Mobile-Health Approach: A Critical Look on Its Capacity to Augment Health System of Developing Countries

Sanjeev Davey[1], Anuradha Davey[2], Jai Vir Singh[3]

[1,3]Department of Community Medicine, Muzaffarnagar Medical College and Hospital, Muzaffarnagar, [2]Department of Community Medicine, Subharti Medical College, Meerut, Uttar Pradesh, India

ABSTRACT

Background: The mobile-health approach is currently knocking the doors of public health to make use of this rapidly advancing technology in developing countries; therefore, it needs a critical look on its capacity in improving health system of developing countries. **Materials and Methods:** A systematic review of studies in literature published till 31st October 2013 of last 10 years on key search word: "Capacity of mobile-health in improving health system of developing countries" was done from medical search engines abstracting databases such as Pub-med, WHO, Cochrane database, Google scholar, and Bio-med Central. Both types of studies elucidating utility and no benefit of mobile-health in developing countries were included as main criteria for deciding the capacity of mobile-health approach in health system of developing countries. M-health studies on areas of impact, effectiveness, and evaluation and previous reviews, conferences data, and exploratory studies were the main study designs incorporated. Studies on m-health in developed world, Indian studies as well data from thesis or dissertation were excluded in this review. **Discussion:** Multi-faceted mobile-health applications, strategies, and approaches currently lack proper regulation and standardization from health care authorities, and currently their results also vary from good to no beneficial effects as found in this review. **Conclusion:** Umbrella of mobile-health approaches must be used intelligently, keeping in mind the fact that, it can provide a greater access and quality health care to larger segments of a rural population and its potential to improve the capacity of health system in developing countries.

Keywords: Developing countries, health system, m-Health, mobile-health, public health

Key messages

- In developing countries- Majority of mobile-health initiatives are focused on spreading prevention and awareness messages.
- Mobile-health approaches can - a) Lower cost, b) Modify behavior towards prevention, c) Strengthen emergency response systems, and d) Improve decision support information availability at health care provider level.
- Mobile phones can also be used as a research instrument, can be used for household surveys, clinical trials, surveillance, and spatial or geographical data collection.
- Most mobile-health trials on success of m-health have done in developed countries, and their replication in developing world is debatable.
- Most systematic reviews reveal moderate m-health's success in the developing world.

Background

Increasing threat of communicable as well as non-communicable disease epidemics coupled with acute shortage of healthcare professionals is a real challenge in developing countries. The problem can be solved by a rapidly growing mobile communications as mobile

Address for correspondence:
Dr. Sanjeev Davey, B-197, 3rd Floor, Prashant Vihar, Sector-14 Rohini, Delhi - 110 085, India. E-mail: Sanjeev_kumar175@rediffmail.com

phones penetrate deeper into developing countries than any other information and communication technology (ITC) and health infrastructures.[1] In the current era of technological innovations- mobile phones, therefore, have occupied a special space due to their rapid spread from richest to the poorest in developing countries and faster penetration in low- and middle-income countries.

Emergence and growth of mobile-health technologies in developing world

The Global Observatory for eHealth (GOe) by WHO (2011) has defined Mobile-Health or m-Health as the "provision of health services and information via mobile technologies such as mobile phones and Personal Digital Assistants (PDAs)."[2] Mobile-health field is one such emerging area in use of mobile phones, which can not only improve the well-being of people in developing counties but also it can improve health outcomes in long run. Mobile-health consequently has expanded in numbers and type of initiatives, and it is expected to become a multi-billion dollar industry by 2017.

Mobile-Health approaches are currently emerging as an upcoming promising tool in providing greater access to healthcare to populations in developing countries, as well as creating cost-efficiencies and improving the capacity of health systems to provide quality healthcare.[2] A multitude of m-Health solutions have emerged recently in countries such as Ethiopia, Kenya, Nigeria, and South Africa i.e. leaders in using mobile-health services, as per the Global Observatory report for e-Health by WHO (2011).[2] Mobile phones can be an appropriate and promising tool for disease control interventions in developing countries, for diseases such as HIV/AIDS, and this approach has been found to be well accepted.[3] Moreover, mobile phones as a research tool in public health can also be used for household surveys, clinical trials, surveillance, and spatial/ geographical data collection.[4] With this problem in mind, authors have chosen this research area and systematically reviewed the capacity of mobile-health in improving public health system of developing countries in this paper briefly.

Materials and Methods

Search strategy

A systematic review of studies in literature as per PRISMA (2009) guidelines published till 31st October 2013 of last 10 years on key search word: "Capacity of mobile-health in improving health system of developing countries" was done from medical search engines abstracting databases such as Pub-med, WHO, Cochrane database, Google scholar, and Bio-med Central.

Inclusion criteria

Out of 40 articles searched, 16 met the inclusion criteria. Both types of studies elucidating utility and no benefit of mobile-health in developing countries were included as main criteria for deciding the capacity of mobile-health approach in health system of developing countries. M-health studies on areas of impact, effectiveness, and evaluation and previous reviews, conferences data, and exploratory studies were the main study designs incorporated.

Exclusion criteria

Studies on m-health in developed world, Indian studies as well data from thesis or dissertation were excluded.

Results

The result of the systematic review is summarized in Table 1, to show the qualitative synthesizing process of key issues and concepts emerged from systematic review of the literature as per PRISMA (2009) guidelines.

Discussion

To achieve the MDGs and to maintain better maternal and neonatal health beyond 2015, there is an emerging need of searching new ways of using existing resources. Expanding mobile phone penetration and network coverage is one such solution, which can remove traditional geographic and economic barriers to health care in developing world. Combining mobile technologies with existing health system resources offers significant potential to provide women and newborns with adequate and appropriate care.

Emergence and growth of m-health projects, applications, strategies, and approaches at different levels

The combined effect of communicable disease and chronic non-communicable disease is described as an "epidemiological burden" in developing countries, and efforts to reduce the dual burden of disease can improve quality of life for millions. Mobile-health offers hope on both fronts. Study of James G. Kahn et al. (2010) reveal the fact that mobile technologies are widely available and can play an important role in health care at the regional, community, and individual levels.[5] The integrated nature of mobile communication systems provides unique opportunities for m-health in large geographic areas. At the community level, social networking can be used to exchange information about the local health system. And at the individual levels, mobile-health offers improved communication, access to diagnostic tools, and ability to store and access personal medical data in central repositories.[5] Mobile technology also promises a wide range of functions through the use of intelligent handsets called Smart-phones. The functions which smart-phones can play include remote diagnostic monitoring, data collection,

Table 1: Key issues and concepts emerged from qualitative synthesis of studies from systematic review of literature

Name of author or organization	Year of study	Study methodology	Key findings	Implications of study	Key qualitative issue synthesized from studies with references citation
Report: UN Foundation, "m health for development"	2009	M health alliance- quick collection of vital health data.	M health projects -1. Wide variety in developing countries 2. Demonstrable impacts. Mobile technology -improves the efficiency of healthcare delivery.	Facilitates global innovation and maximum impact. Understands m-Health's scope, implementation, and applications with the greatest impact on heath care initiatives.	Emerging mobile-health applications, strategies projects, and approaches at different levels for accomplishment of MDG goals in developing countries.[5-7]
James G. Kahn, Joshua S. Yang, and James S. Kahn	2010	Conceptual model on potential contributions of m-health	Emerging m-health applications at different levels (geography, community, and individual)	M-health applications - risks and benefits of each. Positive examples with little solid evaluation of utility	
Aqil Burney, Zain Abbas, Nadeem Mahmood, Qamar-ul Arifeen	2013	Conceptual model and systematic approach of m-health system	Message campaigns, remote monitoring, and mobile technology can impact every aspect of health system.	Careful thought in creating incentives to encourage all stake holders to contribute in the development of m-health	
Chigona *et al*. a) [Haque*et al*. Bangladesh], b) [Hoefman*et al*. Tanzania] c) [Littman-Quinn *et al*. Botswana].	2012	Review-general inductive approach SMS and medical sensors SMS	m-health research on electronic version of the 2012 M4D conference proceedings a) Remote patient monitoring b) Automatic assessment of patients' emotional and physical state a) Health promotion; b) Medical male circumcision campaign a) Mobile oral telemedicine; b) Mobile tele-radiology; c) Mobile cervical cancer screening; d) Mobile tele-dermatology, e) Mobile tele-mentoring	Literature on m-Health implementations -dominated by studies of pilot projects and implemented to run for a short period. Guides policymakers in health and information technology; mobile telecommunications and software development industries.	Expansion of m-Health activity in developing world[8-10]
[WHO global observatory for e Health series]	2011	Global survey	m-Health: New horizons for health through mobile technologies		
West D.	2012	Review on global m-health research	Mobile health innovations around the world Mobile Economy Project	Reviewed adoption of innovative examples of m-health. Impact on service delivery and medical treatment,. How mobile devices - saving money in the health care system.	
Kaplan WA.	2006	A Web-based and library database search	No literature on using mobile telephones- a healthcare- intervention for HIV, TB, malaria, and chronic conditions in developing countries. Clinical outcomes rarely measured. Convincing evidence -overall cost-effectiveness of mobile phone " telemedicine" - limited. Good-quality studies -rare.	Creating a sustainable, large-scale mobile phone/ healthcare model-agreement among different stakeholders with different agendas. Regulatory reforms required for proper operation of basic.	Current m-health activities and its future role in developing world[11]
Lacal,	2003	Workshop proceedings	Mobile tele-health systems model	Proposed framework to measure roi of mobile	
Mechael	2006	An Egyptian case study	Mobile phones in general population and among health professionals -creating new opportunities for improving access to emergency and general health services and improving coordination and collaboration among users in most countries	tele-health solutions in the management of chronic diseases provides understanding of how mobile phones have been 'domesticated' for health in Egypt	Promises from m-health approach[3,12-14]
Déglise C	2012	Systematic review	Role of SMS for disease control in developing countries	Mobile phones _ an appropriate and promising tool for disease control interventions in developing countries.	
Shruti M	2013	Case approach on Tanzania	M-health potential-to revolutionize healthcare around the world; It needs rigorous evaluation and research.	m-Health interventions can increase economic development of developing countries.	
[Chang, *et al*.	2013	a mixed methods study-formative research approach	Number of potential inhibiting factors -discovered.	Help and guides future design and implementation of m-health interventions.	Pitfalls in adopting m-health approach[15-16]
Motamarri, *et al*.	2012	a multiple discriminant analysis	The comparative insights and house of quality (HoQ) model	mobile health is costlier despite patients liking.	

information dissemination, and public education and alerts systems as revealed by m-health running projects in developing countries in studies found from literature as shown in Table 2.[5-7]

Expansion of m-Health activity in developing world

The mobile communication technologies are currently considered essential for improving the access and quality of health services, and overall health outcomes, by providing informational support and regular care as found by many authors in literature (Klasnja and Pratt, 2012; Noordam, Kuepper, Stekelenburg, and Milen, 2011; Tezcan, Von Rege, Henkson, and Oteng-Ntim, 2011; Kreps and Neuhauser, 2010; Krishna, Boren, and Balas, 2009).[8] In 2011, a global survey of 114 nations done by the World Health Organization (WHO) has also found that m-health initiatives have been established in many countries, but there is variation in adoption levels, and the most common activity noted was the creation of health call centers, which respond to patient inquiries.[9]

Remote monitoring in chronic diseases via m-Health approach

Remote monitoring occupies two-thirds of the m-health market as doctors and patients use these devices to manage chronic illnesses. Good example of efforts in this direction is *China* where *Qualcomm's Wireless Reach* in partnership with Life Care Networks and the

Table 2: Currently running M-health Projects in developing countries[5-7]

SMS approaches
  Learning about Living, Nigeria
  Project Masiluleke, South Africa
  Text to Change (TTC)-HIV Prevention through SMS Quiz, Uganda
Remote data collection
  Cell-PREVEN, Peru
  Dokoza System, South Africa
  EpiHandy, Uganda, Zambia, Burkina Faso
  Phones for Health, Rwanda
Remote monitoring
  Cell-Life Project, South Africa
  Colecta-PALM, Peru
  Virtual Health Pet, Brazil
Training for healthcare workers
  HealthLine, Pakistan
  Mobile HIV/AIDS Support, Uganda
  Uganda Health Information Network, Uganda
Disease and epidemic outbreak tracking
  Alerta DISAMAR, Peru
  Frontline SMS, Worldwide
  GATHER, Uganda
Diagnostic and treatment support
  HIV Mobile Decision Support, South Africa
  Mobile E-IMCI, Tanzania
  Mobile Telemedicine System, Indonesia

Community Health Association of China had deployed an electrocardiogram sensing handset, which can record 30 seconds of heart data and transmits that information electronically to the 24-hour Life Care Networks Center in Beijing.[10] 3rd Mobile for Development (M4D) Conference held in 2012 also reveal similar key issues and areas in m-health remote monitoring and mobile telemedicine approaches by few researchers such as Haque *et al*.; Hoefman *et al*. and Littman-Quinn *et al*. on new areas, for example:

a. SMS and Medical Sensors,
b. Mobile Oral Telemedicine,
c. Mobile Tele-radiology,
d. Mobile Cervical Cancer Screening,
e. Mobile Tele-dermatology, and
f. Mobile Tele-mentoring.[5,8,10]

Current m-Health activities and its future role in developing world

M-health studies currently are revealing mixed results in terms of demonstrating the potential that fixed-line and mobile phones can serve as a support for more effective delivery of healthcare services (Kaplan, 2006).[11]

Promises from m-Health approach

With the ubiquity of mobile devices both in developing and developed countries, there have been innovations in awareness, prevention, diagnosis, and treatment. Yang, and Kahn (2010) have emphasized the steady growth of disease in developing countries and that using m-Health to combat this growth shows promise.[12] The potential impact of m-health in health delivery in developing countries is largely untapped due to technical as well as socio-economic, cultural, and regulatory barriers (Kaplan, 2006).[11] Kaplan (2006)[11] *et al*. from his study suggest that functional and structural properties of mobile phones like low start-up cost, text messaging, and flexible payment plans make them attractive to use as a healthcare intervention. With the development of standardized health-related software applications, mobile phones can provide real-time feedback and pre-programmed portable automated services that enable support to increasingly decentralized health systems as advocated also by Lacal, [2003] and Mechael [2006].[3,13,14]

Pitfalls in adopting m-Health approach

Most m-health studies are not guided by any conceptual framework, neither the research questions are instigated by existing theories, and research in this domain has not focused on the impact of the interventions on the various stakeholders. There are also a number of impending challenges such as cost, both at the macro systems level (Istepanian and Lacal, 2003),[10,13] as well as at the level of the individual citizen and healthcare provider (Mechael, 2006).[14]

Although most qualitative and quantitative results are generally consistent, and overall, there is enthusiasm for m-Health technology, there are a number of potential inhibiting factors found also in study by Chang *et al*. (2013) in their mixed methods formative research approach on m-health area in Kampala (Uganda).[15] The primary barriers in m-health field identified currently are language, timing of messages, mobile network fluctuations, lack of financial incentives, data privacy, and mobile phone turnover affecting effective health care delivery through m-health approach despite their immense potential (Motamarri, S 2012).[16]

Conclusion

Mobile technology-supported health care undoubtedly has many potentials in improving health outcomes in the long run in developing world provided m-health technological solutions are designed according to local realities and local needs. There is also an emerging need to evaluate the benefits and pitfalls of this technology application urgently; therefore, further research in this field is suggested by authors such as more in-depth qualitative as well as quantitative studies in future, if we need to use this technology for better public health status in developing world.

List of abbreviations used
- M-Health: Mobile Health
- WHO: World Health Organization
- HIV/AIDS: Human Immunodeficiency Virus/Acquired Immuno Deficiency Syndrome
- MDGs: Millennium Development Goals
- PRISMA: Preferred Reporting Items for Systematic Review and Meta-Analysis

References

1. Kouadio IK, Ghazi HF, Maimaiti N,Rahimi A, Aljunid SM. Potential of mobile technology in meeting the public health need sin developing countries. BMC Public Health 2012;12(Suppl2):A13.

2. Lemaire J. Scaling up mobile health elements necessary for the successful scale up of m-health in developing countries. [white paper commissioned by advanced development for Africa Actevis Consulting Group]. Available from: http://www.actevisconsulting.com. [Last accessed on 2011 Dec 25.

3. DégliseC, SuggsLS, OdermattP. SMS for disease control in developing countries: A systematic review of mobile health applications. J Telemed Telecare2012;18:273-81.

4. Pakhre P, Bali S, Kalra G. Use of mobile phones as research instrument for data collection. IndianJ Community Health (IJCH)2013;25:95-8.

5. Kahn JG, Yang JS, Kahn JS. 'Mobile' health needs and opportunities in developing countries. Health Aff (Millwood) 2010;29:252-8.

6. UN Foundation, "mHealth for development: The opportunity of mobile technology for healthcare in the developing world," 2009. Available from: http://unpan1.un.org/intradoc/groups/public/documents/unpan/unpan037268.pdf. [Last accessed on 2013 Oct 20].

7. Burney A, Abbas Z, Mahmood N, Arifeen Q. Prospects for mobile health in Pakistan and other developing countries. Advances in Internet of Things (AIT) 2013;3:27-32.

8. Chigona W, Nyemba M, Metfula A. A review on mHealth research in developing countries. J Commun Informatics 2013;9: 2.1011-19

9. *World Health Organization*. "m-Health: New horizons for health through mobile technologies", global observatory for eHealth Series — Volume 3.2011.

10. West DM. How Mobile Devices are Transforming Healthcare. Issues in Technological Innovation (ITI). 2012;18:1-14. Available from: http://www.brookings.edu/~/media/research/files/papers/2012/5/22%20mobile%20health%20west/22%20mobile%20health%20west. pdf. [Last accessed on 2012 May 31].

11. Kaplan WA. Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries? Global Health 2006;2:9.

12. Modi S. "Mobile health technology in developing countries: The case of Tanzania,". Pepperdine Policy Review 2013;6:566.

13. Lacal J. Cell phones and tele-medicine. Health Com 2003: Proceedings of the 5th international workshop on enterprise networking and computing in healthcare industry. Santa Monica, California: 2003.

14. Mechael PN. Exploring health-related uses of mobile phones: An Egyptian case-study public health and policy [Internet] Published Information from London School of Hygiene and Tropical Medicine website. 2006;01 1-264. Available from:http://www.ihris.org/mediawiki/upload/PatriciaMechaelThesisFinalDecember2006.pdf [Last accessed on 2013 Dec 25]

15. Chang LW, Njie-Carr V, Kalenge S, Kelly JF, Bollinger RC, Alamo-Talisuna S. Perceptions and acceptability of mHealth interventions for improving patient care at a community-based HIV/AIDS clinic in Uganda: A mixed methods study. AIDS Care 2013;25:874-80.

16. Motamarri S, Akter S, Ray P, Tseng C. Mhealth: A better alternative for healthcare in developing countries. Pacific Asia Conference on Information Systems (PACIS) Vietnam: AISeL. Available from: http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1119andcontext=buspapers. [Last accessed on 2013 Oct 31.