Perceptions of Tanzanian Health Care Workers Towards the Use of Mobile Phone Clinical Applications

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Accessibility

Glossary

Integrated Management of Childhood Illness (IMCI)
Tanzanian Commission for Science and Technology (COSTECH)
Comprehensive Community Based Rehabilitation in Tanzania (CCBRT)

Table of Contents

Section 1: Introduction

Tanzania is a peaceful democratic republic located in Eastern Africa. It has two official languages, English and Swahili. Tanzania has an established medical system with including secondary, tertiary, and quaternary levels of care to which patients can be referred depending on their medical needs. Barriers to care include inadequate supplies and providers at existing facilities and the inability of much of the population to afford necessary care. According to World Bank statistics, the number of mobile phone subscriptions in Tanzania has increased over the last decade from 4 per 100 people in 2003 to 56 in 2013.[1] This rapid increase in mobile phone utilization has encouraged numerous projects that have shown the value of this technology in particular domains of health care provision. These include using text messages to increase antenatal visits[2], provide family planning information[3], and maintain accurate stock counts of essential medicines at rural health facilites[4]; mobile phone based banking to address the logistics of fund distribution to cover transport costs for patients with identified obstetric fistulas[5]; telemedicine, whereby medical professionals in other countries provide advice on clinical management[6]; decision support tools that improve the quality of care in outpatient child health; tools that improve the tracking and productivity of community health workers; phone applications for use by pregnant mothers; and decision support tools to treat malnutrition and improve antenatal care and birth outcomes.

In a recently reported open label pragmatic cluster-randomized controlled trial at primary healthcare facilities in Zanzibar (a semi-autonomous island in Tanzania), Lund et al studied whether sending mobile phone text message reminders to pregnant women would result in increased antenatal visits. After randomizing 2550 pregnant women (1311 interventions and 1239 controls) across twenty four primary health care facilities in six districts to either the mobile phone intervention or standard care, Lund et al found that the mobile phone intervention was associated with an increase in antenatal care attendance. In the intervention group 44% of the women received four or more antenatal care visits versus 31% in the control group (OR, 2.39; 95% CI, 1.03-5.55).[2]

A mobile phone based intervention focusing on women seeking treatment for obstetric fistula in Tanzania has been reported by Fiander et al. An obstetric fistula is the formation of a fistula (hole) between the bladder and the vagina or between the rectum

4

and the vagina due to prolonged labor without prompt intervention. In Tanzania, it is estimated that 1200- 3000 new cases arise annually. Even if care is provided free of charge, transportation costs are thought to pose significant barriers. The Comprehensive Community Based Rehabilitation in Tanzania (CCBRT) Disability Hospital is a center of excellence for performance of fistula repair. In 2009 the CCBRT introduced the transport*MY*patient initiative which involves ambassadors throughout the country referring women with obstetric fistula for further care. Transport funds required are transferred to ambassadors via Vodacom's M-PESA technology (PESA means money in Kiswahili). The ambassador collects currency from their local M-PESA agent (of which there are more than 6000 in Tanzania), buys the bus ticket, and ensures that the patient is transported to the CCBRT Disability Hospital. From 2005 - 2009, CCBRT repaired approximately 170 fistulas annually. Following the launch of transport*MY*patient at the end of 2009, 286 fistula repairs were done in 2010, a 65% increase compared with the number in 2009 with 45% of patients referred through transport*MY*patient. The authors concluded that the increase in fistula repairs was due to the transport*MY*patient initiative which was allowing Tanzanians to overcome the barrier of transport costs to obtain treatment. [5]

As illustrated above, the use of mobile phones in health care offers the promise of improved quality of care in developing countries through myriad routes. While this promise may take many forms from provision of health advice through texting platforms to coordination of resources in medical emergencies to telemedicine whereby clinicians can interact with patients remotely across great distances, a particularly salient opportunity exists to use mobile phones as a tool to increase adherence to evidence based clinical standards of care. Such standards of care are not limited to developing countries, as the use of clinical standards has been shown to improve the quality of health care in both low and high income countries.[7,8] A clear example is the widespread use of the Integrated Management of Childhood Illness (IMCI) protocols for classifying and treating common causes of childhood death including pneumonia, diarrhoea, malaria, measles, and malnutrition. A multi-country evaluation coordinated by the World Health Organization concluded that IMCI has the potential to improve quality of care, reduce cost of treatment, and reduce under-5 mortality when used correctly.[9,10] However, despite a worldwide

effort, the use and impact of IMCI protocols remains limited due to expense of training, lack of sufficient supportive supervision, a tendency for health workers to follow protocols less rigorously over time, and insufficient resource and policy support.[11,12]

The use of mobile technology has been shown to significantly increases the correct use of the IMCI protocols compared to traditional paper based protocols in Tanzania, facilitating a more comprehensive assessment of children by healthcare workers.[13] D-Tree International is a US-based 501(c)(3) nonprofit organization that has developed clinical protocols (decision trees) for use on cell phones by health workers in Tanzania and other countries. Established in 2004, its purpose is to improve the quality of healthcare in developing countries through the use of innovative technology providing accurate and effective point-of-care diagnosis and treatment. D-Tree International is headed by Marc Mitchell, MD, MS. Dr. Mitchell was trained as a pediatrician and management specialist and has worked in over 35 countries in Africa, Asia, and Latin America on the design and delivery of health care services. He is a Lecturer on International Health at the Harvard University School of Public Health where his areas of expertise include health management, health systems design, and program development and evaluation. Under the leadership of Dr. Mitchell, D-Tree International has conducted multiple proof-of-concept studies across Tanzania.   Its projects have used cell phone based protocols in the areas of child health and nutrition, antenatal and post-natal care, family planning, emergency obstetric care, and AIDS and TB chronic care. At the behest of the Zanzibar Ministry of Health, D-Tree International is implementing a mobile phone-based IMCI protocol for widespread use on Zanzibar. Despite the high demand to upscale such technological interventions, there is limited literature showing Tanzanian medical professionals' perceptions of barriers to the adoption of new technologies in general and mobile phone based technology in specific. A deeper understanding of such impediments would likely improve uptake and smooth the up-scaling of technological interventions.

A study by Nilseng et al aimed to assess current approaches to and use of information and communication technology among health workers in two rural districts of Tanzania in relation to drug distribution. Semi-structured, partly qualitative, explorative interviews with 20 health care workers (including three nurses, six clinical officers, and four pharmacists) at thirteen different facilities were conducted. Findings included that all

interviewees used mobile phones, thirteen used computers, twelve used the Internet, and eight reported using smartphones to access the Internet. All participants stated that they were interested in improving their computer skills and they all also thought that information and communication technology could be helpful in their jobs.   Though no participant had seen or used an Android tablet before, interviewees quickly understood the purpose and structure of the application and the touch-screen function. All interviewees reacted positively to the application and stated that it could help improve drug inventory and ordering, which is currently done in paper form.[14]

Adding to the literature on medical professionals' perceptions of mobile phone based technology, Madon et al recently published the results of a qualitative case study of community health workers using a mobile phone-based management information system for the control of neglected tropical diseases. Interviews preceding the implementation of mobile phone based reporting held by the authors in 2007 with Tanzanian Ministry of Health officials suggested that factors preventing accurate reporting of data included inadequate incentive mechanisms for health personnel and corrupt practices such as little importance being attached to reporting. "At the end of the month, health workers would hazard a guess in order to complete the reports," Madon wrote.[15]

After these preliminary interviews, Madon set out to assess how effectively the goals of mobile phone implementation, namely improving data quality for health planning, with a secondary objective of motivating and empowering health workers, had been. Madon et al interviewed fifty-five respondents including fifteen key informants with a combination of community health workers, village leaders and health officials and held four focus group discussions with three to four persons from Village Health Committees. They found that mobile phones increased the efficiency of routine work and boosted the motivation and self-esteem of community health workers. However, the technology did not change the nature of one-way information flow from the village to the district and national level. The use of phones "simply made reporting more hi-tech."[15] This failure to create a culture whereby frontline workers were provided with feedback limited the benefits of the intervention. [15]

Anecdotal evidence from D-Tree International staff suggests that while health workers are willing to participate in clinical trials of mobile technology, when the trials are

over or when supervisory personnel are absent, the health workers cease to use the technology and revert back to traditional modes of care. At this critical juncture, examining the perceptions of these health care workers is vital, as they will provide clear indications for how to ensure maximal adoption of this technology at all levels. This project utilized qualitative methods to survey Tanzanian health care workers to determine why this is the case and what can be done to improve adoption of this and other technologies. The project proposed and others of its kind are the critical planks forming the bridge across the "know-do gap," with the ultimate goal of improving health outcomes.[16] It is our hope that the results obtained will provide knowledge on how a variety of technological solutions to health problems can be widely adopted in Tanzania, other developing countries, and worldwide.

This project set out to conduct semi-structured in-depth interviews with health care workers involved in previous mobile phone clinical protocol studies conducted by D-Tree International at four sites in Tanzania. Following these interviews, we will identify common themes to describe the factors that lead to cessation of use of mobile phone based technology in clinical settings in Tanzania and explore strategies which address how this technology could be sustainably implemented in health care settings.

Section 2: Methods

        We conducted semi-structured in-depth interviews of health care workers involved in mobile phone clinical protocol proof-of-concept studies conducted by D-Tree International in the Dar es Salaam, Pwani, and Zanzibar Regions of Tanzania. Interviews were conducted with members of key groups identified as vital to successful adoption of this technology: community health care workers, nurses, and their supervisors. Interviewees were selected via purposive sampling based on advice from D-Tree International Employees. Attempts were made to maximize diversity of those interviewed, especially regarding type of health care worker, sex, and age.

        Interviews were conducted in 3 regions in Tanzania where D-tree International is implementing projects. Districts selected depended on discussions with D-tree International personnel and the willingness of District Medical Officers to participate in the study. Projects considered for this assessment included an antenatal care project in Morogoro Region, a child health project in Dar es Salaam Region, a community health worker project in Pwani Region, and an antenatal care project in Zanzibar.

        Institutional Review Board approval was obtained in Tanzania for conducting interviews of health care workers using mobile phone clinical protocols with D-Tree International through the Tanzanian Commission for Science and Technology (COSTECH), Ali Hassan Mwinyi Road, P.O. Box 4302, Dar es Salaam, Tanzania (Research Permit No. 2012/269-NA-2012-113). Exemption status was obtained from the Harvard Medical School Institutional Review Board after consideration of (i) the adequacy of protection of the rights and welfare of the subjects involved; (ii) the risks and potential benefits to the subject or importance of the knowledge to be gained; and (iii) the adequacy and appropriateness of the methods used to secure informed consent. (Protocol #22315-101). Exemption status was obtained from the Harvard School of Public Health Institutional Review Board (Protocol #22315-101).

Oral and written informed consent forms were developed in consultation with Tanzanian D-Tree staff and subsequently translated into Swahili by staff members who spoke Swahili as their first language. Interviewees were provided with oral and written informed consent prior to their interview. Copies of written consent can be found in Appendix 1 (English) and Appendix 2 (Swahili). Participants were verbally reassured that their confidentiality was protected.

A data safety plan was created. Interviews were recorded digitally. They were typed as Microsoft word documents in Swahili, de-identified, translated to English, and labeled with participant #, audio file #, position, and location.   Position described the interviewees' role (community health worker, nurse, or supervisor). Location described the region the interview was conducted in (Dar es Salaam, Pwani, Morogorro, or Zanzibar). The digital interviews were stored on a tape recorder and transported in locked backpack from site of interview to D-tree International Headquarters in Dar Es Salaam. The typed interviews were de-identified and comments that could be linked to individuals (especially names and unique locations) were redacted. Audio recordings will be destroyed upon project completion. Research assistants, translators, and Harvard mentors were given access to transcribed interviews as necessary. Local D-Tree employees were not provided access to audio recordings to preserve the anonymity of interviewees.

An Interview Guide was developed in consultation with Tanzanian D-Tree staff and subsequently translated into Swahili by staff members who spoke Swahili as their first language. Copies of this interview guide can be found in Appendix 3 (English) and Appendix 4 (Swahili). Three slightly modified versions of the interview guide, appropriate to each interviewee whether community health worker, nurse, or supervisor, were subsequently developed and translated into Swahili.

After asking interviewees which language they were most comfortable using, interviews were conducted in English or Swahili by Greg Haman who is fluent in both Swahili and English, having spent a total of 4 years in Tanzania. Interviewees were interviewed privately at their place of normal employment or at a previously scheduled D-Tree International meeting or conference taking place within their region of employment. Interviews took place in July and August, 2014. Reimbursements, compensation, or benefits for participants outside were not provided.

The project mentor was regularly debriefed on the progress of interviews. All electronic files were sent to mentors and reviewed for accuracy.[17] Based upon the interviews, a document was written with my impressions of health care worker perceptions and distributed to D-tree's employees which can be found in its entirety in Appendix 5.

A transcription key developed by the University of Washington Department of Global Health and freely available on their website was used with minimal, appropriate modifications to guide the typing of the interviews and standardized formats. [18]

At the completion of interviews, more than 26 hours of interviews conducted with a total of 42 health care workers (nurses, community health workers, and supervisors) on how mobile phone technology can be most sustainably implemented and utilized in Tanzanian health care settings had been collected. The interviewer, Greg Haman, subsequently read each of the interviews, taking notes and identifying themes that were repeated and ideas that were shared across interviewees. After two complete readings and note taking of all transcribed interviews, Mr. Haman judged that thematic saturation had been reached.

Section 3: Results

<u>Familiarity with and Ability to Use Phones</u>

A potentially significant barrier to smart phone based protocol adoption was that most health care workers did not own and had not used smart phones before the project. Indeed, most interviewees had owned and exclusively used conventional (Nokia-brand) phones. Some expressed apprehension about learning a new technology but most stated that these feelings abated as their training went on. On the whole, despite limited prior exposure, health care workers were initially eager to participate and maintained their optimism about the potential for mobile phone use in health care.

Most health care workers felt comfortable using their smart phones within a week to up to a few months of starting their respective project. Only one worker interviewed had ongoing technical difficulty operating the phone, and this worker was convinced that regardless of any amount of training she would be unable to use the phone. This worker expressed that she felt too old for such technology. Despite going through training twice she still felt utterly unable to make use of the phone. Such non-participation merits careful consideration, especially at small health centers where very few workers are employed, where the refusal or inability of one worker to participate can have significant effects.

A further special case that merits careful consideration is that of health centers with a low volume of qualifying patients (e.g. Zanzibar malnutrition project). At locations where 1-2 malnourished children are seen per week, when 3-4 workers are trained on an application, months will sometimes pass without a particular worker having the opportunity to make use of the technology. If the problem of malnourished children improves on Zanzibar, one would expect this to increasingly become an issue. Thus, it might be better to have only one or two people using the application per clinic, as when a particular worker only uses this protocol once per month they can become unfamiliar with the protocol over time and "relearning" it each time will significantly lengthen the time spent using the application.

<u>Training and Troubleshooting</u>

Interviewees felt that D-Tree International's initial training was well done, well understood, and adequately staffed. Many workers expressed that they would have liked to have training for a longer period of time.   Training provided across D-tree projects was

perceived to vary from short time periods of on the job/ in station training to full-time weeklong training. It emerged that regardless of the amount of training, most workers highlighted more initial training as the single most important thing that they would have changed about D-Tree training.

Desire for "refresher" training was widespread among interviewees.   Health care workers, even when interviewed in Swahili, often used this English term to describe a desire for ongoing training. The justification for "refresher" training was expressed in various terms by interviewees. Some expressed the sentiment that 'technology evolves, so should we.' Others pointed out that when applications are altered or updated significantly, a corresponding "refresher" session should be held. Others wanted further training to deepen their ability (technical skills) or understanding (clinical justification for various questions in the protocols). Others saw the refresher as a reward, an opportunity to be recognized for their hard work. Still others saw it as an opportunity to communicate with other community health workers at distant sites, exchange ideas, and thereby grow in their ability to use the applications. At least one interviewee suggested that clinical data could be compared between multiple sites and that friendly competition with rewards could foster camaraderie and also provide additional motivation.

Several healthcare workers expressed a desire to be taught simple steps to fix common technical problems. They expressed frustration at their occasional inability to use their phones (send data, etc.) for weeks, waiting for D-Tree staff to physically come and provide assistance. Upon arrival, D-Tree staff were able to fix the problem in minutes or less.   They saw that in some cases the problem was easily fixed by adjusting settings via menu navigation, and wished that this 'troubleshooting' training had been included in their initial training. The workers wished that they had been taught or provided with resources explaining such simple steps to fix such common problems so that they were not dependent on D-Tree staff coming to visit them.

Amongst the interviewees there was recognition that some users were already familiar with smart phones or very quick in their adoption ('super-users'). Several community health workers described going to their peers for assistance with problems and only when this failed did they approach D-Tree staff (because of the time required for D-Tree staff to travel to their site). There were leaders who were chosen among community

health workers to supervise, but it was unclear if those chosen were the super-users described above, or if super-users were recognized during training or utilized in other ways. One might imagine specialized, parallel, or additional training that might be provided to these individuals to enable them to further help their peers in the field to diminish the reliance on D-Tree staff coming to their site to themselves fix problems.

<div align="center">Expectations</div>

When seeking to implement a new technology sustainably, it is crucial that all parties have an understanding of project duration. Some health care workers seemed unclear about the duration of their current mobile phone project. There was a lack of certainty about if or when the mobile phone usage would end. At least one interviewee mentioned that contracts were signed at the start of the project describing that if the phone was lost or stolen, employees would need to purchase a replacement from their own money. It was unclear if such contracts were used in all projects, but this might well represent a best practice. The contracts might not even need to focus on length of time of the project, but might focus on the phone e.g. how often voucher will be replaced, whether the phone can be used for private use or also for personal use, what will become of the phone at the end of the project, and what will become of the phones if the project ceases.

Given the resource limited settings, it is perhaps not surprising that the above mentioned concern regarding what would become of the phones if the project ended was a recurring theme. Even in cases where health care workers did not directly articulate a desire to own the phone following completion of the project (which several did), several expressed a desire to *know* what would become of the phones. Would it be their personal property? This lack of clarity created a tension within health care workers, some of whom were carrying the phone at all times and effectively using it as a personal communication device. As the health workers become increasingly familiar with the phones, their loss (at the potential cessation of a project) comes to represent a significant loss to them. Though outside of the scope of my interviews, this might be expected to correlate with an increasing incidence of 'lost' or 'stolen' phones on cessation of a project. One idea to address this problem is that for community health workers, a contract might clearly state terms such as "You will use this phone for X years at which point the phone will be yours if

you have not lost it and it has not been stolen. At this time you may be given a new phone to continue your work and the old one is yours to keep."

<div align="center">Security</div>

The security of smart phones utilized in the project was an oft mentioned, pressing concern. Several community health workers described having their phones stolen and this was a significant event, sometimes even emotional, and costly for them as they needed to buy a new phone with their money to continue the work. Guaranteeing the security of phones is further complicated by how they are practically used in community health centers. At such centers where phones are shared and typically locked in storage during non-working hours, even if a phone was checked out in one person's name, it often came to be informally used by several health care workers. This resulted in difficulty ascertaining who was personally responsible for problems with the phone such as use of pre-paid phone time meant for clinical issues but used for personal calls, etc. Several interviewees described attempts to insure phone security by keeping the phones locked at the health center. However, these methods were problematic as often only one person had the key to access the phones and when that person was away, the phones were not used.

An improvement (with its own financial consequences) strongly suggested by some (including one health center worker who was the "key keeper" to his center's stock of phones) was to have each trained worker receive their own phone. Other workers, however, expressed their desire to keep the phones at their place of work. They pointed out that at some point in training they had been told that if they lost the phones, they would be financially responsible. Thus they viewed taking the phones home as a great risk given their high expense (a month's salary or more) and were unsure how they would be made to pay if they lost the phone. Thus losing a phone could be financially catastrophic to themselves and their family. This fear even led to decreased use in the clinic as workers felt that there was limited pressure on them to use the phones, the phones did not bring them any personal benefit, but might bring them personal significant harm ('what if I lose the phone at the clinic? What if it gets stolen when I am up from my desk? I will need to pay for that!') Thus the security issues and responsibility for phones is an ongoing issue both for community health workers and nurses.

<div align="center">Overall Impressions: Community Heath Workers</div>

Community health workers expressed broad support for the phones. Reasons provided included reducing stigma for patients (rather than carrying folders and papers and arousing curiosity, community health workers were able to appear to community members as though using the phone for personal communication when conducting interviews), leaving a permanent record (papers can be lost, stolen, destroyed, etc.), having an external authority (community health workers expressed that they would often show the patients the advice from the phone after their interview and occasionally allow them to look on as they entered information from the interview). For instance, a patient might appear reluctant to travel for a referral but the community health worker would then show them the phone and say "Yes, it is not just me as me giving you this advice, but look here. This program made by these 'white people' says you need to go too." Many of them specifically appreciated the "mtiririko" or "flow" of questions.

Overall Impressions: Nurses

Nurses and workers at health centers were more complex in their evaluation of the applications, and likely to express both the advantages and disadvantages of use. The feeling that the phone would improve clinical outcomes for the patient being interviewed was widely held. However, there was skepticism about whether (due to a longer interview than without the phone) the phone could realistically be used for all patients given high patient volumes. Some thought it was unrealistic to use the phone to evaluate all patients given this increase in time required. One health care worker stated that the patients who are in the interview room "love it" because they feel they are getting great care, but that those on the other side of the door (whom they could hear at the same time they were interviewing the patient) were complaining loudly about how slow the service was. "So the patients hate it until they get into the exam room, where they love it." This was an illustrative image of the balance these workers must strike between quality of care and number of patients to be seen. This might also partially explain why community health workers are less nuanced in their support for mobile phones: they may feel less necessity to see a given number of patients given their volunteer status, and thus the increase in time required for each interview is not as acutely noted.

Common Technical Problems

Perhaps the most common technical problem faced by interviewees was failure to sync the data entered on their phones to the d-tree server. In some cases this was due to insufficient voucher on the phone for the pre-paid data connection, in other cases there were phone network problems, and in other cases there were software problems. From interviews it emerged that some community health care workers were trying to sync after seeing every patient. If they were unable to sync, they stopped using the phones until syncing worked. This seemed unwarranted in most cases, particularly in cases of network failure. A suggested improvement in cases of network unavailability is a message to inform the user to continue seeing patients until the network again became available.

Suggestions to Improve Adoption of Mobile Phones

Community health care workers suggested that their satisfaction might be improved with simple, low cost interventions that D-Tree might advocate for. Ideas included user ID cards so that community health care workers could identify themselves to villagers as well as to health care professionals at care facilities when they are following up on admitted patients and t-shirts so that they can be recognized in their community for their contribution. In addition to advocating for particular types of compensation, D-Tree might influence types of compensation that are appropriate. An example that came through in interviews is an organization working in partnership with D-Tree that offered bicycles to community health workers. The bicycles were foreign and local repair was not possible. Within a year almost all of these bicycles were rendered unusable. Though not a fault of D-Tree, complaints about these bicycles were pervasive among those who were provided with them and, as many workers did not clearly distinguish between d-tree and the partner organization, this choice reflected poorly on d-tree.

Uncertainty

The maternal program on Zanzibar was most unequivocally and exuberantly supported by users. The uncertainty surrounding its continuation (given the cessation in registering new mothers as D-Tree was determining the next step in the project) was a source of frustration and regret. The workers involved felt powerless to continue a program that they believed was undoubtedly successful. Opening lines of communication between the D-Tree office and these workers to make clear that funds are actively being sought, conditional approval has been made, etc. would help prevent the idea that forms

when such obstacles are encountered: that mobile phone application use is transient and subject to the whims of grant cycles of pre-determined length.

Section 4: Discussion, Limitations, Conclusions, and Suggestions for Future Work

While D-tree staff have a vision for widespread mobile phone use in clinics, it was clear through the course of the interviews that front line health care workers are unaware of this vision and thus do not clearly see themselves as parts of it. When considering the possibility that mobile phones would be used by all health care workers in Tanzania, most respondents took this as a very hypothetical question. Most health care workers were unaware that mobile phone applications outside of the application they were trained on were being used in Tanzania. On several occasions in response to the question "what additional application would you like to see developed? " health care workers mentioned an application that was already developed by D-Tree and in use in a different part of Tanzania. Making health care workers aware of the numerous locations in which D-Tree operates may well lead to an increased appreciation for the sustainability of D-Tree's work. This might be accomplished by including a map during the introduction session that includes the geographic location of current D-Tree projects, the number of staff trained, and the various protocols that are in operation. D-Tree has numerous projects and these ought to be doing more work to its advantage at the level of the individual health care worker. This will also help to overcome the "why me, why do I need to learn this when I am not getting additional pay" reaction that can occur in the adoption of new technologies.

The strong, near universal desire for further education in the setting of seminars or training courses noted in our interviews appears common amongst East African health care workers. Jones et al write that in over 24 in-depth interviews with Kenyan health workers (21/24 were nurses) none of the participants expressed the view that SMS text messages (the intervention studied) could be used to replace training and seminars. Trainings were seen as "essential to help in the interpretation and understanding of new guidelines, to give protected time away for learning (without the distractions of daily practice), to allow for an exchange of experiences with colleagues and to act as motivation (through staying in a nice hotel for a few days)" echoing the emphasis placed on and justification provided for further trainings voiced by our Tanzanian interviewees.[19] Jones et al further describes the nature of health care worker's perceptions of effective and ineffective training, suggestions that anyone providing training for technological interventions might well be careful to consider.

Jones et al further describe many of the complaints of health care workers regarding the use of standard clinical guidelines. Participants in their study perceived that guidelines were less effective in providing a reminder or reference than SMS messaging because they can be "put in a drawer and forgotten" "requiring a provider to physically locate them and then read through to find the appropriate advice, all of which takes time."[19] In contrast, a mobile phone is within easy reach and cannot be removed from the clinic (or lost) as is often the case with communally shared guidelines. One wonders that an intervention like the mobile phone based clinical protocols implemented by D-Tree would not be well received by these Kenyan health workers, combining the ease of access of the text messaging intervention they took part in with the increased complexity of a clinical protocol available on a mobile phone. [19]

Currently, individual health care workers are not benefiting from advances in data collection and analysis by receiving personalized feedback. Despite representing a tremendous advance in ease of data collection and analysis, this progress has not yet trickled down to health workers who when interviewed expressed getting no more feedback than the previous paper based method of documentation. Allowing users to view their own progress based on certain established goals or the contribution of their health center to regional or national health goals will increase the personal stake that these workers take in their performance and allow them to appreciate the significance of their work.

In the Tanzanian context, performance based compensation for application use has tremendous potential. One interviewee, when asked how we should encourage mobile phone protocol use, answered bluntly with one word "money." Though D-Tree does not want to link the adoption of this technology to ongoing financial compensation, performance based compensation is increasingly recognized as an effective tool, both in the USA and Tanzania. Performance based compensation need not be a "we give you money for your work" deal, but has many possible iterations. The possibility should be considered that even miniscule amounts, redistributed from other fixed costs, might enhance implementation. Other incentives such as certificates of recognition were also recognized by many as rewards for good work. Messages of support less so, but most interviewees still agreed they were an improvement over nothing.

Limitations of this project included difficulty in insuring participation of a representative sample of participants. It remains unclear just how much our findings at particular sites across Tanzania will be generalizable outside of these particular locations, across projects, across the country, and to different technologies. Given that the interviewer, Greg Haman, was not a native Swahili speaker and his skin color was different than that of the interviewees, he was easily identified as a non-Tanzania. It is unclear how this status affected the quality of interviews conducted. Furthermore, as he travelled with and was introduced by D-Tree staff, there was a likely perceived association that he acted as a representative of D-Tree International. Thus, the study was vulnerable to social desirability bias whereby participants may not feel comfortable speaking frankly about disincentives to adoption of this technology. With the aim of reducing these consequences the purpose of the study, Greg Haman's own role, and protection of the participant's anonymity were emphasized prior to starting the interview.

Of note and significantly, due to numerous unforeseen delays in obtaining Institutional Review Board exemption from Harvard Medical School, the project was significantly delayed, and time which had been dedicated to data analysis was instead allocated to data collection. A more rigorous qualitative analysis was intended that would have quantified the number of respondents expressing the themes noted above, and relied on several independent reviewers outside of the interviewer to code for emerging themes. Given time constraints, the analysis described above was conducted.

In conclusion, the findings of our interviews have revealed that most Tanzanian health workers were eager to adopt new technological interventions to improve their work flow. They were readily able to make use of D-Tree's clinical protocols with limited smart phone experience. Difficulties identified in successfully adopting and sustaining this technology included maintaining a sufficient volume of patients for whom the protocols were designed that technical skills were maintained and technological challenges including difficulties syncing data. The interviews revealed several ways in which adoption of this technology might be further encouraged including educating health workers on the breadth and duration of D-Tree's projects across Tanzania, addressing concerns for phone security, providing individualized user feedback, and implementing performance based compensation.

Suggestions for further work might focus on several realms. Firstly, examining how broadly applicable the findings of this research are to adoption of other technologies in a Tanzanian context would be quite interesting. Will Tanzanians prove to be as eager and adept at adopting other new technologies as they reported being for clinical protocols on smart phones? As Tanzania has a number of private companies selling technologies intended to reach the village level (cell phones, GPS systems, appliances, televisions) there might be an excellent opportunity for public-private collaboration in elucidating best practices for improving the adoption of technologies. It may well be that, as in other countries, the health industry is quite behind in innovation and would benefit significantly from looking at other industries with proven records in this area. Secondly, D-Tree might, with the data it gathers on patient encounters, implement a pay for performance strategy for its protocol users. The number of patients seen or other quality metrics could then be analyzed to determine if such a system led to increased utilization of this technology. D-Tree might also attempt to make use of its "super-users" by offering them special status and training in supporting their co-workers. This might be expected to decrease requests for assistance from its various locations of operation as problems that once were insurmountable for individual users can be troubleshot by empowered local users. The effect of providing individual feedback to users could be quantified and analyzed rigorously. Given the pride that Tanzanians take in their work, it might well be that such feedback would further increase utilization and improve adherence to clinical protocols.

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Appendix 1: English Consent form

Protocol Title: Perceptions of Tanzanian Health Care Workers Involved in Mobile Phone Clinical Protocol Studies
Principal Investigator: Dr. Marc Mitchell/M.D./M.S.
Description of Subject Population: Community health workers, nurses, physicians, supervisors, or funders involved in mobile phone clinical use in Tanznaia
Version Date: May 29, 2012

Consent Form to be Read to Prospective Research Participants

Hello,

We invite you to take part in this research because of your prior voluntary involvement in or knowledge of mobile phone clinical use in Tanzania. The purpose of this research is to identify the factors that lead to cessation of use of mobile phone based technology in clinical settings in Tanzania and to explore strategies that address how this technology could be sustainably implemented in health care settings. Your participation is voluntary. It is your choice whether or not to take part in this research. If you choose to take part, you may change your mind and leave the study at any time without penalty. Participation in this research study will involve participating in a brief tape-recorded interview on your experiences regarding the use of mobile phones for clinical application for up to an hour of time. You will not be paid for participation in this study and will receive no other form of compensation. If you need additional information you may contact Gayo Mhila, D-tree Tanzania Field Office, +255222774416.

Appendix 2: Swahili Consent form

<table>
<tr><td>Kichwa Cha Uchunguzi: Hisia za Wafanyakazi wa afya wa Tanzania Walioshirikiana na Uchunguzi Uliohusu Matumizi ya simu za mkono zenye miongozo kwenye klinki</td></tr>
<tr><td>Mkuu wa Uchunguzi: Dr. Marc Mitchell/M.D./M.S.</td></tr>
<tr><td>Maelezo Yahusu Watu Wanaochunguliwa: Wafanyakazi wa afya wa jamii, Wauguzi, Madaktari, Wasimamizi, au Wanaotoa fedha kwa Matumizi ya simu za mkono kwenye klinki Tanznaia</td></tr>
<tr><td>Tarehe ya Mswaada Huu: 29 Mei, 2012</td></tr>
</table>

Fomu ya Idhini Kusomewa kwa Washiriki Wanaoweza Kujiunga na Utafiti

Karibu,

Tunakualika kushirikiana na uchunguzi huu kwa sababu tayari umeshatumia au umeshapata ujuzi kuhusu matumizi ya simu za mkono zenye miongozo kwenye kliniki Tanzania. Lengo la utafiti huu ni kutambua vitu vinavyochangia wafanyakazi wa afya wanapoacha kutumia simu za mkono zenye miongozo kwenye klinki Tanzania na kutafakari mbinu za kuanzisha na kudumisha matumizi ya teknolojia hii kwenye hali ya kutoa huduma za afya. Ushirikiano wako ni ya uhuru. Ni uamuzi wako kushirikiana na uchunguzi huu au la. Ukiamua kushirikiana, unaweza kubadilika mawazo na kuamua kuacha kushirikiana muda wowote bila hasara. Ushirikiano wako katika uchunguzi huu utakuwa pamoja na mahojiano mafupi yatakayorekodiwa kwa kutumia chombo cha kuandikisha maneno ("tape recorder" kwa kiingereza) yatakayohusu uzoefu wako kuhusu matumizi ya simu za mkono zenye miongozo kwenye klinki kwa muda isiozidi saa moja. Hutalipiwa kwa ushirikiano wako wala kufaidika kifedha kwa namna yoyote wala kupewa posho. Kama unahitaji taarifa zaidi unaweza kuwasiliana na Gayo Mhila, Ofisi ya D-tree Tanzania, +255222774416.

Appendix 3: Interview Guide and Questions (English)

Interview Guide and Questions

Participant #_____ Audio File #_____Position*_____District_____
* = caregivers, funders, supervisors

General description of the study and its purpose
Expected duration of the interview (less than 1 hours)
Read Consent Form
Answer any questions
Tape Recorder Turned on

Job Description, Relevant History (< 6 minutes)

1. Can you please describe your job responsibilities?

2. Do you supervise others? If so, what positions/jobs do they have?

3. Do you report to anyone? If so, what positions/jobs do they have?

4. Did you own or regularly use a phone before using one in the hospital? If yes, was it a smart phone?

Experience with Mobile Phone Clinical Applications (< 26 minutes; total time elapsed: <32 minutes)

5. Can you describe your experience with mobile phone usage in health care?

6. In total, from the first time to the last time, how long have you used mobile phone clinical applications in medical practice? Are you still using them? How many times an hour, day, week, or month do or did you use the phones?

7. For what types of patients or medical conditions of patients do you use mobile phone clinical applications?

8. Do you now know how to use the mobile phone clinical application well? If yes, how much time did it take you to learn?

9. Was the training you received for the phone adequate?

10. What was your initial feeling when you heard of the mobile phone clinical application?

11. Did that feeling change over time and with use?

12. What do you like about the mobile phone clinical applications?

13. What do you dislike about the mobile phone clinical applications?

14. Can you tell me about the last time that you used the phone in a clinical encounter?

15. Did using mobile phone clinical applications change your interview with the patient? Please be specific.

16. Did using mobile phone clinical applications change the time you spent interviewing the patient?

17. How do you think patients feel about the phones?

18. Do your fellow workers in the same position generally agree with your views on mobile phone clinical applications? If some disagree what do they disagree about and why?

19. If you supervise others, how did those who you supervise perceive this technology?

20. Did you feel that your supervisor was supportive in your use of this technology?

Potential of Mobile Phone Clinical Applications(< 8 minutes; total time elapsed: <40 minutes)

21. Do you think mobile phone clinical applications can mitigate the effects of the national human resource health crisis?

22. Do you think using mobile phone clinical applications can improve outcomes? Do you think it has improved outcomes for your patients?

23. Do you think mobile phone clinical applications are most useful for community health workers, nurses, or doctors? Why?

24. What programs/applications on phones would you like to see developed that could improve health?

Sustainable Implementation (< 20 minutes; total time elapsed: <60 minutes)

25. About how many times did you want to use the mobile phone clinical application but were unable to? Why were you not able to?

26. If the study you were a part of ended, how long did you continue to use the mobile phones after the study ended? If you stopped using them, why?

27. Did you feel that technical support was adequate during the research?

28. What do you think would motivate staff to use phone based applications?

29. Do you think that certificates of recognition for using the phones would motivate workers?

30. Would software that automatically provides messages of support and acknowledgement motivate workers?

31. Do you think that it is realistic that mobile phone clinical applications will one day be used by every health care professional in the country as standard practice? Why or why not?

32. That was our last question. In closing if you have any final thoughts you are welcome to provide them now.

Appendix 4: Interview Guide and Questions (Swahili)

Mwongozo wa Mahojiano na Maswali

Numba ya Mshiriki___ Namba ya faili la sauti (Audio File)___ Cheo cha
mshiriki_____Wilaya_____
 Sifa ya mshiriki, Mtoa huduma za afya, wafadhali, wasimamizi

Maelezo kuhusu utafiti na madhumuni yake
Muda unaotarajiwa kutumika wakati wa mahojiano (si kuzidi ya saa moja)
Soma fomu ya idhini
Jibu maswali
Washa kifaa cha kunukuu maelezo (Tape Recorder)

Maelezo ya Kazi, Historia ya Matumizi ya Simu (< dakika 6)

1. Tafadhali unaweza toa maelezo juu ya majukumu yako kazini?

2. Je wewe ni msimamizi wa wengine? Kama ndiyo, kwenye nafasi zipi /Majukumu
   waliyonayo?

3. Uko chini ya usimamizi wa mtu mwingine kazini? Kama ndiyo, ana cheo
   gani/Majukumu gani?

4. Je uliwahi kumiliki au kutumia simu mara kwa mara kabla ya kutumia simu zenye
   miongozo ulizopata kituo cha afya? Kama jibu lako ni ndiyo, je simu uliyotumia
   ilikuwa ya kisasa (smart phone)?

**Uzoefu wa miongozo ya Afya kwenye Simu za Mkono (<dakika 26; jumla ya muda
uliopita <dakika 32)**

5. Je unaweza kuelezea uzoefu wako wa matumizi ya simu za mikononi katika kutoa
   huduma za afya?

6. Kwa ujumla, kuanzia ulipoanza kutumia miongozo hii kwenye simu mpaka sasa,
   umeshatumia kwa kipindi cha muda gani? Je bado unazitumia? Ni mara ngapi
   unatumia simu kwa kipindi cha saa moja, siku, wiki au mwezi?

7. Ni wagonjwa wa aina au matatizo gani wanakufanya utumie programu ya
   migongozo ya afya iliyopo kwenye simu?

8. Je kwa sasa unaweza kutumia programu za miongozo ya afya zilizopo kwenye simu
   ya mkononi vizuri? Kama ndiyo, imechukua muda gani kujifunza?

9. Je mafunzo uliyopata juu ya matumizi ya huduma kwa njia ya simu yametosha?

10. Je hisia zako za awali zilikuwaje juu ya matumizi ya huduma ya afya kwa njia ya simu uliposikia juu ya hii huduma kwa mara ya kwanza?

11. Je, hisia zako zilibadilika baada ya muda na has baada ya kutumia?

12. Je ni kitu gani unachopenda kutoka kwenye huduma hii ya matumizi ya simu?

13. Kitu gani ambacho hupendezewi nacho kwenye huduma hii ya matumizi ya simu kwa huduma ya afya?

14. Unaweza kunieleza ni lini mara ya mwisho ulitumia simu yenye miongozo ya huduma ya afya?

15. Je, ulipotumia muongozo wa simu kwenye huduma ilibadilisha namna unavyotoa huduma kwa mgonjwa? Tafadhali, elezea kwa ufasaha.

16. Je matumizi ya muongozo kwenye simu yamesababisha kubadilika kwa muda unaotumia kumhoji mgonjwa?

17. Unafikiri wagonjwa wanafikiri vipi au wanachukuliaje juu ya matumizi ya simu kwenye huduma?

18. Wafanyakazi wenzako wenye cheo sawa na wewe wanaafikiana na dhana ya inayohusu matumizi ya simu kwenye kutoa huduma? Kama baadhi hawaikubali, unadhani kitu gani kinawafanya wasikubaliane nayo na kwa nini?

19. Kama wewe ni msimamizi wa wengine, je wale wengine wameionaje teknolojia hii?

20. Je, unadhani msimamizi wako aliafikiana na matumizi ya hii teknolojia?

Uwezo wa miongozo ya simu kwenye huduma ya Afya (<dakika 18; jumla ya muda uliopita <dakika 42)

21. Unadhani miongozo ya simu kwenye huduma ya Afya zitaweza kupunguza tatizo la upungufu wa watumishi wa afya kitaifa?

22. Unafikiri kutumia miongozo ya simu za mkono kwenye vituo vya afya kutaboresha matokeo ya huduma za wagonjwa? Je, udhani imeboresha matokeo ya huduma ya wagonjwa uliyowahudumia?

23. Unafikiri matumizi ya simu kwenye huduma ya afya yanaumuhimu kwa wahudumu wa afya, manesi au madaktari?

24. Ungependa programu/miongozo gani zitengenezwe ili kuboresha huduma ya afya?

Utumiaji endelevu (< 20 minutes; total time elapsed: <60 minutes)

25. Kwa kukisia, ni mara ngapi ilitokea ulipenda kutumia miongozo ya simu lakini hukuweza kutumia kwa sababu moja au nyingine? Sababu gani zilikufanya usitumie?

26. Endapo huduma ya matumizi ya simu mradi wake ulikwisha, je uliendelea kutumia miongozo hii ya simu kwa kipindi gani baada ya mradi kwisha? Kama uliacha kutumia simu kwanini?

27. Je ulipata msaada wa kitalaamu wa kutosha juu ya teknologia wakati ulipotumia huduma hii ya simu?

28. Je unadhani nini kifanyike ilikuwawezesha watumishi waweze kutumia miongozo hii ya simu kwenye huduma wanazotoa?

29. Je unafikiri kama watumiaji watatunukiwa vyeti vya utambulisho wa watumiaji wa miongozo ya simu, inaweza kuwatia moyo?

30. Je unadhani kutuma ujumbe mfupi wa maandishi wa kuwasaidia na kuwashukuru unaweza kuwatia moyo watumishi?

31. Je, unafikiri kuna siku moja ambapo miongozo hii ya simu itatumika na kila mtumishi wa afya anayetoa huduma za afya nchini kuwa sehemu ya huduma ya kawaida? Kwa nini unafikiri itakuwa ndivyo au kwanini hudhani kama itakuwa hivyo?

32. Hilo limekuwa swali letu la mwisho. Kwa kuhitimisha, kama una mawazo mengine unaweza kueleza katika hili.

Appendix 5: Impressions Submitted to D-Tree Staff

Greg Haman

September 9, 2012

Perceptions of Tanzanian Health Care Workers Towards the Use of Mobile Phone Clinical Applications: Preliminary Impressions

From July- August 2012 I interviewed a total of 42 health care workers (nurses, community health workers, and supervisors) in Dar Es Salaam, Pwani, and Zanzibar gathering over 26 hours of recorded data on behalf of D-tree International. We are in the process of transcribing and translating 31 of these interviews (Dar Es Salaam and Pwani) and intend to conduct further analysis on the transcripts.   Though a systematic analysis is forthcoming, having conducted these interviews myself, my impressions of health care worker perceptions may be of value in the interim. Below I have outlined these impressions. Sincerest thanks to all D-tree staff who were indispensable in selecting key informants, arranging transportation to interview sites, and securing permission for the project. Without their work these interviews would not have been possible.

1. **Initial training was well done, well understood, and adequately staffed. Many workers expressed that they would have liked to have training for a longer period of time.**   Training provided across D-tree projects seemed to vary from short time periods of on the job/ in station training to full-time weeklong training. It seemed that regardless of the amount of training, most workers highlighted more initial training as the single most important thing that they would have changed about training.

2. **Most health care workers did not own and had not used smart phones before the project.** Most had owned and used conventional (nokia) phones.

3. **Health care workers were initially eager to participate and optimistic about the potential for mobile phone use in health care.** Some expressed apprehension about learning a new technology as well but stated that these feelings generally abated as training went on.

4. **Desire for "refresher" training is widespread.** Health care workers, even when interviewed in Swahili, often used this English term to describe a desire for ongoing training. From the prevalence of this desire, I assume the idea is common but am not sure why so many workers use the same term (in English) to articulate this need. The justification for "refresher" training was expressed in various terms. Some generally felt that 'technology evolves, so should we.' Others pointed out that when applications are altered or updated significantly, a corresponding refresher should be held. Others wanted further training to deepen their ability (technical skills) or understanding (clinical justification for various questions in the protocols). Others saw the refresher as a reward, an opportunity to be recognized publicly for their hard work. Others saw it as an opportunity to communicate with others at distant sites, exchange ideas, and thereby grow in their ability to use the applications. At least one suggested that clinical data could be compared between multiple sites and that friendly competition with rewards could foster camaraderie and also provide additional motivation.

5. **Several healthcare workers expressed a desire to be taught simple steps to fix common technical problems.** Several health care workers were frustrated when they were unable to use their phones (send data, etc.) for weeks and d-tree staff were able to fix the problem in minutes or less. They saw that in some cases the problem was easily fixed by adjusting settings via menu navigation, and wished that this 'troubleshooting' training had been included in their initial training. The workers wished that they had been taught or provided with resources explaining such simple steps to fix such common problems so that they were not dependent on d-tree staff coming to visit them.

6. **Some users are already familiar with smart phones or very quick in their adoption ('super-users')**. Several community health workers expressed going to their peers for assistance with problems and only when this failed did they approach d-tree staff (because of the time required for d-tree to make it to their site). There were leaders who were chosen among community health workers to supervise, but it was unclear to me if the super-users described above were recognized during training or utilized in other ways. One might imagine specialized, parallel, or additional training that might be provided to these individuals to enable them to further help their peers in the field to diminish the reliance on d-tree staff coming to their site to themselves fix problems.

7. **Most health care workers felt comfortable using the phones within a week up to a few months of starting the project.** I only interviewed one worker who felt that regardless of any amount of training she would be unable to use the phone. This worker expressed that he/she felt too old for such technology. He/she went through training twice but still felt utterly unable to make use of the phone. Such non-participation merits careful consideration, especially at small health centers where very few workers are employed, refusal/inability of one worker to participate can have significant effects.

Health centers with a low volume of qualifiying patients (e.g. Zanzibar malnutrition) merit special consideration. At locations where 1-2 malnourished children are seen per week, when 3-4 workers are trained on an application, this mean that sometimes months will pass without a particular worker using the protocol. As the problem of malnourished children improves on Zanzibar, this will increasingly become an issue and it might be better to have only one or two people using the application, as when a particular worker only uses this protocol once per month they can become unfamiliar with the protocol over time and "relearning" it each time will significantly lengthen the time spent using the application.

8. **Some health care workers seemed unclear about duration of their current mobile phone project.** There seemed to be a lack of certainty about if or when the

mobile phone usage would end. At least one interviewee mentioned that contracts were signed at the start of the project describing that if the phone was lost or stolen, employees would need to purchase a replacement from their own money. It was unclear if such contracts were used in all projects, but this might well represent a best practice. The contracts might not even need to focus on length of time of the project, but might focus on the phone e.g. how often voucher will be replaced, whether the phone can be used for private use or also for personal use, what will become of the phone at the end of the project, and what will become of the phones if the project ceases.

9. **Most health care workers seemed unclear about what would become of the phones if the project ended.** Even in cases where health care workers did not articulate a desire to own the phone following completion of the project, several expressed a desire to *know* what would become of the phones. Would it be their personal property? This lack of clarity created a tension within health care workers, some of whom were carrying the phone at all times and effectively using it as a personal communication device. As the health workers become increasingly familiar with the phones, their loss (at the potential cessation of a project) comes to represent a significant loss to them. This might correlate with an increasing incidence of 'lost' or 'stolen' phones. One idea to address this problem is that for community health workers, a contract might state: You will use this phone for X years at which point the phone will be yours if you have not lost it and it has not been stolen. At this time you may be given a new phone to continue your work and the old one is yours to keep.

10. **Security of phones is a pressing concern.** Community health workers had their phones stolen and this was a significant event, sometimes even emotional, and costly for them as they needed to buy a new phone with their money to continue the work. If contracts as outlined above were provided for employees, they would know that at the end of 4 years they would get a new model at least rather than using their own phone inevitably.

11. **Phones at the health centers, even if checked out in someone's name, are informally used by many.** This results in difficulty ascertaining who is draining the voucher for personal calls, etc. Can such calls not be prevented? Keeping the phones locked at the health center often meant only one person had the key. If this person was away, the phones were not used. An improvement (with its own financial consequences) strongly suggested by some (including one health center worker who was the "key keeper" to his center's stock of phones) was to have each trained worker receive their own phone. Other workers, however, expressed their desire to keep the phones at their place of work. They pointed out that at some point in training they were told that if they lost the phones, they would be financially responsible. Thus they viewed taking the phones home as a great risk given their high expense (a month's salary or more) and that they felt they would be held responsible and were unsure how they would be made to pay if they lost the phone. Thus losing a phone could be financially catastrophic to themselves and their family. This fear even led to decreased use in the clinic as workers felt that there was limited pressure on them to use the phones, the phones did not bring them any benefit, but might bring them significant harm ('what if I lose the phone at the clinic? What if it gets stolen when I am up from my desk? I will need to pay for that!) Thus the security issues and responsibility for phones is an ongoing issue both for CHWs and at clinics.

12. **Community Health Workers expressed broad support for the phones**. Reasons included reducing stigma (rather than carrying folders and papers and arousing curiosity, they were able to appear to passerbys as though using the phone for personal communication when conducting interviews), leaving a permanent record (papers can be lost, stolen, destroyed, etc), having an external authority (community health workers expressed that they would often show the patients the advice from the phone after their interview and occasionally allow them to look on as they entered information from the interview. For instance, a patient might appear reluctant to travel for a referral but the CHW would then show them the phone and

say "Yes, it is not just me as me giving you this advice, but look here. This program made by these 'white people' says you need to go too."   Many of them specifically appreciated the "mtiririko" or "flow" of questions.

13. **Nurses and workers at health centers were more complex in their evaluation of the applications, and likely to express both the advantages and disadvantages of use.** The feeling that the phone would improve clinical outcomes for the patient being interviewed was widely held. However, there was skepticism about whether (due to a longer interview than without the phone) the phone could be used for all patients. Some thought it was unrealistic to use the phone to evaluate all patients given this increase in time required. One health care worker told me that the patients who are in the interview room love it because they feel they are getting great care, but that those on the other side of the door (whom they could hear at the same time they were interviewing the patient) were complaining loudly about how slow the service was. So the patients hate it until they get into the exam room, where they love it. I thought this was an illustrative mental image of the conflicting demands these workers face. This might also partially explain why community health workers are less nuanced in their support for mobile phones: they may feel less necessity to see a given number of patients given their volunteer status, and thus the increase in time required for each interview is not as acutely noted.

14. **Perhaps the most common technical problem was failure to sync.** In some cases this was due to lack of voucher, in others network problems, in others software problems. I am not a technical expert but one idea arose here. It seemed that community health care workers try to sync after seeing every patient. If they are unable to sync, they stop until syncing goes through. This seemed to me unwarranted in most cases, particularly in cases of network failure. I thought they could just continue seeing patients until the network strengthened or came back rather than become so fixated on syncing that they stop using the phone. Perhaps if

the sync issue is just with network availability, a message could inform the user to continue seeing patients until network again became available.

15. **Community health care workers are "volunteer" and in fact do significant work that deserves to be compensated. Even if this is not the realm of d-tree, their satisfaction might be improved with some simple, low cost interventions that d-tree might advocate for.** Ideas suggested in interviews included user ID cards so that community health care workers could identify themselves to villagers as well as to health care professionals at care facilities when they are following up on admitted patients, t-shirts so that they can be recognized in their community for their contribution. In addition to advocating for particular types of compensation, d-tree might influence types of compensation that are inappropriate. An example that came through in interviews is an organization working in partnership with d-tree that offered bicycles to CHWs. The bicycles were foreign and local repair was not possible. Within a year almost all of these bicylces were rendered unusable. Though not a fault of d-tree, complaints about these bicycles were pervasive among those who were provided with them and, as many workers did not clearly distinguish between d-tree and the partner organization, this choice reflected poorly on d-tree.

16. **The maternal program on Zanzibar was most unequivocally and exuberantly supported by users. The uncertainty surrounding its continuation (given the cessation in registering new mothers) was a source of frustration and regret.** The workers involved felt powerless to continue a program that they believed was undoubtedly successful. Opening lines of communication between d-tree office and these workers to make clear that funds are actively being sought, conditional approval has been made, etc. would help prevent the idea that forms when such obstacles are encountered: that mobile phone application use is transient and subject to the whims of grant cycles of pre-determined length.

17. **D-tree has a vision for widespread mobile phone use in clinics that most health care workers see as very abstract or do not articulate.** When considering the possibility that mobile phones would be used by all health care workers in Tanzania, most respondents took this as a very hypothetical question. I make this point to highlight a disconnect that I believe is important and also possible to remedy in upscaling. Most health care workers were unaware that mobile phone applications outside of the application they were trained on were being used in Tanzania. Several times when I asked health care workers "what additional application would you like to see developed" they mentioned an application that was already developed by d-tree and in use in Tanzania! I think that one way to remedy this is to make workers feel like they are a part of a bigger program, a d-tree family if you will. This might include a map during the introduction session that includes the geographic location of current d-tree projects, the number of staff trained, and the various protocols that are in operation. D-tree has numerous projects and these ought to be doing more work to its advantage at the level of the individual health care worker. This will also help to overcome the "why me, why do I need to learn this when I am not getting additional pay" reaction that can occur in the adoption of new technologies.

18. **Satisfaction with D-tree staff was high.** In almost all cases d-tree staff were able to solve technical, hardware and software problems. In cases where they were unable, a new phone was provided. Sometimes, however, this process was time consuming and took several weeks due to infrequent visits to sites.

19. **Individual health care workers are not benefiting from advances in data collection and analysis by receiving personalized feedback.** Despite representing a tremendous advance in ease of data collection and analysis, this progress has not yet trickled down to health workers who seem to get no more feedback than the previous paper based method of documentation. Allowing users to view their own progress based on certain established goals or the contribution of their health center to regional or national health goals will increase the personal

stake that these workers take in their performance and allow them to appreciate the significance of their work.

20. **Performance based compensation for application use has tremendous potential.** One person who I interviewed was so blunt when I asked how we should encourage use as to answer with one word "money". Though d-tree does not want to link the adoption of this technology to ongoing financial compensation, performance based compensation is increasingly recognized as an effective tool, both in the US and Tanzania where I am told performance based compensation is being implemented on a national scale. Performance based compensation need not be a "we give you money for your work" deal, but might has many iterations. The possibility should be considered that even miniscule amounts, redistributed from other fixed costs, might be for the best of the program. I would encourage exploring possibilities in this realm. Certificates of recognition were recognized by many as rewards for good work. Messages of support less so but most still agreed they were an improvement over nothing.

21. **GPS monitoring might be used to accurately compensate CHWs or patients (maternal program) for travel expenses incurred, as well as insure that CHWs are going to visit the patients who they say they are.**