

Feasibility, acceptability and challenges of phone reminder system implementation for tuberculosis pill refilling and medication in Northwest Ethiopia

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Abstract

Background: Mobile health (mHealth) technologies showed a promising effect on improving adherence to Tuberculosis (TB) treatment. However, its implementation was not well studied specifically in low-income settings. This study aimed to fill this evidence gap by exploring the feasibility, acceptability and challenges of phone-based TB medication and pill refilling reminder system implementation during continuation phase.

Methods: The study used phenomenological study design to explore participants' lived experiences on feasibility, acceptability and implementation challenges of the reminder system. This study was part of the Randomised Controlled Trial (RCT) that deployed the reminder system in Northwest Ethiopia. We purposively selected 15 TB patients from eight districts in Central Gondar Zone and Gondar Town Administration who were enrolled in the interventional group of the RCT. The study was guided by the simplified Consolidated Framework for Implementation Research (CFIR). Data was collected using an in-depth interview and also captured events by observation throughout the intervention period. Message delivery reports generated from Ethio-telecom database. Interpretation and analysis were conducted using thematic analysis.

Results: This study has shown that the local telecommunication infrastructure has supported the deployment of the new intervention and more than eight of ten reminder messages were delivered to the participants. All participants that received the reminder messages replied as the system was useful and many of them suggested for wider scale-up. We identified challenges related to the inner and outer setting, implementation process and characteristics of the intervention.

Conclusion: Phone-based reminder systems could have promising feasibility and acceptability to support TB treatment and care in low-income settings with modifiable challenges throughout the implementation process. More implementation science studies are required to improve its effectiveness in more complex contexts.

Background

Non-adherence to TB treatment has remained a global challenge. Patients' failure to optimally adhere to TB treatment results in drug resistance, relapse and death [1, 2]. Unlike to intensive phase, patients in continuation phase were supposed to take their daily pills at their home under the follow-up of treatment supporters including family members and community health workers [3]. In Ethiopia, non-adherence to TB treatment was a major challenge and gets worsen during continuation phase as compared to intensive phase. [3-8]. Evidences indicated that forgetfulness, poor communication and relationship between patients and care providers were found to hinder patients' adherence to TB treatment [9-11]. As part of the solution, digital health technologies were found helpful for resource-limited countries to overcome barriers against access and quality of health care delivery [12-15]. The world health organization has also initiated digital health including mHealth systems to improve TB prevention and care [16].

A Mobile phone-based reminder system is one of the promising solutions that can potentially improve patient engagements and adherence to treatments including TB medication [17-21]. Via phone communication, patients can be motivated to adhere to the treatment course and their doubts can be cleared [22]. Text messages were often used for sending reminders [23-27], health-tips and other educational messages [2,3], and for maintaining users' awareness of their health goals [20]. Audio messages could be used for transferring messages to support TB treatment [28].

In Africa including Ethiopia, mobile cellular penetration has grown and is estimated to grow more than ever and other regions of the world [29, 30]. Despite the improved access of mobile phones and promising effect mHealth to improve the quality of health care in resource-limited countries, mHealth technologies were still underutilized [15, 31]. Previous evidences showed that phone reminder systems were feasible and acceptable [23, 32]. Feasibility, acceptability and implementation related challenges are context-dependent in which, digital literacy, access to mobile network and power infrastructures, culture and many other factors could influence usability of the digital technologies. Scale-up the new mHealth systems into wider contexts often require quality evidences on its feasibility, acceptability and challenges related to its implementation. Therefore, this study aimed to explore TB patients' acceptance and implementation challenges of mobile phone-based daily medication and weekly pill refilling reminder systems during continuation treatment phase. The findings of the study could minimize wastage of resources and could help for effective deployment of the system.

Methods

Study design and setting

We implemented a phenomenological study design to explore lived experiences and perceptions of TB patients recruited in the randomised controlled trial [33]. The trial was implemented using a locally developed web-based reminder system [34]. The intervention was phone-based daily medication and weekly pill refilling reminder for TB patients in continuation treatment phase. The reminder messages involved a combined text and graphic messages. The graphic messages were aimed to engage patients who cannot read and write text messages. Before deployment of the system, we provided five minutes of hands-on training for illiterate participants aimed to familiarize them with the graphic messages. The training process includes: informing the purpose, showed how to operate the message. After, recruitment, the system sends a welcoming message for patients in intervention to improve their engagement. The actual implementation involves a daily medication and weekly pill refilling deployed for four months. Details of the intervention program was mentioned in the published protocol [33]. The study involved both health centres and hospitals in Central Gondar Zone and Gondar Town Administration, in Northwest Ethiopia. The study area consists of 74 functional public health facilities serving an estimated more than 2.9 million population.

Study population and sample size determination

The study included those TB patients who were enrolled in the intervention group of the RCT with established eligibility criteria, including those who started continuation phase, aged > 18 years; own mobile phone, willing and able to provide informed consent were selected for the randomised controlled trial. We selected a total of 15 patients all from different health facilities (health centres and hospitals). Patients were purposively selected from eight districts including Gondar Zuria, Tach-armachio, Wogera, East Dembia, Alefa, West Dembia, Chilga, and Takusa besides Gondar town administration. We also generated individual phone message delivery reports of all study participants recruited in the intervention group of RCT from Ethio-telecom database.

Data collection tools and procedure

The study was guided by the simplified Consolidated Framework for Implementation Research (CFIR) to explore feasibility, acceptability and challenges related to implementation of the intervention [35-37]. The CFIR has five domains and consists of 39 constructs. The framework can be flexible based on the context and specific area of inquiry. This study used a simplified form of CFIR with selected items under each domains [35-37]. We developed a matrix (Table 1) on study themes (feasibility, acceptability and implementation challenges) Vs CFIR domains and selected constructs used for exploring each of the study themes [37-39].

Table 1: A simplified CFIR to explore feasibility, acceptability and implementation challenges of phone-based TB reminder system

Themes	Domains and items				
	Intervention Characteristics	Outer setting	Inner settings	Individuals' characteristics	Process
System feasibility	Complexity, design quality and packaging of the intervention	External policy	Network, communication and compatibility	Individuals' capacity to execute the intervention	External agent (local Telecom's) engagement
System acceptability	Participant's perception on relative advantage	Cosmopolitanism	Perception on its importance	Individuals' willingness and satisfaction to execute the intervention	Local Telecom's willingness and cooperation
Implementation challenges	Responsibility to cover cost of intervention	Barriers to meet patients' needs	Available resource for implementation of the intervention	Individuals' convenience to time of message delivery	external change agent

The source of data includes Ethio-telecom database, observation of the system implementation and key-informant interviews of participants enrolled in the RCT. The Ethio-telecom database was used to access the message delivery status to check feasibility of the outer setting infrastructure to support the intervention. We also followed and documented feasibility of the implementation process from the perspectives of the outer (cosmopolitanism/interconnectedness, external policy) and inner setting (network, communication and compatibility or fit of meaning & values) of the intervention. Additionally, to explore feasibility of the intervention, we interviewed key-informants about intervention characteristics in terms of the complexity, design quality and packaging of the intervention.

To explore acceptability of the intervention, we interviewed key-informants about intervention characteristics in terms of the complexity, design quality, packaging and participant's perception on relative advantage and cost of the intervention. In addition, we interviewed about individuals' characteristics including willingness, satisfaction and capacity to execute the intervention and also asked participants about inner settings including perception of its importance. Challenges related to implementation of the intervention were explored using all CFIR domains, see details in Table 1.

We officially requested and accessed message delivery messages from Ethio-telecom for all participants (n=152) involved in the RCT. During the implementation process, we used checklists to capture events throughout the implementation period. A semi-structured interview guide was employed in Amharic (national language) for the in-depth interview. The interview was held using phone-call due to the restriction of movement at initial stage of COVID19 pandemic from February 15 to March 24, 2020. The data collection tool has been attached as a supplementary file (Additional file 1).

Data management and analysis

We transcribed and translated the audio data and events captured during the implementation period and familiarized with the transcript before analysis. Codes were selected deductively and inductively as emerged out of the data then categorized into the themes. We used OpenCode 4.02 software for data management. Information saturation and completeness of data were checked for each theme. Interpretation and analysis were conducted using thematic analysis. We reported quotes to represent the participants' shared perceptions. The proportion of messages delivered to the participants was calculated using the number of delivered messages divided by the total number of messages sent out to all eligible participants in the RCT. The proportion of message delivery then triangulated with the in-depth interview data and observed events during implementation of the system.

Results

Characteristics of study participants

In this study, fifteen eligible participants responded to the interview. The age of the participants ranged from 21 to 45 years. Among study participants, nine were males and six were females. Six of them were urban and nine of them were residents. Two participants were attending their treatment at hospitals and thirteen at the health centres. Regarding educational status, twelve participants had a formal education of different levels and three participants with no education at all (Table 2).

Table 2: Socio-demographic characteristics of the study participants.

Participant's ID	Age	Sex	Educational level	Residence	Facility type
P01	22	M	Higher	Urban	Hospital
P02	34	M	Primary	Rural	Health centre
P03	42	F	No education	Rural	Health centre
P04	21	M	Secondary	Urban	Health centre
P05	36	F	Primary	Rural	Health centre
P06	43	F	No education	Rural	Health centre
P07	42	F	No education	Rural	Health centre
P08	41	M	Secondary	Rural	Health centre
P09	38	M	Primary	Rural	Health centre
P10	21	M	Secondary	Urban	Health centre
P11	20	M	Secondary	Urban	Health centre
P12	28	M	Secondary	Urban	Health centre
P13	37	F	Primary	Rural	Health centre
P14	32	M	Higher	Urban	Hospital
P15	45	F	Primary	Rural	Health centre

The study established three main themes including feasibility, acceptability and implementation challenges of mobile phone-based reminder systems for TB treatment support during continuation phase.

Feasibility of the reminder system

The local telecommunication (Ethio-telecom) corporation was willing, cooperative and their system was compatible to support the implementation of a phone-based medication reminder system. We also realized the engagement of participants who could not read text messages via the enclosure of graphic messages in the package and providing a five minutes hands-on training during enrolment individually to familiarize them with accessing and understanding the messages. The training process followed: informing the purpose, showed how to operate the messages. After enrolment, a welcoming messages were sent for patients in intervention group for testing and motivating patient's engagement before commencement of actual reminder messaging.

Overall, from the total expected reminder messages sent out to the participants, 84.6% of them were delivered to the participants. The report from the local telecom database indicated that 4 of 152 participants did not receive reminder messages at all. Regarding access to reminder messages, the

majority of the participants received both daily and weekly reminder messages almost every day for the four months of continuation phase. One of the participants responded to the question “how frequently received the reminder messages?” that:

“I received the medication reminder message almost every day and every week for the refilling..., P15, Female TB patient

On the other hand, few participants reported inconsistent delivery of the reminder messages.

“...last week, I received all messages continuously, but this week, I received only two messages...” P04, Male TB patient

All who received the reminder messages replied that they can easily open and see the messages. All participants differentiated and understood the daily medication and weekly pill refilling reminders.

Another participant replied to the question “how easy to open and understand the messages?”

“... opening the message was not difficult for me, I sometimes opened and saw, but always see the notification without opening, and I realized that messages were all the same.” P05, Female TB patient

Acceptability of the reminder system

All participants that received the reminder messages replied as the system was useful and satisfied their expectations. Many of the participants suggested the system for wider scale-up. Some of the participants were texting and some calling back our system to acknowledge the reminder services providers, even though, we had informed them during enrolment into the intervention that the system was a one-way that had no display for incoming messages from the participants. The telecom generated call-details data also shown that many participants were texting back to our system, even if, we had informed them not required to SMS back to the system during participant enrolment. One of the participants replied to the question “how satisfied with the benefit of the reminder system?”:

“I [participant] was happy with the reminder messaging that had supported me a lot, sometimes I text back to you saying thank you...” P04, Male TB patient

Another participant was also added that:

“I frequently tried a phone call back to you [the reminder system’s number] but not working, I wanted to thank you for the support. I also wish others [other patients] to use the system.” P07, Female TB patient

One participant mentioned that the intervention package was not comprehensive enough to fully engage patients in their treatment. It focused only on reminding pills and suggested including other TB treatment-related components like nutritional, drug side effect and precaution, related Lab tests, awareness creation and motivational messages.

"The system was helpful..., but it [reminder system] was focused only on reminding pills. It would have been good, if you also include other related messages e.g. nutritional messages and others (could be drug side effect and precaution, related laboratory test, awareness about the disease and motivational messages)" P02, Male TB patient

We asked participants whether they were bored with reminder messages. All except one participant replied that the system was not boring.

"...it's like reminding to take your breakfast, I never bored of the reminder messages." P04, Male TB patient

On the other hand, one of the participants mentioned that receiving daily reminder messages for long period could create unpleasant moods in the patients.

"I agree with the benefit particularly for those who may forget their pills. I was also receiving the messages, but after a while, I feel bored and switched off the notification because I don't need it [reminder message]. I'm strict with my pills and my wife also supported me." P14, Male TB patient

Challenges related to implementation of the reminder system

Throughout the implementation of the new intervention, we identified major challenges like system interruption doubting fraud, cost of intervention, failure of message delivery and individual differences with convenient time of sending messages.

The reminder system was interrupted for four days in the middle of implementation doubting fraud during the national curfew related to political unrest. We investigated that the reminder system was suspected of fraud due to bulky messages sent out from a single subscriber. The problem was sorted out with official communications. The local telecom experts suggested corporate SIM cards than personal-subscribed lines to reduce risk of system interruption. One of the four participants who did not receive messages at all reported a technical problem (damage) of mobile devices as a reason for failure to receive messages. Failure of message delivery was also among the major challenges. Few reported that they had lack and/or fluctuating electric power and poor telecommunication network connections were not stable in the area.

"...last week, I received all messages, but this week, I received only two messages. Our electric power and mobile network was not stable, if that could be the possible reasons for missing your reminder messages" P04, Male TB patient

Regarding time of message delivery, many participants were convenient to receive the daily medication reminder message 30 minutes before 8:00 AM (conventional time of TB medication) and a day before the due date of clinic appointment for pill refilling. One participant responded to the question "How convenient with the time of delivery of reminder messages to take daily medication and weekly refilling pills on time?"

"I received the messages 30 minutes before taking my pills but the weekly reminder was not consistent with my scheduled date of appointment. Otherwise, the time for daily medication reminder and even the weekly reminder, if correctly scheduled [consistent with the actual date of appointment], both would be a convenient time for me and I guess appropriate for others too" P04, Male TB patient

However, a considerably large number of participants received the reminder message after taking pills. It indicates that this particular group of participants used to take their pills before 8:00 AM (the prescribed time of medication). One of those participants responded that:

"...messages often delivered late. Due to the nature of my work, I used to take my pills very early at 6 AM, however, the messages often delivered at 7:30 AM, however, I'm carefully following my pills and with full support from family." P11, Male TB patient

According to the current Ethio-telecom tariff, the cost of the intervention was 15.00 Ethiopian Birr equivalent (rate of exchange during implementation) to 0.43 USD to deliver 136 messages per individual patient to complete the four monthly continuation treatment phase. The TB treatment service has been nationally provided for free of charge.

Discussion

The local telecommunication system has supported the implementation of a phone-based medication reminder system. We also confirmed that more than eight of ten reminder messages were delivered to the participants. All participants that received the reminder messages replied as the system was useful and many of them suggested for wider scale-up. We identified major challenges related to implementation of the intervention.

This study realized that a mobile phone-based reminder system could be feasible in resource-limited settings within available infrastructure, technologies and level of literacy. Similar studies found that SMS intervention was feasible and user-friendly to support TB and HIV treatment [23, 40]. The study has shown that eight of ten messages sent from the centre were confirmed to be delivered to the patients. The delivery status was lower as compared to similar studies reported 92% in Lesotho [40] and 91% in Uganda [41]. The disparities could arise from variations in the national infrastructure and mobile network coverages among countries. Currently in Ethiopia, there is only one telecommunication corporation (Ethio-telecom) owned by the government that has shown the monopoly of the telecommunication service in the country could also be a challenge for accessing the alternative systems for quality and cost of the intervention [42]. The difference could also be due to a patient-reported delivery status in the study in Uganda could be overestimated than the actual data generated from Telecom Company in the current study.

The study has shown that a combined text and graphic reminder messages with modest hands-on training could address both educated and non-educated patients in one system. Previous studies suggested that graphic reminder systems were known to be more beneficial, cost-effective and accepted

for use by the majority of patients including those with limited education [43]. This is because graphic messages could easily be caught and understood, however, all graphic messages could not be compatible unless on smartphone. Simple graphic messages can still be designed and used in basic mobile apparatuses.

TB patients' acceptance was found to be promising on the reminder system for patient-centered treatment support, however, concerns were raised on the need to carefully design to reduce unsightly and message fatigue. Similar studies also identified that SMS-based mHealth intervention was acceptable for patients for TB as well as HIV treatment [23, 40, 44]. Interactive SMS reminders were a more appreciated method of supporting patients [40, 44]. Patients' acceptance of phone reminder systems could be emanated from the state of feeling cared for, motivation, improved engagement and feeling responsible for their treatment [23, 45]. In return, patients' acceptability towards mobile messaging could improve adherence to TB treatment [39].

Regarding implementation process, system interruption and failure of delivery of the reminder messages, variation in patient's preference to time of message delivery and managing cost of intervention were among the major challenges. System interruption happened centrally by telecom corporation due to doubting of fraud. Lack of power and/or fluctuating power and poor telecommunication network connections were possible causes for the inconsistency of message delivery. It's often unthinkable to implement the system without electric power and mobile network [34]. The collaboration between actors like health, telecommunication and energy sectors could play a key role in the effective implementation of the system.

Variation in patient's preference to time of delivery of the messages was also among the challenges. There was no universally convenient time for all patients to receive reminder messages, because, different patients prefer different time for taking their pills. However, the conventional time was 8:00 AM suggested by the care provider. Generally, it indicates the need for a tailored system that has calibrated on individual needs and convenience. The reminder messages, despite late delivery, still helpful to those who forgot their pills, as taking pills late is better than missing pills at all.

The cost of intervention was 15.00 Ethiopian Birr equivalent to 0.43 USD (current exchange rate) to receive 136 messages per individual patient to complete the four months of continuation treatment phase. To fully transfer the reminder system into routine services, it also requires establishing a system to waive the cost of the intervention as part of the treatment package or as separate support unit.

The findings of this study implies that digital health including phone-based reminder systems are now potential agendas for policymakers and programmers in resource-limited settings including Ethiopia. It's also implied that researchers are required to design more innovative intervention by types of messages like video, audio and hybrid of different message types and conduct implementation science studies to generate more evidences in the area.

Limitation of the study

Due to restriction of movement in the early COVID19 pandemic period, we shifted to deploy a phone-call interview that could potentially restrict the probing and body language responses that could have been benefited from face-to-face interview process. We tried to provide training with close supervision for data collectors to reduce its impact on quality of the data.

Conclusion

Phone-based reminder systems could have promising feasibility and acceptability to support TB treatment and care in low-income settings. System interruption and failure of delivery of the reminder messages, variation in patient's preference to time of message delivery and managing cost of intervention were among the major challenges. More implementation science studies are required to improve effectiveness of the new system in more complex contexts.

List Of Abbreviations

CFIR	Consolidated Framework for Implementation Research
mHealth	Mobile health
RCT	Randomised Controlled Trial
SMS	Short Messaging Service
TB	Tuberculosis

Declarations

Ethical approval and consent to participate

Ethical clearance was obtained from the Institutional Review Board (IRB) of the University of Gondar. Informed consent was obtained from study participants before the interview and recordings of audio data. Patient identifiers were not disclosed during data collection, storage and dissemination.

Consent for publication

Not applicable

Availability of data and materials

Not applicable

Competing interests

The authors declared that there is no competing interest.

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Authors' contributions

KDG, BT contributed in the conception; KDG, BT and KAG in the design, analysis and write-up of the manuscript. All authors read and approved the final manuscript.]

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