

Moving mountains with mobiles: Spatio-temporal perspectives on mHealth in Nepal

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Community healthcare workers (CHW) are an important component of rural healthcare service delivery to remote rural communities in developing countries. The field of mHealth proposes that mobile technologies will have a beneficial impact on rural healthcare development. Current analyses advance the proposition that the utilization of mobile technologies leads to the shifting of space and time (Ling & Campbell, 2009). The current research examined the potential for a sustainable mHealth system for CHW in Achham, Nepal. The community aspect of mobile usage was overlaid with a spatio-temporal lens to examine the information and communication needs and practices of stakeholders within the healthcare infrastructure. Fieldwork was conducted in conjunction with Nyaya Health, at the Bayalpata Hospital, in Achham, Nepal. Qualitative research methods, focus group discussions, and in-depth interviews included 57 respondents.

The findings revealed that limited relevance and information-sharing, limited access due to individual ownership and low income, and ineffective training programs were key barriers to the delivery of rural healthcare services. The spatio-temporal perspective, particularly community communicative practices, revealed technological mHealth design solutions to alleviate the problems identified. The potential shifts in power relationships by using mobile technologies and hybrid fixed-wireless technologies provide opportunities for further theoretical investigation.

Introduction

Advances in the delivery of maternal healthcare over the past century have resulted in vital gains in life expectancies, lowering of child mortality rates, and improved access to critical medication and medical expertise (World Health Organization [WHO], 2008). However, the distribution of healthcare benefits continues to exhibit significant variation (You, Wardlaw, Salama, & Jones, 2009), extending from the global north-south divide to a rural-urban divide. The phenomenon of inverse care, whereby those with the greatest resources appropriate the best healthcare to the detriment of those in real need, often those least able to access and afford it (WHO, 2008), is often driven by public health spending policies that bias resource allocation of healthcare (Brant, Garris, Okeke, & Rosenfeld, 2006). As a consequence, urban births receive greater medical attention than rural births by a factor of two (United Nations Children Fund [UNICEF], 2008).

Critical to the process of primary healthcare service delivery to rural populations are community health workers (CHW) (WHO, 1978) – i.e., non-professional health providers without extensive formal training, chosen by, and accountable to, their own local community (WHO, 2007). Normally compensated minimally with an honorarium (Bhattacharyya, Winch, LeBan, & Tien, 2001), CHW provide a range of services (Bhutta, Darmstadt, Hasan, & Haws, 2005; Bryce et al., 2005), helping to keep diseases at bay (Kahsay, Taylor, & Berman, 1998; Witmer, Seifer, Finocchio, Leslie, & O'Neil, 1995), eventually leading to a positive impact on maternal and infant healthcare (Lewin et al., 2006; Quinn et al., 2005; Sazawal & Black, 2003).

However, rural CHW suffer from illiteracy and a lack of appropriate medical knowledge (Chen et al., 2004), often combined with inadequate training (Kruske & Barclay 2004; McNamara, 2003; O'Heir, 1997). Coupled with a difficult to access and hierarchical medical infrastructure lacking a mechanism for two-way communication, CHW often lack operational effectiveness (Haines et al., 2007).

Mobile phones (MP) have bridged these healthcare service delivery gaps by delivering information, improving knowledge levels, and providing critical communication links (Chib, 2010; Kanter, Mechael, Lesh, Dhadialla, & Kramers, 2008; Olla & Tan, 2008). In particular, mobile phones have provided instantaneous voice and information transfer to semi-literate CHW and patients (Grameen Foundation, 2011; Zerroug & Sari, 2009). Further, the vast majority (73%) of the 5.3 billion global mobile phone users are located in developing countries, with penetration increasingly reaching remote rural areas (International Telecommunications Union [ITU], 2010). MP have been used to access accurate medical information in a timely manner (Angelidis, 2008), provide pre-treatment of primary healthcare problems (Bali & Singh, 2007), improve internal communication within the complex healthcare system (Malkary, 2006) and with the external patient community (Harper, 2006), integrate data in the form of electronic medical records for efficient tracking (Anantraman et al., 2002; Chetley, 2006), and improve administrative efficiency of healthcare providers (Baker, 2006).

A review of the mHealth, or mobile phones in healthcare, field in the context of developing countries (Mechael et al., 2010) suggests a growing body of evidence, particularly in peer-reviewed journals, that points to increasing rigor in the field. Yet, much of the literature reviewed focuses on implementations and their evaluations; there is a gap in the communicative practices surrounding mHealth technologies. To fill this, we examine the potential of developing a mHealth system for deployment with rural CHW in a remote mountainous region of Nepal.

Theoretical approach

Ling and Campbell (2009) extend the spatio-temporal arguments of Castells (1989, 2007), focusing on mobile communication practices, covering issues of coordination, mobility, and co-presence, across a variety of situations. Most relevant here is the contribution of Steenson and Donner (2009), which highlights device-sharing aspects of MP by multiple individuals in developing countries, driven by economic constraints and the presence of community networks.

Such mobile phone sharing practices are relevant to rural mHealth projects in developing countries. Various stakeholders within the healthcare infrastructure are scattered across multiple locations, with little resources devoted to village-based CHW working at the margins of the system. The use of mobile communication technologies allows these diffused networks to derive benefits from micro-coordination, to conduct business in patients' homes, in mobile clinics, and hospitals, and to negotiate multiple relationships (Baker, 2006; Chib, 2010; Harper, 2006; Malkary, 2006).

Nevertheless, current theorizing about the space-and-time shifting characteristics of mobiles is limited to mobile practices post-adoption, viz., actual usage. This study aims to further the application of the spatio-temporal perspective of mobile communication by applying it to a context in which mobile phone usage is still a rarity. The mHealth context examined here takes the form of designing a mobile platform for hitherto non-users of mobile phones. The study focuses on the community practices that exhibit the richest and most relevant spatio-temporal characteristics, as this offers both an opportunity for extension, applied to a health context, and a point of departure, suggesting that non-users may exhibit certain practices that would be useful to designers of mobile phone projects.

Given this context, the study is situated within the Technology-Community-Management Vulnerabilities (TCMV) framework (Chib & Ale, 2009). The model proposes that sustainable information and communication technology (ICT) implementations hinge upon three key intersections of technology, community, and management, while being subject to a range of vulnerabilities.

The TCMV model proposes that technological design is a combination of software and hardware components, while project management requires financial expertise, collaborative partnerships, and a supportive regulatory environment. Essential to success is relevance

to community needs, community involvement via ownership and access, and participation in training programs. The four dimensions of vulnerabilities identified include physiological/psychological, informational, economic, and socio-cultural vulnerabilities. Finally, financial and social sustainability are dependent on the replicability and scalability of projects.

A review of the use of technology in the healthcare literature suggests that the TCMV model can be applied in general to eHealth, and specifically to the mHealth context. First, technological advancements in the medical field have been discussed in studies focusing on tele-medicine (Geissbuhler, Bagayokoa, & Ly, 2007; Hsieh, Hjelm, Lee, & Aldis, 2001), health information systems (HIS) (Germanakos, Mourlas, & Samaras, 2006; Pagliari, Sloan, & Gregor, 2005), and electronic medical records (EMR) (Dick & Steen, 1991; Grimson, 2001; Zheng, Chib, Gao, & Wang, 2011). However, given the developing country context of this study, rather than debating the merits afforded by various technological options, the article focuses on the context of mHealth because of the potential this technology affords versus others such as the Internet. The vast majority (73%) of the 5.3 billion global mobile users (versus 1.2 billion Internet users) are located in developing countries, with penetration (68% versus 21% online) increasingly reaching remote rural areas (International Telecommunications Union [ITU], 2010).

To understand the impact of rapidly diffusing mobile technology, we concentrate on the factors of relevance to the local community within the TCMV model. This component deals with the involvement and participation of the community, defined here as stakeholders within the healthcare system (Parmar, Keyson, & deBont, 2007; Weigel & Waldburger, 2004). The basic information needs of the community are a vital factor, yet are often ignored at the lower levels of the healthcare hierarchy (Pakenham-Walsh, 2000). Certainly, modes of ownership of, and access to, the technology are critical first steps in technology introduction programs (Byrne & Sahay, 2006). Beyond access, there is a dire need for training in the use and management of the technology (Lee & Chib, 2008).

The vulnerabilities dimensions affect both the adoption of technology and its potential impact on ultimate health indicators. The physiological-psychological dimension is a micro-level vulnerability concerning the mental and physical well-being of individuals and the community. The inadequate living conditions of the rural poor affect their general outlook on life (Roman, 2004) and subsequent adoption of technology. Socio-cultural vulnerabilities suggest a lack of equal opportunities for all members of a community, driven by the social structure and values of society that define the human relationships contained therein. These hierarchies of gender, race, religion, caste, and class affect access to resources and the decision making powers afforded by technology (Mitter, 2005; Whitten, Sypher, & Patterson, 2000).

CHW feel reluctant to accept any technological intervention because of a lack of confidence in their ability to use technology (Christoph, Schoenfeld Jr., & Tansky, 1998; Ramachandran & Canny, 2008; Schaper & Pervan, 2007). Poverty, low income, and lack of livelihood opportunities act as demand constraints, while developing country conditions of inadequate telecommunication and ancillary infrastructure act as supply constraints. Such eco-

conomic vulnerability obstructs the adoption, implementation, and effective utilization of ICT, such as mobile phones (Chib et al., 2008).

Situated within the TCMV model, this study aims to answer the following research question: How does a spatio-temporal perspective shed light on the key community factors to take into consideration when designing mHealth implementations in resource-constrained environments?

Context

Nepal is a nation in need of improved healthcare; it is limited by slow economic growth, an unstable governance structure, and challenging geographical conditions. With average income below USD 0.50 a day, most villagers lack the financial means to access basic health services (Newar, 2007; Watchlist on Children and Armed Conflict, 2005). Consequently, maternal and infant mortality rates remain high in Achham district, the fieldwork site, relative to other regions in Nepal (America Nepal Medical Foundation, 2009; Bhattarai, 2010). Almost as alarming is the district's HIV incidence rate, i.e., Asia's highest (Kong, 2009). Other prevalent health issues are child malnutrition and diarrheal diseases.

To alleviate these health issues, a non-profit organization, Nyaya Health¹, runs a free healthcare centre, the Bayalpata Hospital, and a CHW program. The latter is organized to provide training and monthly compensation to CHW, alongside the nationwide government-run Female Community Health Volunteers program.

Methodology

Fifty-one respondents were selected through snowball sampling from seven village development committees around Bayalpata Hospital, the research base; namely Bhagyaswor, Chandika, Janalikot, Mangalsen, Mastamandu, Ridikot, and Siddhaswor. In December 2009, qualitative interviews and focus-group discussions were conducted with 22 community healthcare workers, 10 professional management representatives (MG), and 19 patients and villagers (VL). All interviews were recorded on video. Comments included in the article are summarized as examples; however, individual names are withheld for reasons of confidentiality.

The interview guides were based on respondents' information and communication needs and current usage (experience, frequency, and modality) of mobile phones, split into categories of business (health) and personal use. Throughout the fieldwork, specific ethical procedures were followed. Informed consent forms were administered, and respondents were compensated with NPR 150 (USD 2).

With the help of a local interpreter, the research team kept detailed field notes of interviewees' responses. Debriefings were held regularly to ensure compliance with the research protocol. Digital recordings of all sessions were transcribed by a local Nepali academic to

ensure accuracy, and transcripts were then translated into English. Thematic coding, involving the interpretation and categorization of information with reference to the themes in the context of the TCMV model's community framework, was used for data analysis.

Findings

While the overall results are described within the three dimensions of the TCMV aspect of community, viz., ownership, training and needs, and vulnerabilities, the findings section is structured around the lens of space and time reconstruction, and emergent communicative practices that may have implications for mHealth implementations.

Perspectives on time

The critical nature of the healthcare profession demands that information be made available immediately, particularly in the case of serious life-threatening situations, as emphasized by CHW17: "A new-born baby was not breathing normally. What was required was to blow in the baby's mouth, but we did not know that at that time." CHW expressed a felt need for an immediate response communication system should they encounter difficult or unfamiliar situations, especially in emergencies. As CHW14 stated, "in case of an emergency, it is not possible to use textbooks, so the best option at that time would be a telephone." However, only a minority of respondents had fixed-line telephones due to economic barriers, the lack of an extensive network, and the stifling bureaucratic procedures required to install one. Even in less critical cases, the resource-constrained supply chain required adherence to the regimen, as pointed out by CHW5: "We also have patients who have run out of medicines... so in those cases we get in touch with them."

Hospital administrators expressed the need to keep in regular contact with CHW to obtain patient information. In contrast, CHW wanted to communicate for administrative purposes. This symbiotic need was strongly expressed to resolve scheduling conflicts and better coordinate schedules within the hospital. Failures in such routine tasks were common, as illustrated by MG6: "one time I had incorrectly scheduled a meeting on a Wednesday when I was leaving on Tuesday, and I wasn't able to pass on the message and so the CHW ended up having to walk and then go back. I felt really guilty."

Of greater priority to CHW was training as a means to upgrading skills, as one CHW suggested: "Training is very important as it is the main source of information... if we do not get the right information people cannot use their full potential, so it will just go to waste." However, due to the pressure to spend time with patients, as well as to travel long distances, the duration of training seminars was often reduced... According to CHW3:

To totally eradicate these problems, we need proper training, and if we had received training every two months on how to take care of a baby, then we could have done a lot better

and been successful... if we do not get any updates and training on this, then it tends to just slip out of our grasp.

In the remote reaches of the Himalayan regions, time is a precious resource for CHW, needing to be prioritized based on regular healthcare duties, emergencies, travel, and administrative duties. MP have the potential to save time by improving efficiency, expanding time by allowing multi-tasking, and by allowing tasks to be re-scheduled.

Perspectives on space

Since the primary responsibility of the CHW is to aid the village community distant from the hospital, the remote and displaced nature of the work environment leads to gaps in information retrieval and delivery of services, as highlighted by CHW5: "At times, the health camp and doctors are situated very far away, so in such cases we want to be able to treat the patients ourselves."

The hospital management devised regular information sharing sessions, by bringing the diffused hospital network together at a single location for monthly gatherings of a "small and tightly knit unit" of CHW. To circumvent the lack of a communication link as an informational barrier between the far-flung levels of the healthcare chain, respondents used individuals to relay information. Patients could take advantage of the regular access to the doctors available to the CHW. As patient (VL1) said: "In cases of emergency, we call the doctor through other people", or use peer-to-peer links between CHW, as described by the same respondent:

There are [other] CHWs nearby, so we discuss with them... She [other CHW] asks her [patient's regular CHW] to come to the post around 10:00am, and we go accordingly. So it means that you go after you have the information regarding their availability.

On a daily basis, the sheer risk involved in negotiating mountainous terrain, such as crossing rivers and walking down steep slopes, acts as a barrier, as CHW17 said: "[F]or an hour I need to walk through the jungle and I need to walk for another hour to get to the village." This situation intensifies when dealing with late night visits for emergency cases. The lengthy distance from an important stakeholder such as the local government hospital impeded the CHW' access to information, both in terms of inconvenience of the time lost, as well as the perceived emotional distance, since strong relationships could not be developed between stakeholders. According to CHW9:

There is no proper facility or infrastructure here for giving us information and updates. When we go for trainings at the district, they train us, but do so half-heartedly. They are not interested in it. If it is three day training, they finish it off in one day.

Achham's CDMA² cellular network was the only viable, ready, and relatively low cost mode of connectivity available. However, in distant villages, CHW1 pointed out, "(we) do not have the network towers in our area so mobiles are quite useless." For those in the management team who had MP, the CDMA network coverage around the hospital facility was erratic. When available, the signal strength was usually weak. Users would have to walk to certain spots or wait and try for a long time to get a proper connection. MG6 recounted her experience at Bayalpata Hospital:

This [CDMA mobile phone] won't work anywhere within the complex, within the whole area, until you walk [to] the public tap, that's on top of that hill, which is slightly more exposed...So for the first month and a half I was here, that's how we ordered medication, standing on that tap.

The vast and inhospitable distances across the mountainous Himalayan region made surmounting the notion of space a major ordeal for CHW. MP have the potential to improve the efficiency of the entire healthcare system by shrinking distances between far-flung locations, allowing information to flow from the central hospital to remote villages, and indeed, shift the boundaries of space by enabling greater emotional bonds amongst people and improving professional relationships located at great physical distances.

Communicative practices

The specific circumstances of tight-knit communities in rural Nepal led to the striking communicative practice of sharing telephonic access, both for fixed and wireless lines. To most respondents, MP seemed to be luxuries and was therefore less prioritized over basic commodities such as food, health, and education. VL2 mentioned the following: "You have to spend 5-6 hundred [NPR; USD 8] a month for it [mobile phone]. Where would we get that money from? This is a huge amount, enough to raise a child." Those who owned mobile phones, did so for business purposes (such as shopkeepers), or had greater economic status due to institutional affiliations.

An interesting communicative practice was the communal use of CDMA fixed wireless phones as an alternative to fixed-line and mobile phones. These hybrid phones look like normal fixed-line phones, but connect to CDMA networks via a Re-Useable Identification Module (R-UIM) card. Small business owners simply topped up the prepaid card credits, and charged callers for individual units, with CHW1 reporting: "[I use it] from the market while at times I use my friend's cell phone." We should note that access to CDMA fixed wireless telephones was limited to villages with a certain minimum population level; isolated communities in hamlets would still need to walk considerable distances for access. In such cases, and in general, it was common for people to use their neighbour's telephone or relative's MP, as evidenced by CHW3: "If I get a cellular phone I will borrow it from the people in the community and my friends." Thus, people who did not have specific communication

devices would seek those who did, to use MP, while the people who possessed them were accustomed to sharing them with the other people in the community.

A second communicative practice of interest was the preference for peer-sharing of medical information within healthcare worker networks. Health personnel higher up in the hierarchy, such as government health workers and doctors, preferred reading books or medical publications, but CHW did not, possibly a consequence of having had only minimal formal higher education. Thus, lower education levels acted as a psychological barrier to obtaining critical medical information. Instead, CHW preferred training seminars utilizing discussion formats, with video and practical demonstrations, as they found it easier to absorb the information via peer-sharing. This was echoed by MG4 in his statement:

We have meetings where we teach them about what we have learnt and have been trained on. We share that with the female health workers and then they go and share it with the others.

Discussion

Overall, the research indicates that the spatio-temporal perspective can potentially reveal technological design solutions for mHealth implementation. Information in a rural healthcare situation tends to be quite time-sensitive, with both immediacy benefits and long-term impact. Medical knowledge delivered via MP as a form of training could expand the time available to devote to medically-oriented tasks instead of wasting time travelling to centralized locations. However, critical information required during emergencies is currently unavailable, and would be a major benefit of a mHealth program.

Further, administrative efficiencies can be extracted from making location less of a hurdle for the day-to-day functioning of community healthcare workers. Scheduling meetings, managing patient queues and prescriptions, and eliminating distance, weather and terrain as obstacles to communication are obvious spatio-temporal (Ling & Campbell, 2009) benefits of introducing mobile solutions in rural healthcare. With mobile phones, CHW can micro-coordinate (Ling & Haddon, 2001), planning their patient and hospital visits better, transferring information across various diffused levels. Thus CHW can harness their relationships with peers such as other CHW, and develop new relationships between levels, such as with patients residing in villages and with doctors based in hospitals.

We find evidence of communicative sharing practices, described by Steenson and Donner (2009), in rural Nepal, as MP and CDMA fixed-wireless phones, informally and formally, are shared within the community. Shopkeepers and mobile-phone owners play the role of “hub individuals” and “sharing partners” (Ling & Campbell, 2009, pp. 9-10).

The community sharing aspect has important implications for mHealth project implementations. First, it may be argued that providing mobile phones to CHW would still neglect the most critical level of stakeholder in the rural health service delivery system,

viz., the village-based patient. The communicative sharing practices in existence suggest that this situation would be resolved by a negotiation process, whereby the CHW would become the proxy hub for the villages within her jurisdiction. Secondly, the high growth rates of mobile penetration in Asia, coupled with falling prices of handsets and airtime, suggest that it will not be long before most bottom-of-the-pyramid individuals can acquire handsets and pay for access.

We note, however, that the various vulnerabilities brought about by economic, physical/psychological, informational, and socio-cultural issues, identified within the TCMV model, continued to act as structural issues, and would require a concerted management effort from various stakeholders to resolve. It is important to anticipate the fissures that mobile phone implementation for CHW would introduce into the existing social hierarchy. The material features (Ling & Campbell, 2009) of the current hubs, namely the hospitals, imbue these locations and their management with a command-and-control sense of power. The dissolution of this centralized power via mobile phones to the far-flung posts of the CHW will bring with it a transformation of the hierarchical relationships from the hub to the edges of the spokes. CHW will be able to access information from the centre or from peers, to obtain training, and to micro-coordinate with patients and doctors – all without the necessity of administrative management. This would suggest that power embedded within relationships is an added dimension to space-and-time perspectives on MP usage; existing social hierarchies will come under pressure in unique ways with their introduction. Whether such social transformation would occur naturally or whether it would require negotiation to ease frictions, and how the transformation would occur, are questions that require further investigation.

From a theoretical perspective, further investigation is required into understanding the shifting definitions of mobility and the relation to space when confronted with particular communicative practices of developing countries. The CDMA fixed-wireless phone offers a hybridity that challenges much of the assumptions and theorizing concerning the mobile phone. Here is a fixed device that can be used while walking away from a location, thus allowing the type of “cocooning” described by Ito, Okabe, and Anderson (2009).

Simultaneously, the fixed-line physical nature of the machine allows both for conferring social status on the owner (obtaining a fixed-line telephone is a formidable task within the bureaucratic system), and acts as a deterrent to individual claims of ownership. Upon reflection, the technology may have arisen as a consequence of infrastructural issues, such as the prohibitive costs of installing fixed-line networks in remote mountainous regions, requiring a large antenna to catch the weak cellular signal, and electricity to power the hardware. Conversely, mobile phones that require a particular physical space, such as the water-tap on the hill, confer a location-specific rigidity and a public notion of what has been theorized as a mobile and private medium.

With mHealth attracting a greater number of adherents, investments in mobile technologies for rural health are likely to increase. Nonetheless, projects aiming at the introduc-

tion of MP should investigate the social environments as well as the health infrastructures involved. The implications for the physical well-being of marginalized communities may very well be immense, but these opportunities need to be tempered with an understanding of the sociological impact that would need to be managed, aided by the latest developments in spatio-temporal theorizing regarding mobile phones.

Notes

1. The authors are grateful to Nyaya Health for providing access to their hospital and CHW program, as well as acting as a research partner.
2. Code Division Multiple Access refers to protocols used in 2G and 3G wireless communication networks, and is a competing standard to GSM, which is more ubiquitous globally.

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