

Mobile Graphic-Based Communication: Investigating Reminder Notifications to Support Tuberculosis Treatment in Africa

Haji Ali Haji, Hussein Suleman, and Ulrike Rivett

University of Cape Town, 7701 Rondebosch, South Africa
hajiali10@hotmail.com, hussein@cs.uct.ac.za,
ulrike.rivett@uct.ac.za
<http://www.uct.ac.za>

Abstract. Visual communication is a method of communication using visual elements, which is suggested to be more effective than text or voice, and has the additional advantage that it, can also be used by who are unable to read. In this paper, the findings of a user requirements study, which was conducted at MnaziMmoja Hospital in Zanzibar, are presented. In a cross-sectional study, twenty nine people including TB patients and TB Health care workers were interviewed. The findings show that participants agreed that the use of mobile graphic-based communications could support TB patients in their treatment. The contribution of this work is the process to investigate and develop a new mobile graphic-based application for push notification services that are literacy-level and language agnostic.

Keywords: visual communication, mobile graphic-based, tuberculosis.

1 Introduction

The rapid adoption of mobile technology in developing countries has provided new avenue to reach and improve the level of care for the under-served, at-risk populations with infectious diseases such as Human Immunodeficiency Virus (HIV) or Tuberculosis (TB).

According to the World Health Organization (WHO) [1], almost nine million infections of TB occurred in 2011, and more than one million people die every year from this disease. Sub-Saharan Africa carries the greatest proportion of new cases, with over 260 cases per 100 000 people in 2011 [1]. The majority of patients fail to take their medication at the appropriate time. As a result, the recovery rates increase, resistant strains develop and medication success is reduced.

The standard approach to treating TB is by Direct Observed Therapy Short-course (DOTs), an intervention where the patient is observed by another person taking medication in order to ensure adherence. A full recovery from TB is only possible if patients strictly follow the prescribed medication regime for a minimum period of six months. Patients are required to take between three and five tablets daily for seven days per week [1,2].

The DOTs generally requires healthcare workers to remind and observe patients a time of taking their daily TB medication. This process necessitates adequate human labour that is a challenge in developing countries [2]. The technology-assisted DOTs seek to reach more patients at a lower cost through automated reminders via mobile phones. The process needs a few human labour and cost less.

Mobile phones have become very popular and affordable. The number of mobile phones reached almost six billion in the world by the end of 2012. Of that, more than 86% of the 660 million new mobile cellular subscribers were from developing countries [3]. Additionally, most mobile phones today have advanced applications. Multimedia Message Services (MMS) are a standard telephone message system, allowing the sending and receiving of multimedia objects (image, audio and video) [4].

In recent years, the use of cell phones for medical care has increased rapidly. Short Message Service (SMS) and telephone calls are the most common mobile interventions currently used in medical reminder applications. Various studies indicate how SMS text messages [5,6] and telephone calls [7,8] encourage patients to follow their treatment as scheduled. There is potential for mobile technology to help people to reduce missed medications and appointments [9,10].

Different mobile reminder methods; including SMS text message and telephone call have been proposed, as approaches have limited use by some people. Compared to voice call the text message has potential, but only for literate people. Voices call reminder system faced by language barrier. It also requires good network connection during implementation, as shown in the research conducted by Chen et al [11].

The aim of this paper is to present the findings obtained during the user requirements study. Several reminder notifications were suggested by participants and these will be used in the development of the mobile graphic-based application. Based on the findings, people can better understand pictures better than text [12]. Picture languages enable people who speak different languages from different countries to understand one another.

2 Related Works

2.1 Mobile Healthcare Systems

Mobile health, or mHealth, refers to the use of mobile devices, such as phones, to support the practice of medicine and public health. It is a rapidly-growing field with potential for frequent use of mobile phones for healthcare services [13].

The growing field of mHealth in low-income regions has seen an increasing number of projects targeting patients, such as those with TB. The advantages of mobile reminder systems are indicated in the research of Okuboyeyo et al [14] and Lester et al [15]. In their studies found that mobile phone reminder applications are more effective at reducing missed medication than manual reminder systems, or no reminders at all, among a wide range of patients. The two mobile interventions that have been recently used for reminders: SMS text messages and telephone calls.

2.2 SMS Text Messages

Studies carried out by Akhter et al [16] and Barclay [17] focused on text message reminders system that encourage patients to take their medication regularly. The

studies reported that mobile reminders were most helpful to reduce the number of missed medications, compared to the manual reminder systems. SMSs can be sent a few minutes before the medication time to remind patients to take their tablets at the right time.

Text messaging can also be used to remind patients of clinic appointment times. SMSs could be forwarded to a patient's phone 24 hours prior to the appointment day and also a few minutes before the appointment time [18]. This can help patients to attend the clinic more regularly for medical consultations. However, the problem of the language barrier is a major challenge, as addressed in the study of Prasad and Anand [18].

Moreover, text messaging systems are used as a "store and forward" communication technique. It is more preferable in the areas where network connections are unstable [19]. The "store and forward" helps to store the messages if the recipient's cell phone is not available and forward it as soon as the phone becomes reachable [20]. The concept of "store and forward" will be considered in this study.

Although text messages have potential in helping patients to take their medication and keep appointment times more effectively, the problems of language and literacy barriers are still challenges facing that intervention, especially in the rural areas of developing nations [13],[18].

2.3 Telephone Calls

Research conducted by Parikh et al [21] and Hanauer et al [22] indicated how telephone call reminder methods encouraged patients to follow their medication regimes. Parikh et al [21] investigated the effectiveness of telephone reminders to out-patients. Their study showed positive results for those patients who were receiving the calls.

However, telephone call communication is real-time. The approach requires good network coverage and high management costs [20], and this is challenging in the majority of developing nations. Chen et al [11] indicated that during their study the majority of reminder calls were not delivered, due to the unavailability of the recipients' phones.

In this study several multimedia picture-based applications will be developed. The approach is to push graphic reminders that are literacy-level and language-agnostic. Unlike text or voice, images do not lead to language and literacy barriers. Therefore, it is hoped that the use of pictures in mobile reminder systems will be helpful to encourage the patients to aware to their treatment regimes.

Images have become a more powerful way of communication than writing [12]. Use of images in medical diagnosis has been rapidly increasing with positive resources [23, 24].

Pictures and other visualizations are the only media that connect people from different areas in the world, who speak different languages, regardless of their age or literacy levels [25,26,27].

3 Materials and Methods

Participatory action research (PAR) is used as the core research method. PAR consists of two aspects:

- **Action:** Research should be more than just finding out; research should also involve an action component that seeks to engender positive change.
- **Participation:** Research is a participatory process that requires the equal and collaborative involvement of the ‘community of research interest’ [28].

This method is useful as the development process for the study is expected to be cyclic. The strategy is to involve the target users as co-researchers; the PAR accommodates user-centred design [29].

Data for this study was collected through a survey. This enables the researcher to collect first-hand information on users’ preferences and identify the required solution.

In-depth interviews were conducted to understand the key issues. Both TB health workers and TB patients were interviewed semi-structured. Face-to-face interviews were carried out in group and individually.

The user requirements study was conducted in Zanzibar from July to August 2013, in the department of infectious disease at MnaziMmoja Hospital.

4 Results and Discussion

4.1 Outline of User Requirements

A user requirements study aimed to identify the challenges that face TB health workers and patients during treatment. It also aimed to identify the reminder notifications to use in the application. Furthermore, the study aimed to find out the number of people who were infected with TB and rate of transmission and how those who infected are treated.

Twenty nine people participated in the data collections process including TB patients, TB health workers, TB coordinator, TB pharmacist, TB data manager and TB patient’s supporter. The interview sessions were conducted in groups and individually. Interviewed patients were both inpatients and home-based care patients.

Table 1. Outline of interview sessions

Session No.	Type	No. of Participants	Participants Status
1	Group	5	4 Health workers and 1 TB coordinator
2	Group	5	Health workers
3	Individual	1	Pharmacist
4	Individual	1	Data manager
5	Group	2	Patients
6	Individual	1	Patient
7	Group	3	Patients
8	Individual	1	Patient’s supporter
9	Group	4	Patients
10	Individual	1	Patient
11	Group	2	Patients
12	Group	3	Health workers

A total of twelve sessions were conducted, including: seven groups and five individual sessions, as shown in Table 1 below. Each session lasted for 30 to 45 minutes. The researcher was assisted by the health worker in each patient's interview session. This was to ensure that the conversations were done in a safe environment for the researcher and patients.

4.2 Participants' Demographic Information

Figure 1 below shows the gender of participants who participated in the user requirement study, where 17 of participants (59%) were females compared to 12 (41%) of whom were males. Participants were categorised into six different statuses. There were twelve health providers, thirteen patients, one coordinator, one data manager, one pharmacist and one patient's supporter, as shown in Figure 1 below.

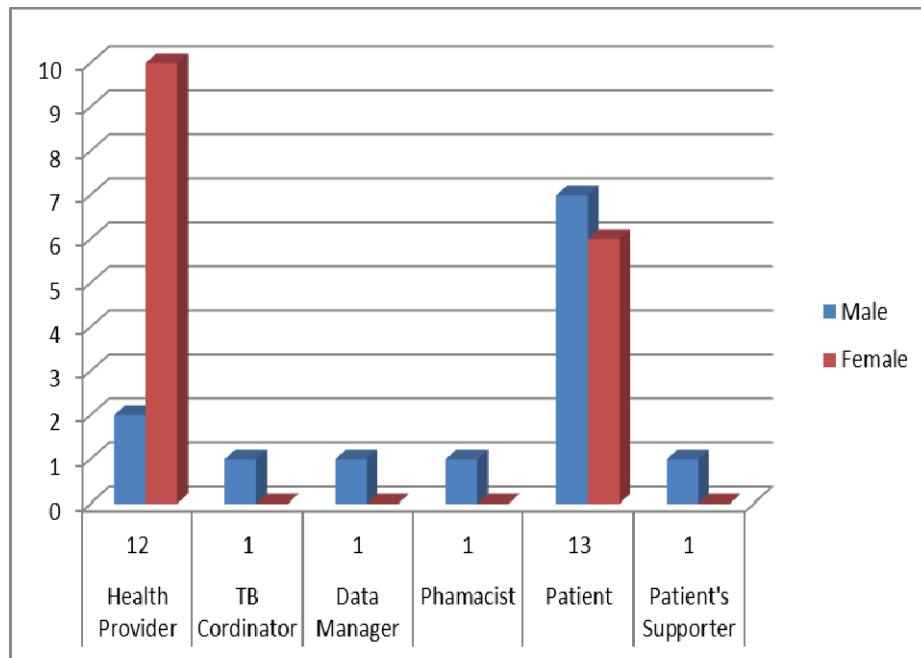


Fig. 1. Participants' demographic information

It was found that all interviewed participants had mobile phones. This shows that the majority of target users have mobile phones that could support them for accessing the proposed mobile application. Furthermore, participants were asked about their awareness regarding the use of mobile phones for health care service ("Do you think the mobile phone can support you in your treatment?") It was found that all participants (100%) agreed the use of phones for healthcare services. Furthermore, interviewed patients were illiterate and semi-literate. They were excited as the idea of the use of pictures as reminders.

4.3 Collected Reminder Notifications

The researcher was able to identify the challenges that face the TB health workers and patients during their treatment. Such challenges include poor infrastructure, unsafe working environments, insufficient working instruments and lack of financial support. It was also found that patients did not frequently attend the clinic for consultations due to several reasons, such as unaffordable transport cost and little knowledge of the TB disease. All patients believed that the use of mobile phones could help them to follow the medication procedures as prescribed.

Participants proposed various types of reminder notifications that may be used in the tuberculosis treatment, as indicated in Table 2 below. This assisted the researcher to develop the graphic-reminder notifications using professional graphic design software. The graphic-reminder will be used to remind the patient of the medication or appointment process. The concept of this system is to push graphic-reminder notifications so that TB patients can receive medication or appointment reminders at specific times as suggested by a health care professional. The intention is to develop an application that will accessible to any type of mobile phone that supports multimedia. The first experiment is about a cross platform application that could be insured on different smartphones.

Table 2. Collected reminder notifications

S/N	Reminder item
1	Please take your medication
2	Please visit the hospital for consultation
3	You are required to send your sputum smear for checking
4	You are required to collect your medication at the hospital for upcoming days
5	Different consultation and reminders regarding disease care: do this, don't do that
6	If you see "this" sign please visit clinic or see a doctor as soon as possible
7	Meal suggestions. That is: You are advised to get vegetables from time to time, take a glass of milk, etc

The study also confirmed, as found in the literature review, that patients failed to follow the medication procedures as recommended by health workers. This hampers the effective treatment of the patients for the prescribed period. All participants supported the idea that the proposed mobile picture-based communication can help them to follow the medication regimes.

5 Conclusion

Currently, the use of mobile graphic-based communication to support TB treatment and other infectious diseases such as HIV is a new area, particularly in Africa. The preliminary findings show that people support the use of a mobile picture-based application.

Picture communication will enable every person to easily understand the meaning, unlike text. It is expected that the findings of the study will help TB patients to follow the treatment regimes. The next phase of the study is to develop the collected

text-based reminder notifications into graphic-reminder. After that the mobile graphics-based application will be developed and evaluated.

Acknowledgement. I would like to express my gratitude to the Hasso Plattner Institut (HPI) for funding me in my study. I would also like to express my thanks to Mr. Khamis Abubakar and Ms. Rahma Ali for their support during data collection. And all people who participated in the interview.

References

1. WHO. Global Tuberculosis Report 2012 (2002), http://www.who.int/tb/publications/global_report/en/
2. Gordon, A.L., Nigro, C.C.M., Poling, P.C.: UC Berkeley: Technology Assisted DOTs (2008), <http://groups.ischool.berkeley.edu/Technology%20Assisted%20DOTs>
3. ITU Statistical, International Telecommunication Limited: Key statistical highlights (2012), http://www.itu.int/ITU-D/ict/2011%20Statistical%20highlights_June_2012
4. ITU. Making mobile phones and services accessible for persons with disabilities, A joint report of ITU – The International Telecommunication Union and G3ICT – The global initiative for inclusive ICTs (2012), http://www.itu.int/ITU-D/sis/PwDs/Documents/Mobile_Report.pdf
5. Pop-Eleches, C., Thirumurthy, H., Habyarimana, J., Graff Zivin, J., Goldstein, M., de Walque, D., Bangsberg, D.: Mobile Phone Technologies Improve Adherence to Antiretroviral Treatment in Resource-Limited Settings: A Randomized Controlled Trial of Text Message Reminders. *Aids* 25, 825–834 (2011)
6. Mohammed, S., Siddiqi, O., Ali, O., Habib, A., Haqqi, F., Kausar, M., Khan, A.J.: User engagement with and attitudes towards an interactive SMS reminder system for patients with tuberculosis. *Journal of Telemedicine and Telecare* 18(7), 404–408 (2012)
7. Piette, J.D., Weinberger, M., McPhee, S.J.: The effect of automated calls with telephone nurse follow-up on patient-centered outcomes of diabetes care: A randomized, controlled trial. *Medical Care* 38(2), 218–230 (2000)
8. Kunawararak, P., Pongpanich, S., Chantawong, S., Pokaew, P., Traisathit, P., Srithanaviboonchai, K., Plipat, T.: Tuberculosis treatment with mobile-phone medication reminders in northern Thailand. *Southeast Asian Journal of Tropical Medicine and Public Health* 42(6), 1444 (2011)
9. Roux, P., Kouanfack, C., Cohen, J., Marcellin, F., Boyer, S., Delaporte, E., Spire, B.: Adherence to antiretroviral treatment in HIV-positive patients in the Cameroon context: promoting the use of medication reminder methods. *JAIDS Journal of Acquired Immune Deficiency Syndromes* 43, S40–S43 (2011)
10. Mosen, D.M., Feldstein, A.C., Perrin, N., Rosales, A.G., Smith, D.H., Liles, E.G., Glasgow, R.E.: Automated telephone calls improved completion of fecal occult blood testing. *Medical Care* 48(7), 604–610 (2010)
11. Chen, Z.W., Fang, L.Z., Chen, L.Y., Dai, H.L.: Comparison of an SMS text messaging and phone reminder to improve attendance at a health promotion center: A randomized controlled trial. *Journal of Zhejiang University Science B* 9(1), 34–38 (2008)
12. Marsh, E.E., White, M.D.: Taxonomy of relationships between images and text. *Journal of Documentation* 59(6), 647–672 (2003)

13. Kaplan, W.A.: Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries? *Globalization and Health* 2, 9 (2006), doi:10.1186/1744-8603-2-9
14. Okuboyejo, S., Ikhu-Omoregbe, N.A., Mbarika, V.: A Framework for the Design of a Mobile-Based Alert System for Outpatient Adherence in Nigeria. *African Journal of Computing & ICT* 5(5), 151–158 (2012)
15. Lester, R.T., Ritvo, P., Mills, E.J., Kariri, A., Karanja, S., Chung, M.H., Plummer, F.A.: Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): A randomised trial. *The Lancet*. 376(9755), 1838–1845 (2010)
16. Akhter, K., Dockray, S., Simmons, D.: Exploring factors influencing non-attendance at the diabetes clinic and service improvement strategies from patients' perspectives. *Practical Diabetes* 29(3), 113–116 (2012)
17. Barclay, E.: Text messages could hasten tuberculosis drug compliance. *The Lancet*. 373(9657), 15–16 (2009)
18. Prasad, S., Anand, R.: Use of mobile telephone short message service as a reminder: the effect on patient attendance. *International Dental Journal* 62(1), 21–26 (2012)
19. Perron, N.J., Dao, M.D., Righini, N.C., Humair, J.P., Broers, B., Narring, F., Gaspoz, J.M.: Text-messaging versus telephone reminders to reduce missed appointments in an academic primary care clinic: A randomized controlled trial. *BMC Health Services Research* 13(1), 1–7 (2013)
20. Sidney, K., Antony, J., Rodrigues, R., Arumugam, K., Krishnamurthy, S., D'souza, G., Shet, A.: Supporting patient adherence to antiretroviral using mobile phone reminders: Patient responses from South India. *AIDS Care* 24(5), 612–617 (2012)
21. Parikh, A., Gupta, K., Wilson, A.C., Fields, K., Cosgrove, N.M., Kostis, J.B.: The effectiveness of outpatient appointment reminder systems in reducing no-show rates. *The American Journal of Medicine* 123(6), 542–548 (2010)
22. Hanauer, D.A., Wentzell, K., Laffel, N., Laffel, L.M.: Computerized Automated Reminder Diabetes System (CARDS): E-mail and SMS cell phone text messaging reminders to support diabetes management. *Diabetes Technology & Therapeutics* 11(2), 99–106 (2009)
23. Waran, V., Bahuri, N.F.A., Narayanan, V., Ganesan, D., Kadir, K.A.A.: Video clip transfer of radiological images using a mobile telephone in emergency neurosurgical consultations (3G Multi-Media Messaging Service). *British Journal of Neurosurgery* 26(2), 199–201 (2012)
24. Ohtsuka, M., Uchida, E., Nakajima, T., Yamaguchi, H., Takano, H., Komuro, I.: Transferring images via the wireless messaging network using camera phones shortens the time required to diagnose acute coronary syndrome. *Circulation Journal: Official Journal of the Japanese Circulation Society* 71(9), 1499 (2007)
25. Sipe, L.R.: Revisiting the Relationships Between Text and Pictures. *Children's Literature in Education* 43(1), 4–21 (2012)
26. Smith, K.L., Moriarty, S., Kenney, K., Barbatsis, G. (eds.): *Handbook of visual communication: Theory, Methods, and Media*. Routledge (2013)
27. Hyodo, K., Chihara, K., Yasumuro, Y., Imura, M., Manabe, Y., Masuda, Y., Naganawa, M.: Doctor-to-Patient communication by 2.5 G mobile phone; preliminary study. *International Congress Series*, vol. 1281, pp. 196–199. Elsevier (2005)
28. Walter, M.: Participatory action research. *Reason* 71 (1998)
29. Avison, D.E., Lau, F., Myers, M.D., Nielsen, P.A.: Action research. *Communications of the ACM* 42(1), 94–97 (1999)