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Can mobile phones help control neglected tropical diseases? Experiences from Tanzania

Shirin Madon [a,b,*], Jackline Olanya Amaguru [c,d], Mwele Ntuli Malecela [e], Edwin Michael [f]

[a] Dept. of Intl. Development, London School of Economics & Political Science, Houghton Street, London WC2A 2AE, UK
[b] Dept. of Management, London School of Economics & Political Science, Houghton Street, London WC2A 2AE, UK
[c] Department of Social Policy, London School of Economics & Political Science, Houghton Street, London WC2A 2AE, UK
[d] CBM – Haiti, 10 Rue Latortue, Delmas, 48, Port au Prince, Haiti
[e] National Institute for Medical Research, 2448, Ocean Road, P.O. Box 9653, Dar es Salaam, Tanzania
[f] Dept. of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556-0369, USA

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ABSTRACT

The increasing proliferation of mobiles offers possibilities for improving health systems in developing countries. A case in point is Tanzania which has piloted a mobile phone-based Management Information System (MIS) for the control of neglected tropical diseases (NTDs) where village health workers (VHWs) were given mobile phones with web-based software to test the feasibility of using frontline health workers to capture data at point of source. Based on qualitative case study research carried out in 2011, we found that providing mobile phones to VHWs has helped to increase the efficiency of routine work boosting the motivation and self-esteem of VHWs. However, despite these advantages, the information generated from the mobile phone-based NTD MIS has yet to be used to support decentralised decision-making. Even with improved technology and political will, the biggest hindrance to local usage of information for health planning is the lack of synthesised and analysed health information from the district and national levels to the villages. Without inculcating a culture of providing health information feedback to frontline workers and community organisations, the benefits of the intervention will be limited. If not addressed, this will mean that mobiles have maintained the one-way upward flow of information for NTD control and simply made reporting more hi-tech.

Introduction

Neglected tropical diseases (NTDs) are a devastating burden for the people of Tanzania and are prevalent throughout the country hampering quality of life for people and constraining the long-term progress of the country. Campaigners have argued that control of the NTDs, largely through Mass Drug Administration (MDA), is relatively cheap and very important to achieving MDG-6 (Hotez, Raff, Fenwick, Richards, & Molyneux, 2007). In Tanzania, the number of people at risk of infection from NTDs ranges from 1.9 m for onchocerciasis to 34.5 m for lymphatic filariasis (NIMR, 2007) and in 2005 the government introduced an integrated NTD control programme which earlier was comprised of vertical interventions on a disease-by-disease basis (Malecela et al., 2009). Integration was anticipated to increase the profile of the NTDs as a major health issue at all levels in the country so as to ultimately control or eliminate them, as well as to maximise the capacity of the health system to tackle these diseases. Integration was also envisaged as a means of maximising efficiency using the same distribution system to address five of the NTDs targeted for preventive chemotherapy (PCT) using the MDA approach. By 2011, there were functioning NTD coordination units established at national, regional and district levels providing a 53% geographical coverage throughout the country.

Early efforts by donor agencies to support overall efficient and effective data collection effort resulted in the development of a Health Management Information System (HMIS) which was rolled out by the Government of Tanzania at district level throughout the country in the mid-1990s after a successful pilot in Mbeya. The system was designed and developed by a team comprising of representatives from the Tanzanian Ministry of Health (MoH), a major Danish donor agency and the numerous vertical health programme stakeholders. While it remained the 'de facto' system of accountability for primary healthcare in Tanzania for over a decade, there was little effort undertaken to critically evaluate its effectiveness in terms of supporting decentralised decision-making (HERA, 2000). Discussions held with MoH officials by three of the authors in 2007

* Corresponding author. Department of International Development, London School of Economics & Political Science, Houghton Street, London WC2A 2AE, UK.
E-mail address: s.madon@lse.ac.uk (S. Madon).

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identified several factors that prevented the HMIS from improving effectiveness of healthcare delivery including the lack of an adequate incentive mechanism for health personnel and corrupt practices (Smith, Madon, Anifalaje, Lazarro-Malecela, & Michael, 2008). An endemic lack of motivation amongst health workers for collecting quality data was also identified as a major reason. Senior officials complained that village registers were frequently not updated at facility level and that little importance was attached to HMIS reporting formats by doctors and nurses during their rounds. They believed that at the end of the month, health workers would hazard a guess in order to complete the reports – a state of affairs that prevailed largely throughout the country.

In Tanzania, as in many parts of the developing world, recent efforts have been directed at replacing traditional manual field data collection systems with mobile phone and web-based platforms. An alliance of national and international partners led by the National Institute of Medical Research (NIMR), an agency of the Tanzanian Ministry of Health, has developed a unique, highly flexible and scalable mobile phone-based NTD MIS using smart phones with internet. The primary objective of the system is to improve data quality and programme delivery of the integrated NTD programme with a secondary objective of eliciting greater empowerment of health workers (and ultimately of the treatment communities) to engage in primary healthcare decisions. The mobile phone-based NTD MIS was introduced as a pilot project for use by community-based VHWs in four villages in Mkuranga district. Each VHW was given a phone to facilitate direct entry of data collected at village household level for the 2011 annual MDA programme.

Our objective in this paper is to study the extent to which mobile phones can help control NTDs in the context of Tanzania. Based on the case of the mobile phone-based NTD MIS, our focus is on gaining conceptual clarity on the social processes associated with the deployment of the technology. In the next section, we review the increasing amount of academic literature on mobile telephony[1] in developing countries focussing on the health sector. While noting the contributions that appear in medical journals, we draw on literature that takes a social science perspective on health communication and develop a conceptual framework linking greater interconnectedness brought about through mobile telephony with improved communication and empowerment. Then, following a description of our methodological approach, we present the results of our study. The data used in this paper are in-depth interviews and focus group discussions which were held with health workers and other officials. Finally, we draw on our findings to discuss theoretical and policy implications associated with mobile phone deployment for supporting NTD control.

Mobiles & health: understanding the value of communication

In recent years, a significant amount of research has been devoted to studying the impact of mobile telephony on development (Donner, 2008). The majority of this literature has focused on illustrating the economic and social benefits of mobiles, for example in terms of expanding market opportunities for small entrepreneurs, or strengthening social networks to support vulnerable groups (Acker & Mbiti, 2010). In terms of governance applications, despite the fact that mobiles are increasingly beginning to expand as an alternative service delivery channel (sometimes called m-government), it is only recently that literature is beginning to emerge (Smith, Spence, & Rashid, 2011).

For the most part, research on mobile phone usage for health governance has appeared in medical journals. In particular, studies have focused on assessing the extent to which mobiles have been used to improve communication between healthcare workers and patients thereby improving clinical outcomes. The majority of research on such experiments uses randomised control trials to study the impact of mobiles on health outcome (Shet & de Costa, 2011). In Kenya, for example, a simple low-cost mobile phone-based system has evolved that includes nurses sending weekly short message service (SMS) texts to clients receiving antiretroviral therapy to inquire how they are doing and then triaging their responses according to patient needs. In general, evidence shows that receiving text messages via mobile phones improves patients' adherence to antiretroviral therapy and other clinical outcomes (Lester et al., 2011).

A second focus of studies, which links to the theme of this paper, has been on the possibilities of mobile phones enabling more long-term systemic changes in accountability structures for primary healthcare delivery in developing countries. Beyond tracking human rights abuses and monitoring elections, crowdsourcing[2] applications have emerged to provide a complimentary monitoring and evaluation tool for development and humanitarian programmes (Bott & Young, 2012). In the context of healthcare, a form of 'bounded crowdsourcing' refers to local sources such as volunteers or paid staff members capturing information on their cell phones and sending it back to a central location improving data quality and promoting the cause of decentralisation in primary healthcare. These local sources are trained in identifying relevant and reliable data which they send via mobile phone for access by health professionals using a web-based platform thereby replacing traditional manual field data collection systems. This policy drive has resulted in many experiments in recent years in which mobiles have been provided to local health workers with the intention of obtaining more reliable field-level data, as well as providing front-level health workers with a greater sense of motivation and empowerment in their interactions with the health administration and the community. Despite the growing number of m-government experiments of this type, however, there has been little exploration of the pathways between greater connectedness through mobile phone penetration, improved communication within the health system and greater empowerment of health workers.

Connectedness, communication & empowerment

The ability of countries and regions to connect to digital media is increasingly assumed to be a proxy for economic development. Aside from its transmission value, communication is understood to play a key role in developmental processes in terms of enabling context-specific information exchange through low-cost mobile phone data collection and reporting solutions (Medhi et al., 2012). For example, in Uganda, health workers are using mobiles to make 24% savings in spending over the traditional manual data collection and transmission procedures (Rashid & Elder, 2009). Beyond efficiency gains, communication is also recognised as a key social process with organisational value in terms of catalysing processes of debate, deliberation and eventual empowerment amongst communities (Manyozo, 2013; Sen, 1999). Indeed, in Sen's theorisation of the famines in Asia, the press had a major role in carrying information and messages, in value formation through public discourse, and in allowing for critical scrutiny by citizens. For

[1] Mobile telephony refers to the provision of telephone services to phones which may move around freely rather than stay fixed in one place.

[2] Crowdsourcing is defined as the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally larger group of people in the form of an open call (Howe, 2008).

example, in a study undertaken to report on health worker perceptions of using mobile phone text-messaging to improve malaria case management in Kenya, Jones et al. (2012) found that workers gained new capabilities as well as reinforced the knowledge and skills they had previously acquired.

Much existing work in health communication focuses on the extent to which increased information flows amongst health workers and users result in improved feedback on service delivery, new forms of organising amongst health workers and greater empowerment (Jones, Abeku, Rapuoda, Okia, & Cox, 2008; Zoller, 2005). A process of gaining control, referred to as 'conscientization' by Paolo Freire (1970), is assumed to occur as people develop new knowledge of their existential situation and come up with action plans to liberate themselves from their dependent and exploited situation. In an experiment that deployed mobile phones to rural health assistants in India, the video recording feature of the phones served to both persuade village women to adopt new health practices and services offered by government and to motivate the health assistants to bring about change (Ramachandran, Das, Canny, & Cutrell, 2010). Greater connectivity between health workers and beneficiaries has also been shown to enhance the self-esteem and confidence of health workers who use the mobile phones to record the care they give to patients and to receive alerts to follow up on patients who become overdue for care (Grameen Foundation, 2012).

In this section, we have reviewed some of the main arguments from the literature regarding mobile usage for improving health service delivery in the context of developing countries. Beyond connectivity, the literature has identified the organisational value of communication through mobiles in terms of efficiency gains, improved capacity for local organisation and empowerment of health workers. In the rest of the paper, we relate this conceptualisation of mobile telephony in the health sector to the NTD control programme in Tanzania.

Methods

We adopted a qualitative case study design acknowledged as being an appropriate strategy for developing conceptual clarity in the early stages of research on a topic (Eisenhardt, 1989). The present inquiry falls into this category as at the time of the research, piloting of the new NTD MIS was still in its early stages with less than six months of implementation and lack of conceptual clarity as to the social processes through which the deployment of mobile phones to rural health workers could improve service delivery. The key objective of the Tanzanian government, both for the earlier web-based system and for the mobile phone-based NTD MIS, was to improve data quality for health planning, with a secondary objective of motivating and empowering health workers (NIMR, 2007). This study represents the first evaluation of the programme for which empirical work was conducted in the Pwani Region of Tanzania in four villages of Mkuranga district as this was the pilot district for the mobile phone-based NTD MIS. The four villages – Tengelea, Mwanambaya, Sangalani and Kitonga – were selected as they represented high and low endemic locations in terms of the spread of NTDs within the district. While in Tengelea all the VHWs had mobile phones even before the project commenced, this was not the case in the other three study villages.

Fieldwork was conducted from 28 June to 13 July 2011. Our study methodology included both primary and secondary data. Secondary data sources included academic literature, an earlier evaluation report of the health management information system (HERA, 2000) and the monitoring and evaluation plan for the integrated NTD programme in Tanzania (NIMR, 2007) all of which served as useful background contextual material for our study and have not been reported in the findings. The method of inquiry for primary data collection included observation, key informant interviews and focus group discussions to capture the perspectives of health officials, VHWs and community members. Targeted respondents were Tanzania's NIMR officials in Dar-es-Salaam, the District Medical Officer (DMO) and the NTD Coordinator of Mkuranga district. There were 10 VHWs per village and all were invited for the focus groups discussions. Two or three VHWs per village were also requested for key informant interviews. 15 key informants interviews were held with a combination of VHWs, village leaders and three health officials. At the community level, four focus group discussions (one per village) were held with three to four persons who were available from each Village Health Committee. Four focus groups were also held with the 10 VHWs from each village. On average, focus group discussions lasted 1 h. In total, fifty-five respondents were interviewed – 17 female, 38 male by one of the authors. As the interviews were not tape recorded, notes were taken which were then transcribed. The gender bias reflected the fact that VHWs and village leaders were predominantly male. The adoption of multiple approaches to primary data collection provided an opportunity for triangulating the responses of different informants in order to strengthen the validity of our findings. Another source of primary data collection was a workshop held in Arusha, Tanzania in April 2012 convened by three of the authors who were involved in a British Council DelPHE academic exchange project. The workshop entitled 'Neglected Tropical Disease Control: Policy Challenges and Opportunities' involved participants from a wide cross-section including health policy makers and personnel from different tiers of government in Tanzania, donor agencies, disease programme managers, academics, local politicians, NGOs, the private sector, media and civil society representatives.

Our interviews and focus group discussions provided narratives which we used to analyse different aspects of NTD control according to a thematic coding scheme derived from our conceptualisation of mobile phones, communication and health. The coding of data which was carried out by one of the authors involved three steps. First, formulating initial codes from the transcripts as closely as possible to the sub-themes identified in the conceptual framework. Second, identifying emergent codes from the data different from the preset codes to identify interesting stories. Third, looking for patterns in the data resulting in the clustering of codes or in the breaking down of initial codes into sub-codes.

In order to undertake the study, ethical clearance was sought and permission obtained verbally from NIMR and from the Commission for Science and Technology in Tanzania. This was facilitated by one of the authors who holds a senior position within the Health Ministry. During the field data collection, the scope of the study was explained to respondents in local language. Every effort was taken to respect the customs and culture of the people of Mkuranga.

Results

In this section, we report on findings from four villages in Mkuranga district of Tanzania, namely Tengelea, Mwanambaya, Sangalani and Kitonga, in order to meet our main research objective of studying the extent to which mobile phones can help control NTDs. Mkuranga is one of six districts in the Pwani region of Tanzania and is located 53 km away from Dar-es-Salaam city centre. Mkuranga has a population of 200,000 people and the district is bordered by Dar-es-Salaam to the North, Rufiji to the South, the Indian Ocean to the East and Kisarawe to the west. The district which spans 2.434 km^2 is administratively divided into 15 wards. The majority of the inhabitants of the district are

subsistence farmers involved in maize and cassava cultivation (Mubyazi et al., 2007). In terms of access to healthcare there are over 40 health facilities (including dispensaries, health facilities and hospitals, both public and private) and it is estimated that one facility serves 6100 people (Kema, Komwihangiro, & Kimaro, 2012). In terms of utilisation rates, approximately 40% of the population access conventional health facilities. The literacy rate (% completing primary education) in Pwani region where Mkuranga is located is 28.4% for men and 26% for women (TDHS, 2011).

In each of the villages under study during the pilot phase, mobile phones were given to all the VHWs which they were allowed to use for private purposes as well as for communicating with other health workers and with district officials about NTD cases. These health workers were responsible for arranging their own phone credit and for paying the costs of private calls which were not related to the MDA exercise or any other specific project-related exercise. It is worth noting that in Tanzania there are two village leaders – one that is formally employed by the government (Village Chairman) and has an office in the village, the other who is elected at village level. This elected representative who exerts considerable influence at village level leads a village council of volunteers. Both types of village leaders were interviewed in our study. We present below our findings categorised into five main themes drawing on quotations from our field notes to highlight perceptions of specific aspects of the pilot project.

Community perceptions of the NTD programme

According to the majority of VHWs, many community members questioned the motive behind the Tanzanian government's free NTD MDA policy as reflected by this quote from a VHW who said:

> 'in hospitals, people are asked to buy drugs but since these are distributed free, some people refuse them thinking they are expired, or make you impotent'.

All our VHW respondents perceived that the NTD programme was difficult to implement due to the physical difficulty of visiting households, many of which are far from each other and from the district headquarters and hospital. On average, they estimated that households were a 1.5 h drive away causing transport problems for these workers, particularly during rains.

Perspectives on the utility of mobile phones for the NTD programme

Network problems interfered with mobile usage as three of the four villages are very remote and far from the main road and Mkuranga district town centre. In cases where the network did exist, the majority of VHWs reported that sometimes it took over 30 min to load or search for information via the phone. In terms of the technology, at the time of our data collection, two of the phones had already been withdrawn for repair. However, overall, there was a positive attitude at the village level amongst our respondents with regards to the mobile phone. For example, one village leader in Kitonga said that the VHW's mobile phone 'has brought light' to the village.

a) Perceptions of data handling

The majority of VHWs interviewed appreciated the fact that unlike the paper registers, the mobile technology offered the option of correcting errors or adjusting the number of members in a household. The mobiles also appear to have greatly reduced the cumbersome load of registers the VHWs used to carry in the villages during the MDA exercises. For example, one VHW in Tengelea said,

> 'It has reduced the work of carrying documents. We don't need any more papers'.

Another said,

> 'You can just send the information on the phone rather than carrying luggage'.

b) Feelings of empowerment amongst VHWs

Most of the VHWs interviewed felt that the mobile phones, which are expensive and high-tech, have boosted their credibility and legitimacy amongst villagers even in the study village with a high earlier coverage of mobile phones. As expressed by one of the VHWs,

> 'We have been recognized and accepted by the community'.

Another VHW from Tengelea tried to provide an explanation for why their reputation and standing has improved within the community,

> 'It has helped me because when I go with a mobile phone, they trust me that the information I give or take is true because the one who gave me the phone had trust in me so I give true information. They know it is true and not a joke'.

The majority of VHWs in all four study villages reported that their social status had been boosted because of the expensive mobile technology they were entrusted with. As one VHW said,

> 'People thought that we are low class people and that we cannot be provided with such phones, but we are using them'.

Some VHWs also reported that in their view, the drug take-up of the households they are responsible for has increased because of the application of mobiles in their work.

c) Improved communications between the VHWs and district

According to most of the VHWs interviewed from all four study villages, when there are no network problems, the NTD mobile phones have increased the speed of getting tasks completed and information transmitted making work much easier. These respondents also acknowledged that the NTD mobile phones have increased the flow of communication with district-level health officials. For example, one VHW reported:

> 'I can communicate with leaders at district and national level anytime'.

Another VHW from Sangalani, a village that is approximately a 4-h bicycle ride from Mkuranga District Hospital said,

> 'Before, if we had a problem, we had to write a letter and send somebody to deliver it. If it is urgent, they may get it late. Now, any message is received right on time. For example, if we have messages about drug stock-out, we call the District NTD Coordinator and she tells us when they can send more drugs so we know immediately if they shall bring it then or the next day'.

Another VHW told us that with the former HMIS, they had to take reports physically to the health centre and in case the doctor was not there, it was a problem but now,

> 'Information goes direct to the office whether the person is in the office or not. Something that could take us two days now takes two minutes'.

The majority of VHWs also reported that their phones have increased access to doctors at the district level since they can now be easily located on phone in case of need.

d) Communication between VHWs and with other local social networks

In all four villages, most VHWs reported that the NTD mobile has increased communication and support among their co-workers even in the study villages where mobiles were already in regular use. In the words of one VHW,

> 'If you have a problem with operating the phone, you can call your colleague to help you out'.

Another commented, 'It has increased the closeness among us'.

For example, because of lack of electricity in the villages, the mobile phones have to be charged in a nearby town. To save on costly bus fares and time, all VHWs we interacted with told us that they would contribute funds to pay for bus fares for one VHW to whom they would all give their phones and the fee for charging.

On a personal level, a widely held perception amongst VHWs was that the mobile phones have helped them to communicate with friends and relatives. One VHW even reported that the mobile phone helped him to get a wife. Furthermore, with the mobile phones, especially for the majority of VHWs we interviewed who did not have mobile phones before, many now have access to mobile banking services.

Building capacity amongst VHWs

Even in the village where all VHWs had already been using mobile phones prior to the launching of the pilot project, the majority of VHWs agreed that the introduction of the high-tech NTD mobile phone presented a steep learning curve for them and some requested more training. As one VHW said,

> 'In the beginning, it was difficult'

Another commented,

> 'We have learnt so much … and we have seen so much'.

At the same time, some VHWs were discriminated against for being unable to adapt to new ways of working as a result of the technology. For example, in one of the villages with low prior phone possession, some VHWs with visual impairments who had become used to entering health information onto paper registers were declared as being unfit to work because they could not easily operate the mobiles.

Information management, sharing and use

a) Planning and decision-making

Several senior representatives of the Ministry of Health commented that the mobile phone-based NTD MIS had helped them to know the quantity of drugs that were needed for each village MDA. For example, in the words of one official,

> 'Before this, we used to know such information after, but now we can know before and plan'.

Several senior health officers at state level whom we interviewed commented that the NTD MIS has given them the opportunity to influence decisions in the District Health Plan. At the district level, the majority of officers we interviewed were also pleased with the NTD MIS as reflected in the following comment made by one officer,

> 'I can sit in my office and make a decision based on what is in the database'.

At the local level, the majority of interviewed village leaders appeared to appreciate the value of data for decision-making. For example, we found that generally most of the village leaders understood what the information was used for at higher levels of the administration. Most of them had the same response as exemplified by the following quotes from village leaders,

> 'They want to analyse to see whether there are challenges and illnesses and if so, what the extent is and what to do about it'.

> 'Any agency can know about the village and use that information to design development programs'.

> 'It will help us know who has taken the drugs and how the community has been mobilized to take the drugs'.

> 'Data is collected and sent so that they can keep records at national level'.

Many village leaders commented that they found the census information useful for their own reference and to inform aid distribution. For example, one village leader commented that he used the village census information to identify the number of vulnerable beneficiaries for an NGO's bed net distribution.

However, in terms of higher-level decision-making, several senior health officers indicated to us that village level health actors have very little actual influence on policy decisions because most of it is decided at the WHO with the Government of Tanzania as a signatory. For example, one health officer at the central government commented,

> 'They decide what diseases are prioritised and what the minimum percentage drug uptake countrywide should be. There is no room for debate or for villagers to say they do not want the drugs because it has already been decided'.

b) Supervision of VHWs by senior health personnel

Since the system is able to show the specific information entered by any particular VHW, the majority of senior health personnel we interviewed acknowledged the ease with which they could identify which VHWs were working well and who may be facing some challenges. For example, in the words of one senior district representative of the Ministry of Health,

> 'Thanks to the NTD database information, we can now give supportive supervision'.

c) Local ownership of information

Although in theory the NTD MIS information could be used as a catalyst for debate and discussion at sub-district level, most senior health officials interviewed commented that in practice only decisions on operational issues, for example, who will be the VHWs to distribute drugs can be made by the local health administration. As reported by previous researchers, the NTD MDA targeted drug intake for Tanzania has been set at 80% (Simonsen et al., 2010). Nonetheless, VHWs reported that they felt a sense of worth and appreciation within the health system because the information they send goes directly to the district and national level without intermediaries. For example, as one village leader said,

> 'We do something important'.

But when asked what happens to the information they collect and transmit via the mobile phones, most VHWs interviewed said they did not know. For example, we were told,

'When you have given it [the data], that is it. That is why we don't know. We don't know what the information is used for'.

Respondents at village level did not have access to the analysed reports of village NTD drug uptake. When questioned about this, a senior district health official said that under the pilot project, the only time she shares information from the NTD MIS with VHWs is when she uses it for supervision support, to question their performance. For example, if they are not reaching the required household numbers in a given period. On the other hand, all of the respondents at village level felt that access to reports would help them understand how the community has accepted the MDA. One VHW commented,

'We feel like students who sat an exam and never got our results'.

When asked what they would do with analysed NTD village level information if they had access to it, most Village Health Committee representatives we interviewed said that they had the potential to do a lot with it because they had already engaged in positive initiatives like clearing the water source to solve the problem of dirty drinking water. In particular, most village leaders seemed highly interested in having access to village level information and using it to inform their decisions as corroborated by these two quotes from village leaders,

'If we have the information, that will be good because we shall be able to understand what was done and if it was done well. It will help us know how many people are ill, from what diseases and who has taken or not taken the drugs. We can then decide what we can do about it'.

'If I had a report with the village health information, I would call the Village Council, the Health Committee and VHWs to discuss it. If the report does not show good outcomes, I would meet with the whole village to try to find the solution to reduce the disease burden if it is high. However, if it is low, then the report remains simply information'.

Digital divide at local level

Mobile phone possession among the VHWs before the project in the four study villages was 10/10, 2/10, 6/10 and 8/10 respectively. By providing a mobile phone to every VHW in the pilot project, the earlier digital divide has been bridged. Indeed, even in Tengelea where all the VHWs already had mobile phones, none were quite as sophisticated as the ones given to them under this pilot project. However, while bridging the digital divide amongst VHWs, other divides have emerged between stakeholders at the local level, for example between the VHWs and village leaders. According to the set-up of the pilot project, the mobile phones belong to the VHWs while the majority of village leaders do not have access to the technology, have received no training on its usage and consequently do not understand how the high-tech mobiles work. The words of one village leader reflected the fact that he did not know how to operate the phone,

'Truthfully, if I were given the phone, I would not know where to start'.

Another said,

'We cannot know how to see reports on the phone'.

Yet another said that he needed to be trained on how to use the phone because,

'I cannot understand information in there'.

Another leader asked,

'How can I supervise something that I do not understand?'

He added that because he does not understand what is in the phone, it is hard for him to know if the VHWs are doing their work and whether the disease burden is going down.

Discussion and conclusions

The objective of this paper has been to investigate the extent to which mobile phones can help control NTDs. Our results provide us with greater conceptual clarity on the social processes associated with the deployment of mobile phones for improving NTD control which were categorised into five main themes. In this section, we relate our results to the core objectives of the mobile phone-based NTD MIS.

With regards to the data capture objective of the mobile phone-based NTD MIS, aside from eliminating the need for them to carry manual registers during field trips, VHWs perceived a greater level of efficiency in routine reporting and record keeping. Using the mobile phones to enter household data at source has encouraged VHWs to instantly correct for any inconsistencies, for example, in the number of members in a household.

A dominant perception amongst VHWs is that the mobile phone-based NTD MIS has enabled a more direct channel of communication with senior health staff concerning various aspects of healthcare delivery. For example, doctors were found to be more easily located by mobile phone in case of need and mobiles have been used to send alerts to higher levels of administration when drug stocks are low and to enable information to be passed back to VHWs about when new supplies would be sent. For senior health officers, improved communication has enabled greater scope for performance monitoring and supervision of VHWs as the system makes it possible to identify the data entered by a specific VHW and offer ongoing support for programme implementation. From the standpoint of senior health officers, the availability of good quality and timely data from the mobile phone-based NTD MIS has helped to improve their planning and decision-making capacity, for example to identify the quantity of drugs needed for each village for the MDA programme.

From the perspective of VHWs, the new system has strengthened communications and ties with each other. In all four villages, VHWs felt that they could communicate easily with each other encouraging team spirit amongst health workers to exchange information and work together to address healthcare issues. In some cases, communication was found to extend beyond work networks to include other social ties and linkages such as providing a mechanism to utilise mobile banking. Since the introduction of the mobile phone-based NTD MIS, a dominant perception held by VHWs is that their credibility and legitimacy in the community has increased from being seen as low-level village workers to being entrusted with high-tech mobile devices by the government. The greater sense of empowerment experienced by VHWs within the community has led to changes in the way VHWs are able to develop new knowledge of health issues in their community. A viewpoint expressed by VHWs was that the system has enabled them to increase their knowledge about health-seeking behaviour amongst the community – for example, in terms of understanding whether there is momentum towards increased drug take-up.

An early concern from the pilot study is the perception held by senior health staff as well as VHWs and village leaders that the deployment of mobile phones has not resulted in an increase in local voice and participation in health planning and decision-making. VHWs continue to have little influence on decisions related to which diseases are prioritised at the local level and what

should be the minimum drug uptake in villages with only minimal jurisdiction granted for operational aspects of healthcare provision. As with the earlier HMIS, VHWs lack a sense of ownership and knowledge about what happens to the data they collect and transmit electronically to higher echelons of the health administration. Our findings suggest that there is a genuine desire amongst village leaders and Village Health Committee representatives to access local information for addressing community development priorities such as providing safe drinking water. While the mobile phone-based NTD MIS has bridged the digital divide between VHWs in the four study villages as they now all have a mobile phone, an unanticipated consequence of the mobile phone-based NTD MIS has been the emergence of other local divides within the community. For example, a technical divide has emerged between those VHWs who have been able to quickly assimilate the mobile phones into their work routines and those who have not been able to do so and have thus been declared unfit to work despite having earned a good record as a health worker. Another emergent digital divide is that between the VHWs and other community members, particularly the village leader who historically has held a key status in the village but now finds himself unable to monitor village health as closely as before due to lack of knowledge about the mobile phone.

In terms of theoretical implications, our findings contribute to the existing literature on health governance in developing countries by identifying how greater connectedness through mobile phone usage has influenced data flows within the health system and has provided scope for improved communication and empowerment of local health workers. We studied the social processes that underlie the deployment of the mobile phone-based NTD MIS as narrated through the perspectives of VHWs, village leaders and senior health officers.

There are several important policy implications that follow from our study:

- First, the mobile phone-based NTD MIS is characterised by an upward flow of information from the household level to health planners. However, there is a demand for information to flow back down to village level for local planning and decision-making which needs to be supported at policy level. This type of agenda calls for a refocus of Tanzania's decentralisation policy moving from its erstwhile agenda of transferring functional responsibility and resources from central government to local government authority, to actual devolution and participation of local human resources in health planning (Massoi & Norman, 2009). Fortunately, there is political will to do so as minuted in the health policy workshop held in Arusha in April 2012 (NIMR, 2012). However, this now needs to be translated into practice in order to change the way information is used at village level. Analysed and summarised reports from the mobile phone-based NTD control programme should be made available at village level on a routine basis requiring the need to nurture a culture of information sharing with lowest level health cadres who interface with beneficiaries. VHWs should be encouraged to spread their technological knowledge to bridge the digital divide in the village.
- Second, there are serious technical issues that may impact the mobile phone-based NTD MIS project. For example, lack of access to networks in rural areas, inconsistent service and frequent gaps in communication, and lack of maintenance of equipment threaten to undermine the programme during its pilot phase and later when the project is scaled up to country level. In cases where villages lack electricity and technological artefacts such as mobiles and computers, information can be made available in hard copy format.
- Third, strong government ownership and leadership is needed not only in terms of providing reliable and good quality connectivity but also in terms of presenting a vision with a well-defined set of ideals, goals and objectives so that the initiative is perceived as valuable and well-intentioned by various levels of the health administration. Indeed, the potential of mobile telephony for healthcare delivery cannot be overestimated, especially in Africa where mobile networks have grown exponentially during the last ten years bypassing all other infrastructure development on the continent in terms of speed and widespread usage (Sub-Saharan Africa Mobile Observatory, 2012).
- Fourth, in order to identify relevant lessons for the NTD MIS roll out to other districts in Tanzania, it is crucial that resources be devoted to a systematic and continuous monitoring and evaluation of the programme both from a biomedical and social science standpoint. Opportunities exist for the Tanzanian government to conduct a more rigorous impact assessment of the mobile phone-based NTD MIS by digitally tracking call logs, transaction speed and technical reliability over time. This would provide large amounts of quantitative data for future analysis of the programme. Moreover, with government support, the pilot project can facilitate bounded crowdsourcing or bottom-up organising to emerge through the day-to-day usage of mobiles in the busy routine of VHWs as they provide primary healthcare services to the community. However, as recognised at the Arusha workshop on health policy in Tanzania, monitoring and evaluation still remain a seriously under-funded area.

To conclude, the mobile phone presents a unique informational resource for promoting the cause of NTD control in developing countries which affect approximately one-sixth of the world's population (Kaiser Family Foundation, 2012). Our study has focused on identifying the social processes that underlie the deployment of technology for enabling local health workers to collect routine data at source providing an impetus to improve data quality. The mobile phones may also prove to be significant over time as communication and information exchange can develop capabilities of public debate and broader societal change. The conclusions from our study highlight important aspects about mobile phone deployment that influence the overall success of the NTD control programme in Tanzania. In terms of broader relevance, mobile devices for field reporting offer significant potential for capturing drug dispensing at point of care in low resource settings. This represents a major advance in public health service design and provides an impetus for further social science inquiry on this topic (Reidpath, Allotey, & Pokhrel, 2011). At the same time, we must ensure that modern technological solutions such as mobile telephony are not privileged over gaining a deep understanding of the historical processes of health governance that have evolved over time in different cultural contexts.

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