in present time because when patients struggle to find honest and reliable service providers, new institutions such as ICT based 'self-regulatory' mHealth systems can deliver quality care at reasonable cost. The various available application techniques of mHealth and their uses have been discussed and analysed for the purpose of paper.

Keywords— ICT in Health Care, Applications of mHealth, Models, Opportunistic Computing Framework, E-Visit, Aid for underprivileged Introduction

I. INTRODUCTION

Health and Healthcare are two distinct terms with very different meanings. Health is a resource for everyday life and not just the objective of living. As stated by WHO during the Ottawa Charter for Health Promotion in 1986, "Health is a positive concept emphasizing social and personal resources, as well as physical capacities". Whereas, Healthcare refers to the organized provisions of medical care being provided to individuals or a community, or in other words it is the process of maintenance of health through diagnosis, treatments and preventions. In India, Healthcare is delivered through both, public as well as private sectors. The Constitution of India has made 'health in India' the responsibility of State Governments, rather than the Central Government, making every state responsible for the level of nutrition and standard of living of its people. In the present scenario, the investments being made in traditional Healthcare facilities like manual processing through case sheets are failing due to higher service costs and lack of inter-operability between systems. Also, just like any other Industry, Healthcare sector is striving to reduce cost and increase productivity. To overcome these problems, ICT comes to the rescue of the Healthcare Industry with various innovative solutions; the most efficient one being the 'mHealthcare'.

A. SCOPE OF ICT IN HEALTHCARE INDUSTRY

The limited healthcare budget, lack of responsible workers (especially for remote areas) and the ever-increasing health problems are continuously jeopardizing the National healthcare delivery system. But, the use of ICT has raised hopes to deliver reliable healthcare by extending the reach and scope of the healthcare delivery systems and fuel up this transformation. The enormous range of opportunities for significant cost reductions, service enhancements and behavioural changes through 'eHealth' has a widespread scope in India's Healthcare sector. In the recent past, ICT has been widely used to help doctors, nurses and other practitioners to give better care and services to patients. According to patient's point of view, ICTs are altering relationship and balance of power between patient and service providers, leading to more empowered consumers. From the perspective of medical practitioners, the potential of ICT applications to monitor and influence the behaviour of doctors at point of prescription and referral basis is of great significance for all stakeholders. The modern ICT systems provide various benefits such as:

- Swift Access
- Inter-Operability
- Better patient management
- Better scheduling and workflow
- Decision Support Systems
- Better Resource Management

Innovation, applied intelligently is the keystone for everything we do. Keeping this statement in mind, ICT has developed a number of Unique Product Offerings in order to provide fast, easy and effective technical healthcare solutions to the population all around the country. As stated by the ICT team itself, they pride themselves on their technical and synthesis capabilities, knowledge of formulary sciences and timely responsiveness which is provided to the customers through products like:

MEDICAL SMART CARDS:

These cards are specially designed for the purpose of decrypting patient history. It follows a simple process; The card is entered in the reader by the user followed by decryption and validation of patient data. The data is matched with the patient history and details, updated according to current health issues and/or remedies being taken and the card is then returned to the user.

□ CHRONIC DISEASE MANAGEMENT SYSTEMS:

This is a Microsoft Access database system which improvises the process of tracking health care records of chronic disease patients. Such an application is particularly used to manage the patient registry, print progress notes and edit the patient database. A detailed user manual, dictionary and documentation are also provided for users.

□ COMPUTERISED PRACTITIONER ORDER ENTRY:

CPOE is a process of entering patient treatment instructions, as given by the practitioner or service provider, in an electronic manner. The entered details are transferred over a computer internetwork to various departments such as pharmacy, laboratory etc. for fulfilling their responsibilities.

□ RFID and BAR-CODING:

RFIDs and BAR CODEs are special magnetic identification systems. In healthcare industry, a certain group of patient, doctor in-charge along with their staff are connected through a specific RFID band/Bar Code. This helps in keeping track of all hospital, lab and pharmacy related records.

□ BUSINESS INTELLIGENCE FOR REAL TIME DETECTION OF HOSPITAL INFECTION PATTERNS:

Such a system uses business techniques as means of observing different patterns of a particular hospital or health service centre. This helps in recording the diseases with maximum as well as minimum patients which can further help the owners to improve the services being provided by them.

Although the basic technology is available to all customers through means of Internet and Smart phones, but the acceptance to use the above mentioned features of ICT in healthcare vary remarkably among citizens and professionals. The use of ICT is the basic need and condition for the development, implementation and further growth of innovative healthcare technologies. Thus, the gradually increasing use and application of ICT facilities is undoubtedly strengthening the faith of customers in eHealth techniques and also widening the scope of ICT in the Healthcare industry.

B. ICT AS AN AID TO POOR, REMOTE PEOPLE

Today, after 69 years of Independence, man has become completely connected to the world of Internet and its various facilities; the most important one being the availability of healthcare services being provided online. The irony of this fact is that even today, the lower strata of our nation have still not been able to use the numerous ICT facilities available. The rural families and those who live in remote areas are still away from the benefits of advent of technology and are thus living in poor health conditions even today. They are far from the reach of fast, honest and efficient medical advices and treatments of renowned practitioners. Also, due to the cost factor involved in consultations of hospitals, the people from lower income

groups have to stick to government dispensaries and local doctors which are never 100% reliable. The concept of mHealth has been developed by keeping in mind this scenario and with the objective of completely connecting every individual of the nation to an online network in order to assure efficient, easily affordable and trustworthy healthcare services.

The health service providers need to conduct pre-usage seminars for people in the rural remote areas in order to make them understand the ways of usage and also the benefits of using modern day technology to be in regular contact with medical service providers. Such sessions will increase awareness among these people regarding two things. First, they will get to learn how to use smartphones and advance themselves and Second, they will be able to improve their lifestyle and medical conditions by keeping a track of their problems, medicines and consultations through the mHealth services. This, in turn will contribute to the overall development of our nation by removing the dark tunnel of bad health and literacy. This paper has been written to study the various implementations of tech based online services for the lower strata of the country.

II. M-HEALTH

A. Meaning and Usage

In today’s rapidly growing society, mHealth has been envisioned as the most important computer application to provide healthcare services. mHealth is basically a concept which uses wearable and implantable “BODY SENSOR NODES” (BSN) to detect and cure any disease. Using these nodes, the patients are not restricted to get a treatment from some clinic or hospital. Once they are connected to the service providers through a mobile app, Internet connection and the body sensor nodes; the users can avail the services with ease as per their wish, from anywhere anytime.

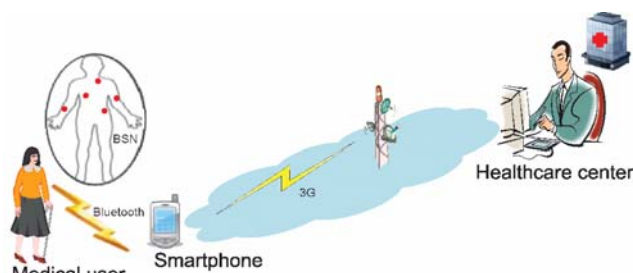


Fig 1. Working of a typical mHealth system through BSN, Source: Internet

As shown in the above figure, the body sensor networks are connected through Bluetooth or WLAN to a personal server. This server is responsible for tracking Personal Health Information (PHI) of the user which includes heart rate, blood sugar level, blood pressure, body temperature and some other factors. This information is gathered and forwarded to healthcare centres through an Internet connection and the desired medical advice is received by a professional. This system has been designed to report the user’s medical information to the service providing centre after every 5 minutes. In case of emergency situations; say, for example, on recording a higher heart rate in case of

heart attack; this system needs to be more efficient and report back to the health centre every 10 seconds till the time an ambulance or physical help reaches the patient.

B. Need and objectives

On the facts based on the demographics of population growth and the ever-increasing health constraints, medical practitioners felt the need to connect to patients in a more technical and efficient way. The high burden of disease prevalence and less availability of doctors and other facilities was a major concern which led to the development of the concept and need of mHealth technologies. Other factors which motivated for spread of mHealth include large number of rural inhabitants who are unable to avail assured medical guidance and the rise in mobile phone usage in all sectors of the nation.

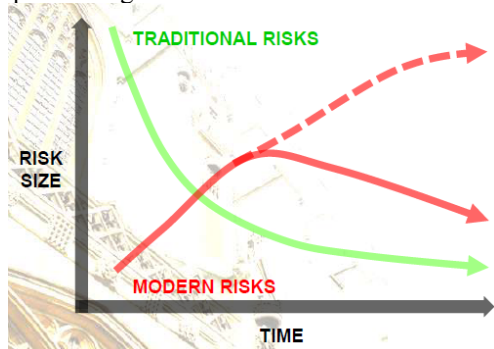


Fig 2. Risk-Time graph of Health Issues, Source: University of Cambridge

The given graph clearly suggests that the modern problems like lifestyle issues, obesity, diabetes, cancer, cardiovascular disease, urban air problems and food quality issues etc. are in increasing risk category while the traditional problems such as water availability, undernutrition, sanitation and hygiene problems are continuously being solved with time and so are in the lower risk category. The major health related problems in today’s world need to be focused upon through more efficient technologies. This is where mHealth comes into picture with the major objective of combining the knowledge of the working professionals, the chemical intelligence of medicinal field along with the superfast and widespread reach and features of ICT in order to bring about welfare for the society by providing a human environment which is free from hustles of clinical disorders. Keeping in mind the problems faced by the poor families, role of mHealth is very meaningful for them as it could be used to provide them a completely different lifestyle where solution to all their medical issues would be just a click away.

C. Stages in Development

An mHealth system can be developed in the following three stages:

1) Initialization of System

This stage includes setup of specific functions/features in a particular user’s smartphone. This is done on the basis of PHP calculations. This PHP represents a vector, say $a = \{a_1, a_2, a_3, \dots, a_n\}$ which is nothing but the binary coded format of medical examination results of the user. These

results compiled by the medical practitioners are sent to Trusted Authority (TA) which generates access control keys and master keys for every user and also selects the BSN nodes. As and when the user uses these keys, the health conditions are updated every 5 minutes in the database and the required action is taken when needed.

2) User-centric private access control for emergency

This stage is further divided into two steps.

PHASE 1: This phase includes enlisting the medical facility users and then checking of available resources and enough power to serve the needs of all intended users.

PHASE 2: This phase groups the various medical users on the basis of similar symptoms and also settles a standard threshold value for all health issues.

3) Opportunistic Computing Framework

This framework is a technique used for encountering emergency situations. It provides opportunities to all service providers to extend their reach and build customer assurance by meeting the emergency needs such as ambulance requirement in least possible time. It works in the following manner:

Suppose, a patient needs emergency treatment and asks for an ambulance through a mobile app using mHealth services. Now, if the average time of arrival of ambulance is say “t”, the service providers who take up the opportunity and provide an ambulance before time “t” would be called successful providers.

D. mHealth Models

mHealth services have been categorized majorly under two models namely “System Model” and “Security Model”. Both models use the basic concept of Opportunistic Computing Framework but vary slightly in the task they focus upon. The working of both models has been explained below:

1) System Model

In this model, there is a Trusted Authority which is basically an entity at the healthcare centre with which the user is connected. The TA is responsible for management of the whole system including initialization of system, provision of key features and locating BSN nodes for retrieving user information from time to time. Also, there is a group of users, say, $U = \{U_1, U_1, \dots, U_n\}$ (as shown in figure) who are connected to the TA through the mHealth services in their smartphones. These users become a part of the system and can thus enjoy all medical services in the most easy and efficient manner by sharing their PHI report with the TA after every certain time interval.

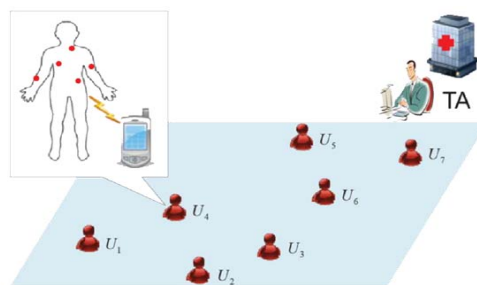


Fig 3. System Model, Source: Shewale (Dec. 2014)

2)Security Model

Security model has been designed to manage and maintain the security of sensitive information like a user’s PHI using the computing framework. This model specifies a two phase privacy access control in opportunistic computing (as shown in Figure).

PHASE 1: This phase acts as a pre-requisite specifying that for obtaining a PHI report, the person should necessarily be an mHealth service user. In case a person passing-by needs to send or receive some information from the TA but is not a medical user; the lack of required software would cut off the possibility of that person receiving ideal help. Therefore, phase1 privacy control strictly manages the needs of the medical services’ users.

PHASE 2: This phase allows the users with similar symptoms to share information with each other as the users with same problems might be skilled enough to work on the available services in a better way. The way to differentiate each user is to provide a different threshold “th” value to each user which comes in use of emergency situations. The “th” value is set high for the user who needs emergency treatment and the PHI of that user is then hidden from all other users.

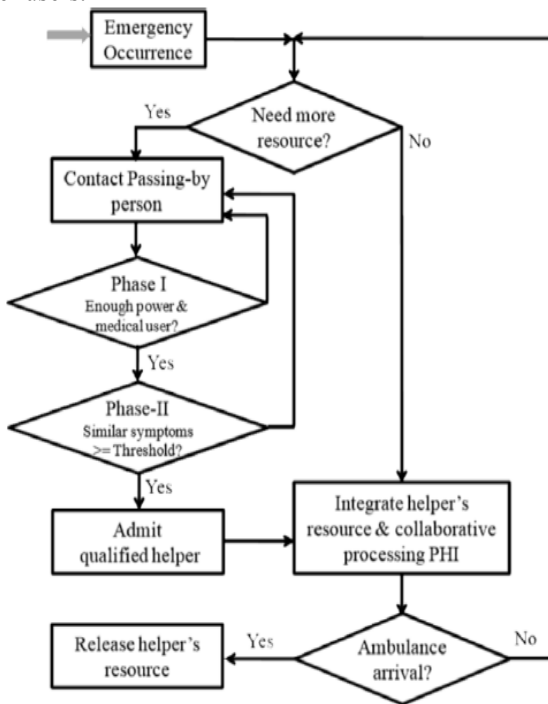


Fig. Security Model, Source: Shewale (Dec. 2014)

III.REVIEW LITERATURE ON EXAMINIG THE CORE CHARACTERISTICS OF M-HEALTH

In this section, a comprehensive study on the core characteristics of mHealth has been attempted. According to Davis TL, DiClemente R, Prietula M (2016), mHealth is basically an ill-defined but ever growing aspect of health around the world. They have focused majorly on 4 characteristics of the foundational platform, i.e., the mobile smartphones.

The first characteristic is the WIDE REACH OF MOBILES IN POPULATION. We all know, mobiles are

the fastest spreading technologies and its use has become ubiquitous among all individuals. Thus, use of smartphones is the easiest way to reach out to every intended user.

The second characteristic is the AVAILABILITY OF APP. Apps are powerful but their usage can sometimes be complicated. The sensitivity of sensors, availability of internet connection and the compatibility of various software with the operating system of a phone are the issues needed to be taken care of while designing an mHealth system or app.

The third characteristic is the WIRELESS BROADBAND, which is the most rapidly growing platform for Internet access among individuals, households and even organizations. The costs involved in setting up an Internet connection and its data rates may vary from place to place. Thus, it would definitely be available for the well-off families but it might not be as much affordable for the people of lower income groups.

The fourth characteristic is the DATA CAPTURED THROUGH INDIVIDUAL MOBILES. As the trend is, every individual has a separate tethered device and so does the mHealth system works. Data is collected from every device on individual basis to analyse behavioural and physiological data and communicate it in real time whenever needed.

The interpretation of these core characteristics is that they serve as both, opportunities as well as constraints. In order to exploit them as either, one must understand what they are and how they relate to mHealth context. Regardless, these characteristics endure to all mobile phone applications. In the present scenario, mobile phones and ICT together afford us characteristics with remarkable capabilities and potential which are changing at an unstoppable and undisrupted rate with each passing day.

IV. IMPLEMENTATION

This section discusses the various aspects of mHealth.

A. Advantages

The key features of mHealth services include Quick Responses through a server based network along with the facility of simple read out or text-to-speech features. The low cost involved in app development, maintenance as well as usage is another attractive feature. There is no power burden on the user or the device which is present in various machines at hospitals. Also, the sensitivity and specifications of mobile sensors are of improved quality as compared to the traditional methods. One of the most important aspect of mHealth technology is that it can be used with minimal training and by people of all regions and income groups. No large equipment or the need to visit labs is required for testing purpose. Not only this, in case of emergency we can also locate several pathogens nearby using the mHealth services. All these features add to the advantages of using mHealth services and also help in betterment of users’ lifestyle and access to healthcare facilities.

B. Disadvantages Or Challenges

Amidst the numerous advantages of mHealth facilities, there are majorly three issues with come between the

growth of this technology. These challenges are: Interoperability, Use of Open Standards and the problem of Evaluation. Let us assume a user needs guidance regarding more than one medical problem at the same time, via multiple service providers. In this case, the system might generate different opinions from different practitioners which will create a confusion for the user. This problem can be solved by development of open standards for the applications which are lacking as yet. These standard will eliminate the multiple opinions' problem and will resolve them on the basis or certain levels. Also, the user is not yet allowed or provided any feature to evaluate the service being provided. In case the user wishes to check on the practitioner or evaluate their accuracy, he/she won't be able to.

Some other challenges of mHealth include the lack of awareness of ICT in lower income groups. Lack of literacy also poses a problem in some areas as such people can't read and understand what is being done in a smartphone. Language is also a barrier sometimes as people in remote areas understand only their native languages but the mobile phone apps are all developed in English, which might not be comfortable for many.

C. Impact As Per Physicians

As the use of technological means to manage health are increasing, the role of physicians to personally treat patients is also changing. As per survey results, majority of the physicians are happy with these advancements as 39% of them say that their administrative work has been reduced due to IT field managing it. Also, 36% medical practitioners feel that by using mHealth services their collaboration with other physicians has increased and the reach of patients has also increased to a good level. The most important effect of mHealth is the expedite decision making process which has been appreciated by 56% of the physicians. While on the other hand, only 24% doctors say that ICT and mHealth have not disturbed their personal practice and rest 76% feel this I an intervention in their traditional ways of working. Considering the aspect of time division for patients, only 26% physicians felt that use of mHealth services allowed them to give more time to their patients.

Overall, the invent of mHealth technology is proving to be a bane for both, users as well as medical practitioners.

D. Applications

Till date, some applications using the concept of mHealth have already been developed and being used by users. Two of such major apps are:

(a) PRACTO

This was founded by Shashank ND and Abhinav Lal, students of B.Tech(final year) in NIT, Karnataka back in 2008. Their motivation behind this foundation was the health condition of Shashank's father. They developed this concept using the basis of mHealth to provide users with the facility of 1,00,000 listed doctors to be consulted as and when needed. Till date, more than 30,000 appointments have been made using this app. Also, it keeps a track of

user's medical condition and updates it from time to time as well.

(b) LYBRATE

An online doctor consultation platform, Lybrate was developed by Saurabh Arora in May 2014, a then data scientist. He created this platform for the users to interact with doctors through texts, videos, voice messages from anywhere anytime. Using this application, patients can get their basic queries answered for free and can also book an appointment with the doctor whose response they prefer. This app also provides a dashboard for the user keep a track of their personal health related issues. Along with all this, regular articles on health lifestyle and general well-being are also posted for the users.

Along with these 2 apps, some minor apps for tracking drink and drive cases, reducing the consumption of cigarettes and for weight reduction and management are also being developed and are under testing phase right now. In addition, some mobile operating systems such as iOS provide in-built apps such as "Health" app, which keeps a track of the number of steps taken by user in a day, intake of calories, and the number of calories burnt per day and can help in measuring the heart rate through sensors.

V. CONCLUSION

The mHealth services have a widespread reach and scope. They range not only from providing medical information but this initiative seems to have tremendous potential to improve the quality of overall healthcare and management system. Although the major study related to mHealth literature is yet to be done, but this concept of ICT provides a great insight to better lifestyle and an assurity of completely turning around the traditional system of availing medical facilities. The use of mHealth technology can definitely reduce professional isolation by bringing together all practitioners at one platform and have the potential to improve the ongoing service providing system, especially in the rural areas. Not only this, further development of mHealth technology will also reduce unemployment as more and more people would be required to maintain the functionality of each and every minute detail of the system. Along with the benefits, the medical organizations and policy makers also need to keep in mind the requirements of critical diseases and also the benefits and pitfalls of using technological applications to promote desired health outcomes. This task can be achieved by providing regular eHealth and mHealth related training to developers as well as users and by regularly updating the scales for attaining the desired results.

REFERENCES

- [1] Davis TL, DiClemente R, Prietula M, "Taking mHealth Forward: Examining the Core Characteristics", JMIR Mhealth Uhealth 2016
- [2] "Connected Health case study | Dignity Health: Increasing Timely Access to High Quality Care Leveraging Telemedicine", HIMSS, March 2016
- [3] Manaswini Pradhan, "Data Mining & Healthcare: Techniques of Application", IJIRCCE, Vol. 2, Issue 12, December 2014
- [4] Mr. Ajinkya S. Shewale, "Opportunistic Computing Framework for M-Healthcare", IJARCSSE, Volume 4, Issue 12, December 2014

- [5] Sayantan, Baidyanath, Baishalee, Madhupriya, Susamay, Presentation on "ICT in Healthcare: towards Sustainable Business Models"
- [6] Professor CR Lowe, "mHealthcare: Opportunities, Challenges and Prospects", 4th Future of Wireless International Conference, the Moller Center, Churchill College, University of Cambridge
- [7] The PLOS Medicine Editors, "A Reality Checkpoint for Mobile Health: Three Challenges to Overcome", PLoS Med 10(2): e1001395, 2013
- [8] Mphatso Nyemba-Mudenda, Andile Simphiwe Metfula, "A review on mHealth research in developing countries", Vol 9, No 2 (2013) Chigona
- [9] Fassil Shiferaw, Mariay Zolfo, "Global Health Action 2012", 2 April 2012
- [10] WHO Global Observatory for eHealth, "New horizons for health through mobile technologies.", Geneva, 2011
- [11] Henry Lucas, Institute of Development Studies, University of Sussex, UK, H.Lucas@ids.ac.uk (2008)
- [12] Original Draft prepared by Patricia N. Mechael August 2007, For the World Health Organization, Update by Daniela Sloninsky, "Millennium Villages Project"
- [13] The Earth Institute at Columbia University, August 2008
- [14] Telehealthtechnology.org
- [15] Connected Health Case Study | "UPMC Telemedicine: Revolutionizing Access to Care", Pittsburgh, Pennsylvania, November 2015
- [16] Bhaskar Purhoit, "Community Based Health Insurance in India: Prospects and Challenges", SCIRP, Health, 2014, 6,1237-1245
- [17] mHealth-wikipedia.org
- [18] Jensen CD, Duncombe KM, Lott MA, Hunsaker SL, Duraccio KM, Woolford SJ, "An Evaluation of a Smartphone-Assisted Behavioral Weight Control Intervention for Adolescents: Pilot Study", JMIR Mhealth Uhealth 2016;4(3):e102
- [19] James G. Kahn, Joshua S. Yang, James S. Kahn, "Mobile Htalth Needs and Opportunities in Developing Countries", Health Aff, Vol. 29 No. 2, February 2010
- [20] Franco RZ, Fallaize R, Lovegrove JA, Hwang F, "Popular Nutrition-Related Mobile Apps: A Feature Assessment", JMIR Mhealth Uhealth 2016;4(3):e85
- [21] ICT for Health, www.europa.net, 2010
- [22] www.smartcardalliance.org
- [23] Wilson H, Stoyanov SR, Gandabhai S, Baldwin A, "The Quality and Accuracy of Mobile Apps to Prevent Driving After Drinking Alcohol", JMIR Mhealth Uhealth 2016;4(3):e98