BRIEF REPORT

FEASIBILITY OF AN MOBILE APPLICATION AS A TOOL FOR MULTIDRUG-RESISTANT TUBERCULOSIS CONTACT MONITORING IN PERU

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ABSTRACT

This study aimed to validate an ODK digital mobile application (ODK-DMA) in contacts exposed to multidrug-resistant tuberculosis (MDR-TB) in Lima, Peru. Using a questionnaire in an application on a mobile device, we registered 129 household contacts of 29 index cases of MDR-TB under treatment in 10 health facilities in South Lima in August 2018. The mean time of registration per contact was found to be 4 minutes. The prevalence of active TB symptoms among MDR-TB contacts was 3.1%. An acceptability questionnaire was completed by 31 respondents; all reported feeling comfortable or very comfortable with recording their data in the ODK-DMA, although 10% expressed concerns about confidentiality. We concluded that the ODK-DMA was a feasible and acceptable tool for registering household contacts exposed to cases with MDR-TB. Future studies should consider the use of mobile platforms for the monitoring of MDR-TB contacts.

Keywords: Multidrug-Resistant Tuberculosis; Tuberculosis; Peru; E-Registry; Mobile Application (source MeSH NLM)

INTRODUCTION

The rise of multidrug-resistant tuberculosis (MDR-TB) and extensively drug-resistant tuberculosis (XDR-TB) threaten advances in tuberculosis (TB) control. According to the Pan American Health Organization, Peru has the highest estimated incidence of MDR-TB in the Americas (31%), in 2017 it estimated a total of 3,500 new cases of MDR/RR-TB and 83 confirmed cases of XDR-TB [1], most of them were identified in Metropolitan Lima [2].

Many countries have difficulty managing the care of MDR-TB-exposed contacts in a systematic approach. The World Health Organization (WHO) recommends the development of technologies with secure methods for case registration and follow-up [3-4]. To this end, the Tuberculosis Management Information System (SIGTB), a national electronic registry of patients and their contacts, was implemented in 2015 in Peru [5].

The Open Data Kit (AM-ODK) mobile application is a secure, free, open-source program for collecting, managing, and using data [6]. It was validated in different resource-limited settings and proved to be cost-effective for surveillance and household monitoring of MDR-TB patients [7-8]. Although in Peru, AM-ODK has not been field-tested as a data collection

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tool for MDR-TB patients, various mobile technologies have been used to assist in the diagnosis and consultation of TB patients in the country [9]. Considering the magnitude of MDR-TB and the ongoing implementation of the SIGTB, an electronic system could facilitate individual contact registration and follow-up; facilitate management in the face of new preventive treatment guidelines; and contribute to MDR-TB surveillance among contacts.

The aim of this study was to validate the AM-ODK in contacts exposed to MDR-TB in Lima.

KEY MESSAGES

Motivation for the study: An electronic system could facilitate individual contact registration and follow-up; facilitate management in the face of new preventive treatment guidelines; and contribute to MDR-TB surveillance.

Main findings: The average registration time per contact was found to be four minutes and all respondents reported feeling comfortable or very comfortable with registering their data in the Open Data Kit (AM-ODK) mobile application. Regardless, 10% expressed concerns about confidentiality.

Implications: AM-ODK is a feasible and acceptable tool for registration of household contacts exposed to index cases (ICs) with MDR-TB in Lima.

THE STUDY

This was a feasibility study conducted in southern Lima. Participants were intra-household contacts exposed to index cases (IC) of MDR-TB between 2017 and 2018. Individuals living with a confirmed MDR-TB IC at the time of diagnosis and treatment initiation were included. Based on MDR-TB case reporting, ICs were identified and selected, who identified respective intra-household contacts. Contacts who were not living at home at the time of MDR-TB diagnosis were excluded.

The researcher met with the IC and their contacts at home or at the health center. The programmed questionnaire was carried out using AM-ODK (installed on a tablet). After signing the informed consent form, adult contacts were asked to complete an acceptability questionnaire (on paper). No identifiable data were collected; the data were stored by encryption on a secure server. ICs were linked to household contacts by an anonymous code.

We developed a survey that included the average number of household contacts per IC, the time it takes to register a single contact, demographic data, the presence of risk factors for active disease in the contacts, clinical and microbiological aspects of the IC, and the relationship between IC and contacts. The frequency of symptoms in MDR-TB contacts was calculated and a descriptive analysis was carried out using the statistical program Stata version 15.0 (StataCorp, College Station, Texas, USA).

Regarding acceptability, the experience in the data collection process by the interviewees, the perception about the interviewer entering their home using the AM-ODK and the security of the data were considered. We conducted a qualitative analysis of open-ended responses. There were reports of technical problems and negative experiences documented by the researcher.

The study was approved by the Research Ethics Committees of the London School of Hygiene & Tropical Medicine (Reference 15687) and the Universidad Peruana Cayetano Heredia (Reference 102632). In addition, authorization was obtained from the Peruvian Ministry of Health and the Directorate of Integrated Health Networks of Lima Sur.

FINDINGS

A total of 129 intra-household contacts of 29 ICs with MDR-TB identified in ten health centers in southern Lima were registered in the AM-ODK. The mean number of contacts per IC was 4.5 (standard deviation [SD]: 2.3; range: 1-11), 57% were female, the mean age was 27 years (SD: 19.5; range: 1-86) and 50 (38.8%) were children. Only one IC declined to participate in the study.

The average time per contact registry was four minutes (SD: 3), reaching a maximum of 16 minutes in the first contact. Subsequent contacts took at least one minute.

Characteristics of the index cases

Most ICs (48.3%) were aged 16-25 years and three ICs were HIV-positive. They initiated MDR-TB treatment between March 1, 2017 and July 4, 2018. The duration of symptoms prior to MDR-TB treatment initiation was reported to be variable with the most reported symptom being cough (72.4%). The characteristics of the index cases can be seen in Table 1.

Characteristics of household contacts

Most contacts (98.4%) lived in the same house as the IC, and 18.7% shared a bedroom with the IC. The main characteristics are presented in Table 2.

Forty-six percent of contacts younger than 16 years and 53% of contacts younger than 5 years accessed testing for latent tuberculosis infection (LTBI) by tuberculin test. Fifteen (11.6%) contacts had no evaluation; two-thirds submitted at least one

Table 1. Characteristics of the index cases

Characteristics	n	%
Age (mean, SD)	30.5	16.4
Sex		
Male	20	69.0
Symptoms		
Less than 2 weeks (n=7)		
Cough	3	42.9
Without cough	4	57.1
Over 2 weeks (n=22)		
Cough	18	81.8
Without cough	4	18.2
Diagnostic method		
Microscopy (n = 29) [a]		
Positive	20	69.0
Negative	9	31.0
Undocumented	0	0.0
Culture (n=29)		
Positive	17	58.6
Negative	12	41.4
Undocumented	0	0.0
Genotype (n=29) [b]		
Positive	25	86.2
Negative	0	0.0
Undocumented	4	13.8
MODS (n=29) [c]		
Positive	2	6.9
Negative	0	0.0
Undocumented	27	93.1
Resistance pattern (n=28)		
Only R and H	17	58.6
R and H plus E and/or Z	4	13.8
R and H (+/- E, +/- Z) plus Lfx	0	0.0
R and H (+/- E, +/- Z) plus aminoglycoside	7	24.1
R and H (+/- E, +/- Z) plus Lfx and aminoglycoside (TB-XDR)	1	3.5

[a] Acid fast bacilli observed.
[b] Determined by Genotype MTBDRplus test (Hain Line Probe Assay).
[c] MODS stands for Microscopic Observation Drug Susceptibility.
R: rifampicin; H: isoniazid; E: ethambutol; Z: pyrazinamide; Lfx: levofloxacin; SD: standard deviation; XDR-TB: extensively drug-resistant tuberculosis.

Table 2. Household characteristics and clinical risk factors of contacts (n=129).

Characteristics	n	%
Age of the contact (mean, SD)	27	19.5
Sex		
Male	55	43
Relationship to index case		
Siblings	34	26.4
Parents	31	24.1
Sons/daughters	23	17.8
Partners	8	6.2
Other relationships	33	25.5
Evidence of BCG vaccination		
Yes	109	84.5
No	14	20.9
Doesn't know	6	4.6
Type of household		
Bricks	121	93.8
Wood	8	6.2
Stone	0	0.0
Number of windows		
1-2	14	10.9
3-4	60	46.5
5-6	35	27.1
>6	20	15.5
Poor ventilation [a]		
Yes	45	34.9
No	62	48.1
Doesn't know	22	17.1
Relevant risk factors		
None	98	76
Positive to HIV	1	0.8
<5 years old	14	10.9
65 years old or more	4	3.1
Diabetes mellitus	5	3.9
Pulmonary disease	1	0.8
Smoker	4	3.1
Former smoker	3	2.3

[a] The interviewer subjectively answered the question about ventilation when interviews were conducted in the household. For interviews conducted in health centers, the interviewer relied on the information expressed by the IC or contact.
SD: standard deviation.

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sputum sample after the IC was diagnosed. One third of contacts reported previous HIV testing, only one tested positive.

At the time of data collection, 8.5% (11/129) of the contacts had symptoms of tuberculosis. Of those eleven, eight had only cough; two had cough with hemoptysis or fever; and one had weight loss. The frequency of active TB symptoms (persistent after two weeks) among the contacts recorded was 3.1%.

Acceptability questionnaire

A total of 31 adults were selected for convenience and completed the acceptability questionnaire, 22 (71%) were women. The mean age was 38.4 years (SD: 12.8, range: 19-57).

In each household, the average number of adults was 4 (SD: 1.6, range: 1-6) and of children was 2.2 (SD: 1.4, range: 0-6). Regarding the time taken to register all contacts, 54.8% of respondents reported <15 minutes and 29% 15-30 minutes. Only 6.5% reported between 45 and 60 minutes.

Regarding the questionnaires, 58.1% were completed at health centers and 41.9% during home visits. Of the latter, all respondents agreed to receive the interviewer at home. None of the respondents identified at the health center disagreed with receiving a home visit. All 31 respondents reported understanding the questions and feeling comfortable or very comfortable with the researcher while using the application to record their data; 90% believed in the confidentiality of their data and recognized that the answers would be beneficial to themselves and their family. Three (10%) of the respondents expressed concern about data privacy and security (Tables 3 and 4).

Table 3. Responses to the acceptability questionnaire

Question/Answer	n (%)
Were you comfortable with healthcare personnel coming into your home?	
Yes	133 (41.9)
No	0 (0)
Insecure	0 (0)
D/A	18 (58.1)
Did you understand the questions asked by the healthcare personnel?	
Yes	30 (100)
Frequently	0 (0)
Sometimes	0 (0)
No	0 (0)
How did you feel about the healthcare personnel who used the mobile application to register your data?	
Very comfortable	17 (56.7)
Comfortable	13 (43.3)
Uncomfortable	0 (0)
Very uncomfortable	0 (0)
Do you have any concerns about the healthcare worker using the mobile application?	
Yes	3 (10)
No	27 (90)
Are you confident that your information will be kept confidential?	
Yes	27(90)
No	0 (0)
Doesn't know	3 (10)
Do you think your answers to the healthcare personnel's questions will help you and your family stay healthy?	
Yes	27 (90)
No	3 (10)
Doesn't know	0 (0)

D/A: Doesn't apply

Table 4. Open-ended responses

Types of responses received
Positive responses
"Yes, I think it is very interesting and fast how the interview is conducted. I think it is a good option to implement at health centers, as it is convenient to answer alone and avoid paperwork."
"It's helpful to society."
"I am glad that they are concerned about this disease that is increasingly affecting almost all of Peru."
"All good, I liked the talk."
Negative responses
"My only doubt is that this is confidential."
"I wish the concern was about the feeding of the [TB] patient and to verify that he/she was fed at the right time, as they do with medications."
Other responses
"You could do virtual email surveys to connect with different people and find out if there is anyone with TB symptoms, you would save time with this as doctors would go directly to homes with suspected TB."

DISCUSSION

This pilot study showed that the registration of MDR-TB case contacts is possible using the AM-ODK. A total of 129 contacts were analyzed, out of 250 planned, due to time constraints for fieldwork, however, they were sufficient to assess feasibility. We estimated that that it would take an average of 18 minutes per household to register all contacts for a single IC. This is consistent with the acceptability questionnaire where 84% of respondents estimated a time of less than 30 minutes. Feasibility studies in Botswana and Mongolia report similar figures for individual contact registration of 3 and 6 minutes respectively [7, 10].

The acceptability of the AM-ODK was high. However, the sample size was small, but acceptability judgments can be made with the responses obtained. The opinions of the eleven ICs who completed the electronic registry were substantial and all respondents expressed comfort with the use of the AM-ODK; they considered it a beneficial tool for health improvement. Positive feedback was expressed regarding time efficiency and paper savings, which was consistent with findings from previous studies using this technology [10-11].

Ten percent of respondents were concerned about the confidentiality of the study, specifically about how their data would be used. This was also the main concern (39%) for respondents in another study with this same ODK technology in Mongolia, in addition to that related to data loss and sharing of personal information [10]. Other studies using mobile technologies in HIV patients in Peru have also reported users' insecurity about the handling of their personal data [12-13]. For this reason, it is essential to assure the respondent that the use of this data will be limited to specific individuals, in addition to having technical specifications that ensure the confidentiality of their data [14].

This study presents AM-ODK as a free, simple and adaptable tool for clinical data collection in a low-resource setting. However, it requires basic technical skills, a secure Internet server, technical support, does not provide real-time information, and although it can be installed on any Android device, access to these devices may be a limitation.

Security was identified as a key issue, both for the interviewer and for the devices in the local health centers. Securing the device with password protection, download restrictions and other strategies can discourage information theft. Internet access was another problem identified in this and other pilot studies [7, 15] and should be analyzed for any future research or implementation efforts.

The electronic system (SIGTB) of the Peruvian Ministry of Health collects data at the national level from local health centers; however, it is not a direct support tool for the centers. Paper records are still used in parallel to electronic registration. It is possible that the SIGTB could be adapted to perform similar functions to the AM-ODK. A tool that facilitates the registration and follow-up of ICs and their contacts can facilitate the management of the care of the latter. Such a tool could potentially be used for national epidemiologic monitoring and surveillance given the current limited data and could contribute to the global efforts to combat MDR-TB [16]. Trials on the preventive therapy for LTBI in contacts exposed to MDR-TB are currently underway [17-18]; if beneficial, implementation would be feasible with an established contact base.

Previous studies on electronic surveillance systems have shown that they increase data integrity and accuracy; save time and increase access; improve confidentiality and security; facilitate linkages to other health programs (e.g., HIV); and allow for more complex analyses of the subject [19]. This application is currently used for research around the world; however, it has not been officially integrated into any MDR-TB monitoring system so far. Another aspect to take into account is the integration of these systems with electronic medical records or other applications used for the same purposes.

The method of recruiting MDR-TB contacts was subject to potential bias. Contacts of ICs with better adherence to treatment had a higher probability of being selected and this may have affected the representativeness of acceptability opinions. Reporting bias may have affected responses about

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contact's risk factors, previous TB examinations or treatment, particularly when a person responded for all household contacts. The acceptability questionnaire was self-reported and subject to response bias. Comprehension of the questions and reading ability may have affected responses. The questionnaires reflected the opinions of ICs and contacts, and may not be generalizable to all MDR-TB contacts.

In conclusion, the AM-ODK is a feasible and acceptable tool for registering household contacts exposed to MDR-TB ICs in Lima. Future studies should consider the use of mobile applications for MDR-TB contact monitoring.

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