Value of mobile based ICT health interventions in healthcare system in India

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ABSTRACT

With rapid exponential growth of population in the country, India is experiencing rapid transition in the health sector. The ever-increasing burden of diseases among populates is creating a threat to the nation-wide health. A variety of ICT based approaches to deliver healthcare services and the potential uses of mhealth have now come into being. It includes usage of mobile from text messaging to smartphones applications for collecting data, monitoring and tracking patients, dissemination of information and awareness, feedback etc. With the limited offered success stories in India, it can be marked that mobile health technology has gained sizeable effects on health outcomes. Henceforth, this paper tries to exemplifies the significance of mobile phone based ICT in healthcare system in order to yield beneficial health outcomes specifically in India.

Key Words : Information Communication and Technology (ICT), Mobile Health (mhealth), Primary Healthcare, Community Health Workers (CHWs), India

Key Insights:
1. There is a significant need to overcome healthcare challenges which can be solved using mobile based ICT intervention due to its high rate of diffusion.
2. Sustainability of mhealth is an important factor for long-term transformations in health outcomes.
3. Mobile phoneaids as a means to bridge the urban-rural healthcare divide

INTRODUCTION

According to the world population report 2015, India's population is projected to continue growing for several decades to 1.5 billion in 2030 and 1.7 billion in 2050. Currently, the population of China is approximately 1.38 billion compared with 1.31 billion in India. By 2022, both countries are expected to have approximately 1.4 billion people. The population of India is exponentially growing and is expected to outdo that of china. With rapid exponential growth of population in the country, India is experiencing rapid transition in the health sector. The

ever-increasing burden of diseases such as communicable, non-communicable and infectious disease among populates is creating a threat to the nation-wide health. Consequently, this is creating a huge burden on the public health system of India, wherein two thirds are still living in the rural areas (Ahamed *et al.*, 2017). With an alarming need of the delivery of efficient services and economical interventions in rural areas it is important for the healthcare system to reach out the unserved people of the country.

Despite the country's rapid economic growth rate, there remains a disturbingly high Maternal Mortality Ratio (MMR) of 212 maternal deaths per 100,000 live births. Furthermore, The World Economic Forum ranked India as 132nd out of 134 nations in terms of gender equity in health. (Hausmann *et al.*, 2010). As per 2011 census, the total population of India was 121 crore. Among this, the rural population was 83.3 crore (68.84%) and urban population was 83.3 crore (31.16%). It is seen that the rural population is more than twice than the urban population. In this regard, 2279 rural villages had increased between the census 2001 and 2011. In 2001 census, the total number of villages were 6,38,588 and in 2011, it increased to 4,40,867. Whilst, the health facilities are not available in each village (Dev, 2016).

Access to healthcare services has long been a central aim of public health and international development policy. In 2000 the Millennium Development Goals (MDGs), have focused global policy attention on healthcare services and delivery.

A comparison of India's major health indicators with those of several other countries (Table 1) highlights the need for improving health system capabilities in India (Planning commission [PC], 2011).

Table 1 : A comparison of India's major health indicator with other countries					
Indicator	India	China	Brazil	Sri Lanka	Thailand
IMR/1000 live-births	50	17	17	13	12
Under-5 mortality/1000 live-births	66	19	21	16	13
Fully immunised (%)	66	95	99	99	98
Birth by skilled attendants	47	96	98	97	99
Health expenditure as percentage of GDP	4.2	4.3	8.4	4.1	4.1
Government share of total health Expenditure (%)	32.4	47.3	44	43.7	74.3
Government health spending share of total Government spending (%)	4.4	10.3	6.0	7.9	14.2
Per capita spending in US dollars	122	265	875	187	328

*Source: World Health Orgazation (2011)

The difference in urban-rural health condition are significantly shown by statistics in infant mortality rate and crude death rate in developing and under developed countries. With huge variation in demographic factors, population density, lack of good quality transport facilitates, inadequate nutrition, illiteracy and poverty the healthcare system in India is unable to deliver the quality of services (Ahamed *et al.*, 2017).

Thus, the necessity of effective healthcare system was recognised in the Bohre Committee, 1946 with recommendation on Primary Healthcare Centres (PHCs) were established to promote, prevent, curate and rehabilitate the services to entire rural population.

(Dev, 2016). The convulsive political changes that took place in the 1970s impelled the Central Government to implement the vision of Sokhey Committee of having one Community Health Worker for every 1000 people to entrust 'people health on people's hand'. India has come quite close to Alma Ata Declaration on Primary Healthcare made by all countries of the world in 1978 (Pal, 2011). Various health policies were developed such as Universal Immunisation programme, reproductive child health, national population policy and national health policy. At present-day the health care structure in India is as per the guidelines provided under the National Health Mission which was launched on April 12th 2015 with the prime aim on primary healthcare (Dev, 2016). Numerous studies shows that the rural part of India have been facing healthcare problems. Such challenges in the healthcare systems are discussed in the next section of this paper.

Challenges in healthcare in India :
Strain on health centres :

The public health system in India is three tier healthcare system which is based on the guidelines of National Rural Health Mission (NRHM). It is expected to provide nurse/midwife, doctor and specialised care at sub-centre, primary health-centre, and community healthcare centre respectively. One single PHC poses one doctor is expected to serve upto 30,000 residents thus, creating a stress on quality of services delivered through PHC (Praveen *et al.*, 2013).

According to the population census 2011, rural health infrastructure shows a significant shortage of health centres for instance a total of 4628 sub centers and PHCs are reported to be of shortage. "There are estimates that India would be required to increase its bed capacity with an addition of nearly 1.7 million beds. Another estimate has put the need for India to increase its bed capacity by at least 600,000 to 700000 per annum for the next five to six years. The need for hospital beds is also significant to meet the growing demands from population" (Chawla and Sharma, 2015, p. 88).*Health Care in India : Opportunities, Challenges and Concerns (A Case Study)*

Shortage of health workforce :

Health workforce is defined as "all people engaged in actions with primary intent to enhance health" (Goel, 2013). According to the World Health Report 2006, a shortfall of health workforce has been documented in 57 countries. The scenario is worse in Southeast Asian regions, which accommodate 25% of the world's population and take 30% of the global disease burden, as these have only 10% of the global health workforce. In India, 20 health workers and 1 doctor for every 10,000 people translates to a shortage of nearly 2.6 million health workers. The health workforce inequity exists between genders, regions, and categories of health workers (Goel, 2013).

The public health system in India faces a shortage of workforce. According to the guidelines of NRHM a minimum of three ANCs is required for a safer delivery of pregnant women on the other hand a case of ANC shows that India is unable to provide the required ANC to one half go the pregnant women. Henceforward indicating requirement of an intervention so as to accommodate the needs of the communities (Garai, 2011). As reported

in a study there is only one doctor and trained healthcare provider is available for very sixteen villages in India (Dev, 2016). "As on March 2014, about 2225 PHCs were without a doctor, about 9825 PHCs were without a lab technician and about 5739 PHCs were without a pharmacist, 4427 CHCs without surgeons and 4106 CHCs without gynecologist, 4432 CHCs without physician. However, total shortfall of the specialists was 17371 as on 31st march 2014" (Chawla and Sharma, 2015, p. 88).*Health Care in India : Opportunities, Challenges and Concerns (A Case Study)*

A report on universal health coverage for India by planning commission has estimated a need of 1.9 million CHWs to meet the requirements of the universal health coverage. Henceforth, the report has recommended to ensure an adequate amount of health workforce *i.e.* a minimum of 23 health workers per 10,0000 population so as to to achieve norms stated by WHO. A detail of which is given in the Table 2 below (PC, 2011).

Table 4 : Summarizes the profile of the nurses and allopathic doctors that is expected to evolve by 2022 as a result of recommendations by planning commission (Planning commission, 2011)			
	2011	2017	2022
Allopathic doctors, nurses and midwives per 1000 population	1.29	1.93	2.53
Population served per allopathic doctor	1,953	1,731	1,451
Ratio of nurses and midwives to an allopathic doctor	1.53	2.33	2.94
Ratio of nurses to an allopathic doctor	1.05	1.81	2.22

Source: (Planning commission, 2011)

Accessible and affordable health facilitates :

Several studies have reported lack of proper facilities, lack of awareness about health issues, absenteeism of doctors and proper referral as the reasons of poor health indicators in rural areas leading to a decrease in accessibility and affordability of healthcare facilitates. Thus, in order to improve on the health outcomes community health workers were established as an integral part of health system of a community. (Dev, 2016).

"Infrastructure in India is low level of healthcare expenditure as a percentage of GDP. The percapita total expenditure on health in India was US$ 61 in the year 2013 while per capita government expenditure on health was US$2013 (Source: World Health Organization).

Government's health expenditure accounts forless than one-fourth of total health expenditure in India, and thus do not drive the private sector to increase its investment. With limitations inpublic healthcare spending, private sector has a major role to enhance the healthcare infrastructure in India" (Chawla and Sharma, 2015, p. 88). *Health Care in India : Opportunities, Challenges and Concerns (A Case Study).*

These challenges highlights that there is an urgent need for innovation and interventions in healthcare system in India. It has been envisaged to use telemedicine to provide healthcare services. But, implementation and the high cost of telemedicine is failing to become a sustainable way of fulfilling the necessity at the grassroots level. Thus a low cost intervention is looked-for in the health system. The application of mobile technologies today is proving to be a great success to change the global health scenario. It is anticipated that the ICT based mobile phone technology has the ability to revolutionise healthcare delivery in India (Ahamed, *et al.*, 2017).

According to (Telecom Regulatory Authority of India (TRAI), 2012), India has recorded a 72% Teledensity in the year 2011 showcasing the high penetration of mobile phone due to cost-effective and easy availability even in the remotest part of the country. (Kittusami and Sathyapriya, 2013). Brommey defines eHealth as the usage of ICT based interventions for advancement in healthcare delivery and reaching out to patients in their own location. Health service delivery with the practise of mobile phones by making it accessible to the people. (Kittusami and Sathyapriya, 2013)

mhealth: Mobile technologies for healthcare :

mhealth is a service provider of health. The term "mHealth" was coined by Professor Robert Istepanian as the use of "emerging mobile communications and network technologies for healthcare" (Goel, 2013). mhealth includes all the electronic devices such as smartphones, mobile phones, laptops, tablets etc. for the wellbeing of community members. In the Global Observatory 2015 survey, mHealth (also known as mobile health) was defined as the use of mobile devices – such as mobile phones, patient monitoring devices, personal digital assistants (PDAs) and wireless devices – for medical and public health practice.

Mobile communication technology has the potential to transform healthcare delivery across the globe (WHO, 2016). As per the telecom regulatory authority of India 2016, there are more than 1000 million subscribers in India at present. India represents almost 17.85% of the world's population. Henceforward mobile phones deeper penetration in the resource-poor settings has created a need to review mhealth for development or to reach the Universal Health Coverage (UHC). Mobile phones present an opportunity to provide health services, especially in rural and resource-poor settings, because of their deeper penetration, extensive network coverage, and ease of use. This is increasing access to mobile technologies which will allow people to be reached residing even in remote areas.

A recent study revealed that there are approximately 51 mhealth programs being implemented in 26 countries in the world (Akter and Ray, 2010). There are different types of mhealth programs being implemented in diverse health settings. Mobile based ICT interventions are being used using varied features such as voice based, SMS or Video formats so as to make beneficiaries aware about health services and making healthcare delivery easy (Akter and Ray, 2010).

Approaches of mhealth delivery

Modes of mhealth delivery includes SMS, Smartphone applications, IVR system and video messages. Smartphone applications are the most recent way of managing, delivering and providing information about health services, as compared to SMS and IVR based interventions (Santo, 2015)

Text-messages and healthcare :

Text-messages are a convenient and cost-effective mode of communication and relatively an old method of mobile technology for healthcare delivery (Santo, 2015)

IVR and healthcare :

Interactive Voice Response (IVR) systems are the voice phone calls for the community

members in order to receive a feedback about any health issue or a medium to give reminders to the beneficiaries and stakeholders. For example citizens in India can complaint or consult for any medical issues by calling on health helpline at a very minimal cost, which is provided by health management and research institute in collaboration with state governments (Maharashtra, Rajasthan, Assam, and Andhra Pradesh (Goel, 2013). A study in the south India revealed that IVR mobile phone based interventions were perceived as valuable and an acceptable method to upkeep adherence as compared to SMS. (Sidney *et al.,* 2011)

Video messages and healthcare :

Video messages are the development and distribution of video for better health and wellness of the people. One such study in Orissa demonstrated the use of mobile communication in Behaviour change communication and healthcare delivery wherein several mobile videos were developed to assist the frontline health workers to advice pregnant women in rural areas (Garai, 2011).

Smartphone applications and healthcare in India :

Smartphones are mobile devices with computer abilities and it can run computer programs based applications which are user-friendly designed and have in-built data-sharing capabilities, messages reminders etc. whilst to operate these applications it requires training for users to get familiar with technology (Santo, 2015)

Potential uses of mhealth and its applications in India :

A wide variety of health objectives can be achieved with the mhealth tool such as awareness, tracking, monitoring, data collection and networking and communication. In this section the evidence based practical applications are discussed in order to achieve a better understanding about the value of mhealth in the public health system in India.

The competence of mobile phones to deliver information and awareness to the people including stakeholders anytime anywhere makes mhealth a powerful vehicle to bring about the desired change. This makes mhealth an important medium to reach people in the remotest part where there is lack of health services and limited health workforce. For example a recent study by Population Council, showed that 12% and 10% beneficiaries who did not receive the immunisation were unaware of the place and timings of immunisation in the state of Uttar Pradesh. This suggests the need of sufficient awareness to achieve a desired behaviour among beneficiaries which henceforth can be achieved by using mobile technologies as a vehicle of revolution (Garai, 2011). Jalaaka Project in India facilitated education and spreading awareness about HIV among the community and high-risk groups by using mobile phones. An open source software application was used by Media Lab Asia to collect medical and demographic data. This aided to build a sustainable health system (Goel, 2013).

Mhealth can be used as a device to collect data and diagnosis of diseases and screening of patients. For example A study of the Foundation for Research in Health System (FRHS) revealed how using computerised database of services provided to the beneficiaries aided health workers and professionals to identify the ones who were excluded or left out in receiving the health services in family planning, maternal health and child health. As the

database helped in generating a list of beneficiaries in Patan, Gujarat state in India which helped healthcare workers to reach the unreached sections of community. Henceforth mhealth also proves to increase the wide range of coverage during care giving (Garai, 2011).

Other potential uses of mhealth includes behaviour change support. ICT based approaches provide a possible means to monitor and help patients to manage their health and lifestyle. For example, Mother and Child Tracking System (MCTS) under National Rural Health Mission (NRHM) in India is being used as a way to eliminate the need of paper based work by digitalising it via mobile phones by sending repeated reminders through phone calls and SMS in order to safeguard improved and timely delivery of services to the recipients. (Goel, 2013). Women in India are highly vulnerable and face a variety of psychosocial barriers such as stigma related to HIV due to low literacy, social discrimination and low social support. Henceforth, which limit their access to care and treatment. A MAHILa mobile based intervention in India proved to be a useful tool. This intervention strengthened the counselling skills of Non-Specialist Nurses leading to a positive change in perception, attitude and behaviour of women with HIV by reducing stigmas through counselling. (Reynolds *et al.*, 2016). Thus indicating the potential uses of mhealth in behaviour change and support.

One of the challenges of healthcare system is timely access to health information, limited training, insufficient knowledge of healthcare workers and errors computed while developing reports. This highlights the need of innovation in primary healthcare. A mobile based campaign demonstrated the use of mobile based intervention in delivering healthcare within limited time and helping reducing errors. For instance a study shows a cancer campaign covered approximately 2.3 million people using a mobile phone for a survey in Punjab within a limited period of time in order to transfer data which significantly reduced errors and time. (Goel, 2013). A similar study has shown a noteworthy improvement in quality of service delivery, reporting of service delivery and timely information and equity in delivery of services by developing an application namely continuum of care services for maternal and child health to track from registration of pregnancy to child's sixth year of age (Balakrishnan *et al.*, 2016).

Additionally another mobile based application titled CommCare showed a wider outreach results where there health workforce is limited. The CommCare application was developed with the aim to disseminate information on different health issues for adolescent girls and pregnant women. Mobiles are acting as a tool to remind and keep a track on implementation for example CycleTel a mobile app in Bihar is used to help community health workers to disseminate information about family planning methods to the beneficiaries (Goel, 2013). A study provides evidence based results for mhealth evidencing it as a cost-effective tool. A application for frontline health workers called "ASTA - A self-tracking Application for ASHAs" developed to access feedback on the performance. The study demonstrated positive results as 21.5% more monthly visits were done by the ASHA (Renzi *et al.*, 2016).

Last of all, mobile technologies is considered as an idol way of communication between stakeholders**,** health professionals, system developers etc. a pilot project at school of public health, Chandigarh India established a new way for communication and networking between beneficiaries, health workers and public health professionals. Thus, encouraging the use of mobile phone for medical consultation (Goel, 2013).

Conclusion and future work :

In this review article the potential use of mhealth has been discussed in variation of health settings and have highlighted some favourable applications. From the limited review done it was revealed that with rapidly increasing population in India, the health sector is undergoing several challenges to meet the growing demands of people. The ever-increasing burden of diseases such as communicable, non-communicable and infectious disease among populates is creating a threat to the nation-wide health. This is creating a burden on the public health system of India, with an alarming need of the delivery of efficient services and economical interventions in healthcare system. Some barriers and challenges can be overcome with the use of mobile technologies. Recent studies of the use of mhealth in healthcare system show exciting benefits in application development, disease surveillance, monitoring and evaluation etc. It is anticipated that mhealth has the plausible to transform healthcare system in India where a majority of people reside in rural areas with shortage of healthcare providers and no access to healthcare services. Although there is still little evidence of these benefits to scale up mobile based programs.

RNTCP's NSP (2012-2017), Ministry of health and family welfare, government of India, 2012 has also recommended the integration of mobile based ICTs to strengthen healthcare system and for patient satisfaction (Kittusami and Sathyapriya, 2013). There are several studies stating mhealth to be still in its early stages. A variety of researches have focused on the development of mobile health applications for better management of tasks, ownership pattern of mobile phone, and its usability by people etc. Whilst very limited evidence are available from the social aspect. Hereafter there are several recommendations for further research studies covering issues such as social norms, how mhealth is aiding in removing stigmas related to diseases, how mhealth is proving as a tool of empowerment to women, strengthening networks among stakeholders, and health communication, how mhealth can overcome specific barriers to adherence and attitude of recipients towards mobile based ICTs at the grassroots level in India. Likewise, it is also important to highlight that there is an immense need for mobile literacy, cost effective strategies, network coverage etc. to make mhealth interventions a success. The overall rigor and evaluation of mhealth should be scaled up at the national and international level. It is anticipated that this review would add body to the evidences so as to enhance the actionable solutions for the policy makers, funders, researchers etc. Thus, this paper tries to mhealth is a new pathway for development in healthcare in India.

REFERENCES

Ahamed, F., Palepu, S., Dubey, M. and Nongkynrih, B. (2017). Scope of mobile health in Indian health care system – the way forward. *Internat. J. Community Medicine & Public Health*, **4**(4) : 875-881. doi:10.18203/2394-6040.ijcmph20171300.

Akter, S. and Ray, P. (2010),mHealth - an Ultimate Platform to Serve the Unserved, IMIA Yearbook of Medical Informatics 2010, 94-100, retrieved from https://www.schattauer.de/index.php?id= 5236&mid=13550&L=1

Arul, C.H.I.B., Cheong, Y.J., Lee, L.C.L., Ng, C.H.C., Tan, C.K. and Kameswari, V.L.V. (2012). The hope

of mobile phones in Indian rural healthcare. *J. Health Informatics Developing Countries*, **6**(1) : 406-421.

Balakrishnan, R., Gopichandran, V., Chaturvedi, S., Chatterjee, R., Mahapatra, T. and Chaudhuri, I. (2016). Continuum of care services for maternal and child health using mobile technology – a health system strengthening strategy in low and middle income countries, *BMC Medical Informatics & Decision Making,* **16**:84 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4937606/pdf/12911_2016_Article_326.pdf

Chawla, S. and Sharma, P. (2015). Health Care in India: Opportunities, Challenges and Concerns (A Case Study). *Americas*, **13**(49.0), 51-0.

Dev, S. (2016). Rural healthcare infrastructure in India. *Kurukshetra J.*, **65**(2) : 23-27.

Garai, A (2011). Role of mHealth in rural health in India and opportunities for collaboration. In, ICCP Technology Foresight Forum: Developments in Mobile Communication, Paris, 26 October 2011. 5 pages. https://www.oecd.org/site/stiffmob/49440234.pdf

Garai, Atanu (2011). Tapping the mHealth opportunity. *CSI Communications,* **35** (7) : 19-20. Online: http://www.csi-india.org/web/csi/online-csic.

Goel, S., Bhatnagar, N., Sharma, D. and Singh, A. (2013). Bridging the human resource gap in primary health care, delivery systems of developing countries with mHealth: Narrative Literature Review *JMIR Mhealth Uhealth,* **1**(2):e25 retrieved from http://mhealth.jmir.org/2013/2/e25/

Hausmann, R., Tyson, L.D. and Zahidi, S. (2010). The global gender gap report 2010. World Economic Forum. [Internet] 2010. [cited 2011 July 21]. Available at: http://www.weforum.org/pdf/gendergap/report2010.pdf

Juneja, N. and Sood, S. (2013). mHealth: Leading the charge. *Internat. J. Adv. Res. IT & Engg.*, **2**(10) : 47-50. Retrieved from http://garph.co.uk/IJARIE/Oct2013/5.pdf

Kittusami, Sathyapriya (2013). ICT - Enabled Treatment Adherence and Follow-Up System Towards Successful Implementation of Revised National Tuberculosis Control Programme (RNTCP), India (September 5, 2013). CPRsouth8/CPRafrica2013 conference. Available at SSRN: https://ssrn.com/abstract=2331912

Maitra, A. *et al.* (2013). A novel mobile application to assist maternal health workers in rural India, ACM Digital Library. Retrieved from http://dl.acm.org/citation.cfm?id=2663594

mHealth. New horizons for health through mobile technologies. (2011) Global observatory for eHealth series volume 3. World Health Organization. Geneva. Switzerland. Available at http://www.who.int/goe/ publications/goe_mhealth_web.pdf.

Pal, B. (2011). National rural health mission: Issues and challenges. *Internat. J. Business Econ. & Manage. Res*., **1**(3) : 139-146, retrieved from http://www.zenithresearch.org.in/images/stories/pdf/2011/Dec/ZIBEMR/11_ZIBEMR_VOL1_ISSUE3.pdf

Planning Commission (2011). High Level Expert Group Report on Universal Health Coverage for India. New Delhi, India.

Praveen *et al.* Implementation Science 2013, 8:137 http://www.implementationscience.com/content/8/1/137

Praveen, D. *et al.* (2013) A multifaceted strategy using mobile technology to assist rural primary healthcare doctors and frontline health workers in cardiovascular disease risk management:

protocol for the SMARTHealth India cluster randomised controlled trial, retrieved from http://download.springer.com/static/pdf/315/art%253A10.1186%252F1748-5908-8-137.pdf?originUrl=http%3A%2F%2Fimplementationscience.biomedcentral.com%2Farticle%2F10.1186%2F1748-5908-8.

Renzi, B. *et al.* (2016)Closing the Feedback Loop: A 12-month Evaluation of ASTA, a Self-Tracking Application for ASHAs, retrieved from http://www.nixdell.com/papers/closing-feedback-loop.pdf

Reynolds, Nancy R.,Satyanarayana,Veena, Duggal, Mona, Varghese, Meiya, Liberti, Lauren, Singh, Pushpendra, Ranganathan, Mohini, Jeon, Sangchoon and Chandra, Prabha S. (2016) . MAHILA: a protocol for evaluating a nursedelivered mHealth intervention for women with HIV and psychosocial risk factors in India. *BMC Health Services Res.,* **16** : 352 DOI 10.1186/s12913-016-1605-1 retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4973541/pdf/12913_2016_Article_1605.pdf.

Santo, K., Chalmers, J., Chow, C.K. and Redfern, J. (2015). m-Health in coronary disease preventive care. *J. Cardiol. & Therap,* **2**(6): 459-464 Available from: URL: http://www.ghrnet.org/index.php/jct/article/view/1516

Sidney, K., Antony, J., Rodrigues, R., Arumugam, K., Krishnamurthy, S., D'souza, G., De Costa, A. and Shet, A. (2011). Supporting patient adherence to antiretrovirals using mobile phone reminders: Patient responses from South India. *AIDS Care*, **24** (5) : 612-617, retrieved from http://dx.doi.org/10.1080/09540121.2011.630357

Sondaal, S.F.V., Browne, J.L., Amoakoh-Coleman, M., Borgstein, A., Miltenburg, A.S., Verwijs, M. and Klipstein-Grobusch, K. (2016). Assessing the effect of mHealth interventions in improving maternal and neonatal care in low-and middle-incom countries: a systematic review. *PLoS ONE*, **11**(5) : e0154664.

Telecom Regulatory Authority of India (2016). Highlights of Telecom Subscription Data as on 31st January 2016. Retrieved from http://www.trai.gov.in/WriteReadData/PressRealease/Document/PR-TSD-Feb-10042015.pdf on 04/07/2017.

Telecom regulatory authority of India (2017). http://www.trai.gov.in/release-publication/reports/telecom-subscriptions-reports

United Nations Department of Economic and Social Affairs/Population Division World Population Prospects: The 2015 Revision, Key Findings and Advance Tables.

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