PATH

(∗) LHSI | Labor and Health Social Initiatives

Partner of the
Stop TB Partnership

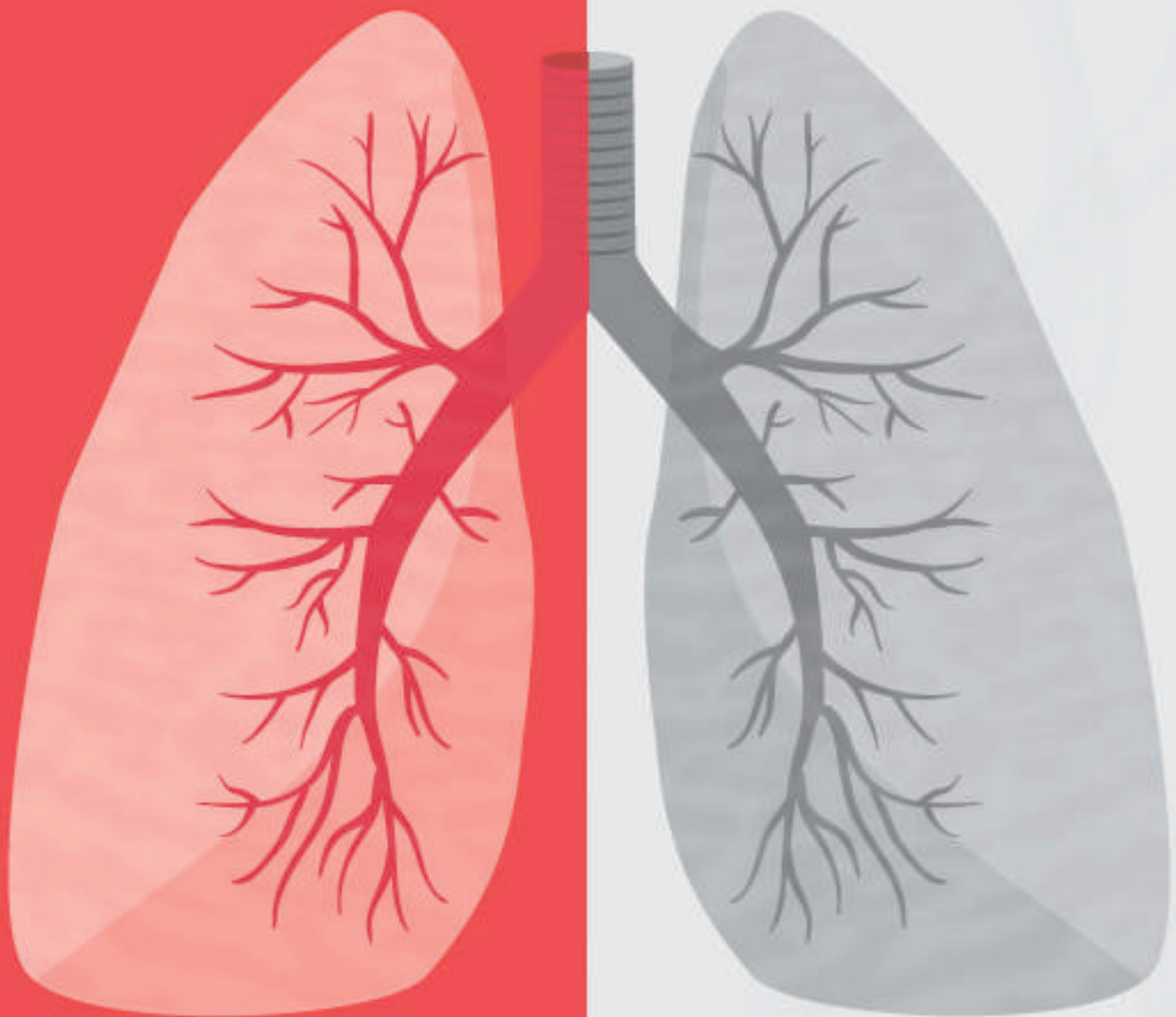IMPLEMENTATION RESEARCH REPORT

Acceptability and Feasibility of Digital Adherence Technology (DAT) in TB REACH project in Ukraine (wave 6)

KYIV, 2020

[1] http://www.stoptb.org/global/awards/tbreach/wave6dat.asp

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List of terms and abbreviations used in the report

99DOTS	99DOTS adherence platform and mobile app
AIDS	Acquired immunodeficiency syndrome
CSO	Civil society organization
DATs	Digital Adherence Technologies
DOTS	Directly Observed Treatment Short-Course
E-TB Manager	National TB register
GFATM	Global Fund to Fight AIDS, Tuberculosis and Malaria
GF	Global Fund to Fight AIDS, Tuberculosis and Malaria
HCWs	Health Care Workers
HIV	Human immunodeficiency virus
IDPs	Internally Displaced Persons
MDR-TB	Multidrug- Resistant Tuberculosis
MOH	Ministry of Health
NGO	Nongovernmental organization
NTP	National TB Program
Oblast	The name of an administrative territory in Ukraine, similar to province
PLWHA	People Living with HIV/AIDS
PWIDs	People Who Inject Drugs
RTMM	Real Time Medication Monitoring system
Smartbox	nickname used for the DAT (box with evriMED device)
SMS	Mobile text message
Stop TB	Stop Tuberculosis Partnership
SOPs	Standard Operational Procedures
TAM	Technology Acceptance Model
TB	Tuberculosis
URCS	Ukraine Red Cross Society
USAID	United States Agency for International Development
VDOT	Video Directly Observed Therapy
WHO	World Health Organization
XDR TB	Extensively drug-resistant TB
Xpert® MTB/RIF	GeneXpert – TB screening test that can be used in mobile and remote settings

I. Introduction

WHO Guidelines

Ensuring adherence is a central component of WHO's global 'End TB Strategy'. In April 2017, the WHO released a comprehensive Update on Guidelines for Drug Susceptible TB treatment which provides advice on the use of Digital Adherence Technologies (DATs) to improve adherence. The Guidelines contain evidence-based recommendations on the use of electronic medication monitors to help patients adhere to TB medication. WHO Guidelines define "digital medication monitor" as "a device that can measure the time between the pillbox's openings. The medication monitor can give audio reminders or send SMS to remind patients to take medications and record when the pillbox is opened." The Guidelines expressly approve the use of digital medication monitors to improve TB treatment outcomes[2].

At the same time, WHO guidelines outline that with all the digital interventions, patient support and the ability of a patient to interact with Health Care Workers (HCWs) should be preserved and that these interventions should be considered as tools to enable better communication with healthcare provider rather than as replacements for other adherence interventions. In practice, it is expected that SMS, telephone calls and VDOT may replace in-person DOT for periods rather than for the entire duration. Additionally, patients' ability to participate in these programs depends on the patients living in an area with a good telecommunication infrastructure. There may be privacy concerns surrounding phone data security , so encryption and other measures to safeguard privacy need to be included. The feasibility of implementing these types of interventions depends on telecommunication infrastructure, phone availability and connection costs. There may be reluctance on the part of implementers (e.g. national or local governments, health partners) to pay for incentives. (WHO 2017, p. 28)

All the above factors have been considered within the country context during the implementation of the W6 TB REACH Ukraine project, which enabled the assessment of feasibility and applicability of DATs in Ukraine.

TB treatment in Ukraine: an overview

Ukraine remains a country with MDR-TB burden. According to WHO Tuberculosis surveillance and monitoring in Europe 2019[3], Ukraine is one of the five countries with the largest absolute number of incident TB cases (37 000). According to the WHO estimation, 29% of newly detected TB cases and 46% of previously treated TB cases have MDR-TB or rifampicin-resistant tuberculosis (RR-TB). Significant challenges in TB control are related to poor treatment outcomes for all categories of patients. The national treatment success rate of drug-sensitive TB cases (new and relapse) registered in 2017 was 76%, with some gradual improvement in the last several years[4]. However, this rate still not reaching the WHO target of 85%. The treatment success rate for drug-resistant TB patients started on treatment in 2016 was 49% that is significantly below WHO-recommended levels.

Current patient support is limited since directly observed treatment (DOT) procedures are not properly followed[5]. Patients typically need to be observed when taking their daily medication either by visiting the health center or by a healthcare worker at their home. Obviously, these supportive measures put a burden on both the patient and the health system. There is an urgent need to develop strategies to improve treatment adherence.

Diagnosis and management of TB is performed according to Ukraine's National TB Program (UNTP) guidelines, which specify that diagnosis and management of TB are free of charge[6]. All patients evaluated for TB should undergo sputum smear microscopy, culture and molecular testing with Xpert® MTB/RIF. Standard TB treatment for smear-positive patients in Ukraine covers 2–4 months of intensive inpatient therapy at the central TB dispensary. Once patients' tests are smear-negative, patients are referred to the TB cabinet or polyclinic closest to their home for 2–5 months of outpatient continuation therapy. Directly observed therapy (DOTS) is declared as the standard of care, requiring direct contact between patients and

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[2] WHO. Guidelines for treatment of drug-susceptible tuberculosis and patient care (2017 update). April 2017. Geneva, Switzerland.

[3] European Centre for Disease Prevention and Control/WHO Regional Office for Europe. Tuberculosis surveillance and monitoring in Europe 2019 – 2017 data

[4] WHO Global TB Report 2019 https://www.who.int/tb/publications/global_report/en/

[5] Tuberculosis in Ukraine. Analytical and Statistical Reference Book. The State Institution "Public Health Center of the Ministry of Health of Ukraine", Kyiv, 2017, pp.26-31

[6] MOH of Ukraine, Unified Clinical Protocol for Primary, Second

providers to administer TB medication.

For many years after its independence in 1991, the country struggled to reform its TB control systems and approaches, based heavily on in-patient treatment and mandatory TB screening tests of all population. This approach was highly unsustainable and costly. Another important factor in TB control in Ukraine is its aging workforce – the mean age of TB doctors was over 60 years in 2016 [7].

As noted in some studies, strategies to improve treatment adherence and success were based on DOT with adaptations to different clinical services and social environments. Patient incentives are sometimes included to improve adherence, most commonly periodic food packages, transportation vouchers, and cash payments [8].

In Ukraine, TB treatment and care intertwine with social services support and those are managed by different state agencies, with the MOH being responsible for medical aspects of TB treatment, and care responsibilities being fragmented and for TB patients from vulnerable groups (homeless, PWIDs, IDPs, prisoners, etc.) falling under the mandate of the Ministry of Social Services. Many donor-supported programs fund social support incentives to improve adherence. For instance, in 2010, the Ukraine Red Cross Society (URCS), funded by the USAID, piloted a community-based social support program designed to improve TB treatment adherence during outpatient continuation therapy. URCS provided DOTS to a number of patients in their homes. Additionally, incentive food packages, psychological and career counseling, and/or transportation vouchers or other necessities were provided [9].

Background information on Digital Adherence Technology devices

Various studies suggest that medication reminders and remote treatment adherence monitoring devices, such as evriMED pillbox, are efficient and pragmatic interventions for adherence reminding and measurement, and facilitate more effective allocation of limited healthcare personnel resources in contexts where populations are hard to reach, or health systems under-resourced [10].

While the potential of information and communication technologies to transform healthcare is enormous, its use is contingent on user-specific and context-specific needs, and may imply different impacts and challenges in different contexts [11]. Critical to the successful use of such devices in improving patient medication adherence is providers and patients' ability to effectively use the technology. To optimally design and deploy an electronic monitoring device, one must consider patient and provider acceptability, satisfaction, and feasibility.

EvriMED mode of operation

The RTMM device (evriMED1000) is a pillbox containing a SIM card. The evriMED supports TB treatment adherence and monitoring by beeping when patients need to take their medication, and provides tracking for healthcare providers when the smartbox has been opened (equated with dose being taken).

The evriMED1000 device records and stores medication events (with date and time information) every time the pillbox is opened. The evriMED1000 also sends a heartbeat event every day. The heartbeat event contains device identification and shows the health of the device with technical information on battery status and signal strength. Every day, at the moment of the first opening on that day, these data are sent to a central server through the mobile network in near real-time (within 2 min). All previously unsent events (heartbeat and medication events) will also be sent to the server during this first pillbox opening. If the evriMED1000 is not opened any day, any unsent (heartbeat and medication) events will be sent at the time of the next heartbeat event.

Photo: EvriMED pill box.

[7] https://www.obozrevatel.com/ukr/health/diseases/39607-nazvano-motoroshni-tsifri-z-tuberkulozu-v-ukraini.htm
[8] Priedeman Skiles M, et al (2018) Evaluating the impact of social support services on tuberculosis treatment default in Ukraine.
[9] Ibid., p. 2/13.
[10] LiuX, et al. (2015)
[11] WHO. Handbook for the use of digital technologies to support tuberculosis medication adherence. 2018.

It should be noted that in the W6 TB REACH Ukraine project only device modules were procured from Wisepill. Magnets and boxes were procured and produced locally in Ukraine, following the technical specifications from Wisepill, which enabled cost savings.

Over the project implementation period, EvriMED was fully integrated with the 99DOTS platform. Clinicians could access 99DOTS platform via Android app to enter patients' cases and check daily adherence records for the patients they monitor. (see figure below). Each row represents a patient and each red rectangle represents a missed dose. Clinicians can quickly differentiate patients who are presumably capable of self-administration and those who require a higher outreach model.

Photo: 99DOTS adherence platform.
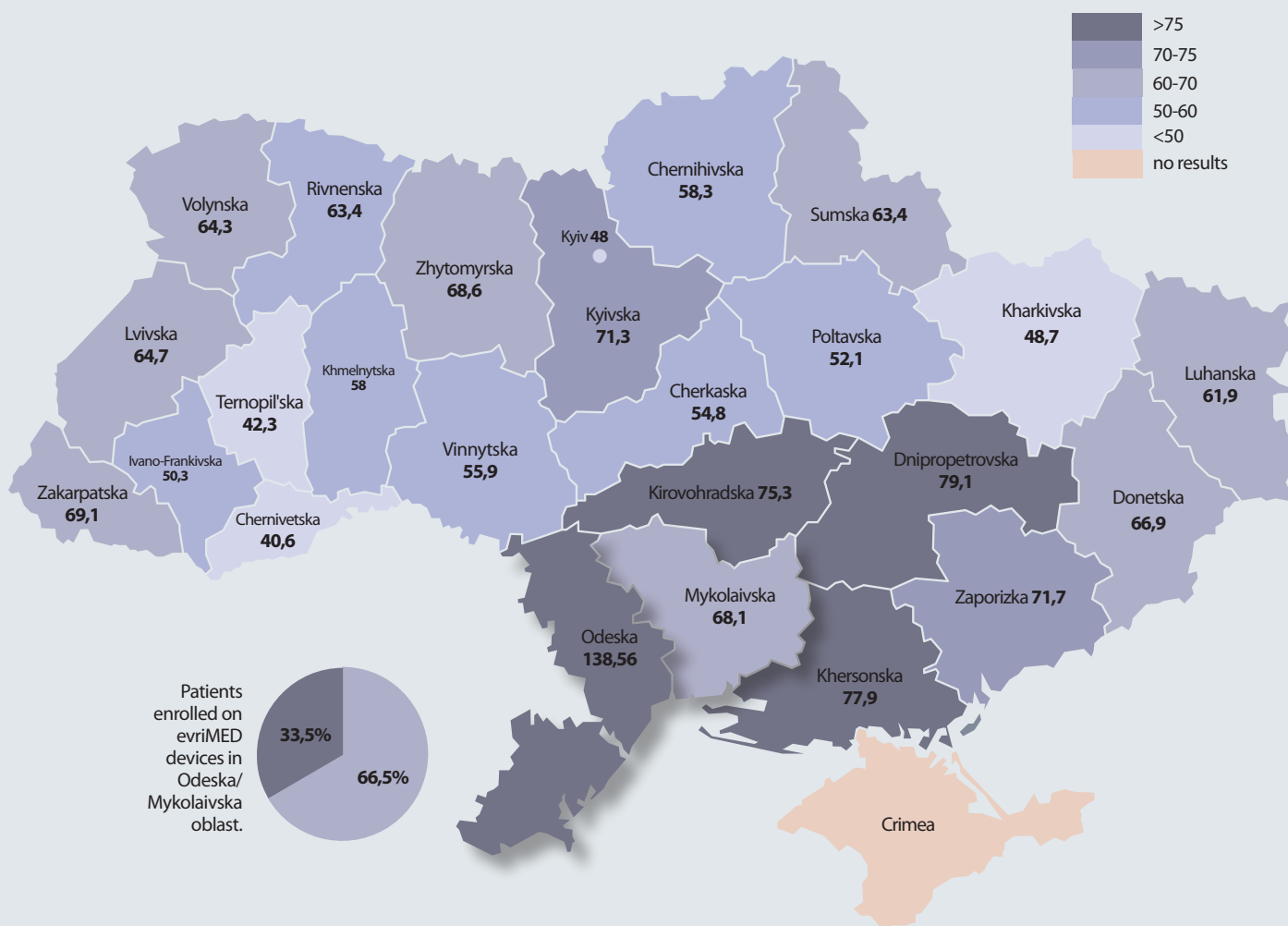
Project information: W6 TB REACH

To explore practical aspects of using DATs in the local context in Ukraine, the W6 TB REACH project, implemented by PATH in consortium with LHSI, KNCV, and Everwell. The project piloted the use of digital health solution, namely real-time electronic dose monitors, in out-patient models of TB treatment, including DR-TB, from October 2018 to December 2019 in high TB burden oblasts in southern Ukraine (Odeska and Mykolaivska oblasts) both with high levels of HIV co-infection (45% and 29%, respectively) (see Figure 1 TB map of Ukraine and project sites below). The project used evriMED devices - medication reminder and digital remote treatment adherence monitoring devices, also called 'smart-boxes' in this report. The 99DOTS platform (Android app) was used to monitor the information sent by smartbox, which captured the medication uptake by the patient. The use of DATs followed Standard Operational Procedures (SOPs) to monitor TB patients' treatment at the regional level[12].

The proposed strategy is solely tied to outpatient care and could be applied for every patient who is not hospitalized at the moment of service provision. The process was integrated into current NTP processes, systems, and supply chains, coupled with patient-centered services already being provided through other efforts.

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[12]Стандартна Операційна Процедура (СОП) № 7, СОП № 2.2, СОП № 2.2/1Б від 26.02.2018, Миколаївський обласний протитуберкульозний диспансер.

Figure 1. Map of Ukraine. TB incidence per 100 000 population (2019)

Legend:
- >75
- 70-75
- 60-70
- 50-60
- <50
- no results

Volynska **64,3**

Rivnenska **63,4**

Chernihivska **58,3**

Sumska **63,4**

Zhytomyrska **68,6**

Kyiv **48**

Kyivska **71,3**

Kharkivska **48,7**

Lvivska **64,7**

Khmelnytska **58**

Ternopil'ska **42,3**

Poltavska **52,1**

Luhanska **61,9**

Ivano-Frankivska **50,3**

Cherkaska **54,8**

Zakarpatska **69,1**

Chernivetska **40,6**

Vinnytska **55,9**

Dnipropetrovska **79,1**

Donetska **66,9**

Kirovohradska **75,3**

Mykolaivska **68,1**

Zaporizka **71,7**

Odeska **138,56**

Khersonska **77,9**

Crimea

Patients enrolled on evriMED devices in Odeska/Mykolaivska oblast.

33,5% **66,5%**

Results: From a total of 1712 TB patients on treatment in project sites, 902[13] (53%) patients on treatment in regional TB facilities were enrolled on evriMED devices in project sites. [Mean age of the registered TB patients was 43 years with predominance of "new cases" (n = 647 , 71%) and "male" gender (n = 585, 63,9%). In addition, proportion of PLHIV among registered TB cases is 46,8% in Odeska and 28% in Mykolaivska oblasts. 708 MDR-TB cases started on treatment in Odeska oblast and 275 – in Mykolaivska.

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[13] As of November 2019

II. Operational Research Study

Objectives

The goal of this descriptive study is to understand the factors that promote or hinder the implementation and/or performance of the DAT tools in supporting treatment adherence. The study uses a standardized approach to collecting data across all TB REACH DAT projects[14] focusing mainly on two components of implementation research (IR) framework, acceptability and feasibility.

In this study, acceptability and feasibility are defined as:

Acceptability – perceptions about using DAT among patients and health care workers (HCWs). Constructs for measuring acceptability are based on the Technology Acceptance Model (TAM)[4] and the Unified Theory of Acceptance and Use of Technology (UTAUT)5 and include perceived ease of use, and perceived usefulness, user satisfaction of the tools, and cultural and social acceptability.

Feasibility – the extent to which the DAT can be practically used in a setting. This includes technology infrastructure and access to mobile phones, cellular networks, and charging batteries.

Materials and Methods

The study took place between August and December 2019 at 20 TB treatment centers, including DOT-sites and rayon/city level TB dispensaries in two oblasts of southern Ukraine – Odeska and Mykolaivska. Study participants who attended a TB clinic for treatment were not less than 18 years old. Patient data from the adherence platform were collected from February 2019 to December 2019. Ethical approvals were sought and obtained[15]. Data were evaluated for socio-demographic pattern, adherence rate, DAT acceptability and feasibility.

Participants

The target population consisted of all diagnosed drug-susceptible and MDR/XDR adult TB patients in Odeska and Mykolaivska oblasts' pilot rayons. Inclusion criteria were: diagnosed drug-susceptible and drug-resistant TB patients (including smear-negative patients); attending care at any of TB treatment centers such as DOT-sites and rayon/city level TB dispensaries in the two oblasts; aged between 18 and 65 years; willingness to use the evriMED-

device; willingness to sign the informed consent document.

Two types of consenting participants were invited to participate in the survey: 1) adult patients using the DAT during TB treatment; 2) front line health-care workers (HCWs) providing TB services to patients using the DAT.

Patient Recruitment and Interviews

As some other studies have shown, sometimes participants lost interest in using the tools in the later phases of their treatment. It was suggested for the interviews to have a sample of patients in the first few months of treatment; some in the middle of treatment; and others at the end of treatment. Therefore, in the Ukraine TB REACH project, patients were purposively selected to ensure the representation of patients interviewed at the beginning, middle, and end of treatment. Patients were invited to participate in interviews by their health care providers.

Two mixed-method surveys were completed with 223 participants. 23 HCWs and 200 patients took part in the interviews.

The study surveyed 123 (61.5%) patients with drug-sensitive TB and 77 (38.5%) patients with drug-resistant TB.

Interviews were conducted in the local languages (Ukrainian, Russian) by Ukrainian research assistants trained in quantitative and qualitative data collection techniques.

Qualitative research methodology

The mixed-method survey contained quantitative and qualitative parts. Qualitative data collection consisted of individual open-ended questions. Qualitative questions solicited information on preferences for content, frequency and timing of SMS adherence reminders, understanding and experiences of SMS reminders, and understanding and experiences of real-time adherence monitoring.

Acceptability questions included perceived usefulness, ease of use, cultural and ethical appropriateness, and duration of patient engagement with DAT over the treatment course.

Feasibility questions included mobile-phone availability and literacy, cellular service coverage, bat-

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[14] **Khan, A., et al.** (2019) '**Acceptability and Feasibility of Digital Adherence Technology (DAT) in TB REACH projects,**' April 15, 2019
[15] Ethics Commission of the Public Health Center of the MOH of Ukraine.
PATH Research Determination Committee.

tery life of devices, the durability of devices, resources needed for implementation, availability of resources, use and perceived usefulness of DAT, and storage and distribution of devices.

Procedures used to collect and analyze qualitative data are described below.

Data collection

Two mixed-methods surveys were administered for patients and HCWs. The survey instruments developed by the TB REACH Secretariat and were applied and tailored to the type of DAT (99DOTS app, evriMED) that the project is using. The project team translated and adapted the instruments to local settings. The survey was conducted in face-to-face meetings and by phone.

Responses were not linked to individual participants and data collected remained anonymous and confidential. In the report's text numbers of participants are used with direct quotes to ensure anonymity. Different numeration is used when quoting HCWs' and patients' answers as those two groups of participants were surveyed separately and at a different time.

Data analysis

The survey quantitative data were descriptively analyzed, based on the scores on the preference scale that assesses satisfaction and acceptability.

The answers to the open-ended questions were studied in detail to derive, via content analysis, various themes from these answers. Categories of inquiry in interview guides formed the basis for an initial coding structure. More themes were added to account for relevant content.

Computer analysis software was not used in the qualitative analysis. Since the study's objective was not to produce generalizable or universally applicable conclusions, the research team did not seek to prioritize among most frequently and less frequently mentioned categories or sub-categories. Instead, the analysis aimed to capture as much feedback as possible from HCWs and patients on their experience with evriMED devices and 99DOTS app. The ability of this study to produce broad feedback on various aspects of DAT use is assumed as its most

valuable contribution.

In constructing the meanings, the following was taken into account. First, as the structure of the survey and Interview Guide have already provided for a certain level of saturation, and secondly, because study participants were purposely selected, this added to the saturation of initial information at the point of collection. Key themes and subthemes were reviewed to allow the linkage of quantitative and qualitative data, illustrated by exemplary quotes. Key themes will be discussed below. Besides, the research team did not eliminate minor sub-themes and even feedbacks to derive as much knowledge as possible on DAT use, and those are presented in this report.

Limitations of the study

The project implemented DATs in the territories and facilities selected considering HCWs' will to participate and oblast TB management's need to use the technology due to the lack of health care services close to the patient. Therefore, the survey was conducted among patients and HCWs of these territories and facilities.

This study is the first to assess the acceptance and perceptions of evriMED devices and **99DOTS platform** in Ukraine. W6 TB REACH was a pilot project to demonstrate the feasibility and impact of the efficient resource allocation to enhance TB/DR-TB treatment success rates and guide the national scale-up of the technologyThe study results should be viewed as describing particular aspects of DAT use within this project as a pilot initiative. This study represents feedback provided by participants who agreed to use DAT and does not include any opinions provided by those who never used DAT.

EvriMED is a desktop medication monitoring and reminder system. The data from evriMED is transmitted to the 99DOTS platform using mobile cellular technology. Interventions can be created and configured to remind patients if they forget to take their medication and notify a responsible healthcare worker. Adherence data and reports can be viewed on the 99DOTS dashboard and mobile

Android application. Over the project implementation period, only a small part of the 99DOTS website was localized, making the resource for clinicians whodo not know the English language. For this reason, 99DOTS website usability could not be fully studied.

III. Operational Research Study Findings

Local context

At the onset of the project and during the project implementation period, Ukraine continued to modify its TB system and care models, following the ongoing health reform, which also influences TB sphere, and governance decentralization reform aiming to transfer care responsibilities to local authorities in regions.

In several oblasts regulatory changes have moved forward and resulted in the adoption of regulatory acts by developing standard operation procedures (SOPs) allowing better availability of outpatient care models, including the uptake of digital adherence technologies.

In Ukraine, smear-positive DS/DR-TB patients are hospitalized until sputum smear conversion, and until therapy with injectable drugs is finished. Then, they continue outpatient treatment via facility-based DOT, or in some cases, home-based DOT and VOT.

In 2018, at the onset of W6 TB REACH and some other donor projects, several oblasts, including Odeska and Mykolaivska oblasts, have adopted local protocols and SOPs enabling outpatient treatment models to include the uptake of DATs. A variety of innovative patient-oriented outpatient treatment models have been introduced to patients in oblasts with resistant and drug-resistant TB, alongside inpatient treatment.

New regional models of outpatient treatment

The rationale to introduce new models of outpatient treatment was that they were more convenient for the patient. In order to ensure adherence to a patient-oriented approach, the project cooperated with local multi-disciplinary teams (MDT), each of which included several specialists of different profiles: TB doctor, DOT Curator, family doctor, social workers.

Outpatient models were determined jointly with the healthcare worker at the PHC unit based on the availability of healthcare units close to the patient's home. To choose the most appropriate outpatient treatment model, the doctor needs to consider all social and psychological issues that may create barriers to successful treatment. This is to be done through joint consultations of all members of MDT.

To choose the right outpatient treatment model, TB doctor should offer possible treatment options to the patient (considering the patient's health and social conditions), and explain details of care in each model. Patients will then choose the model most suitable for them.


Photo: Patient in Belhorod-Dnistrovskiy starts treatment with EvriMED smartbox.
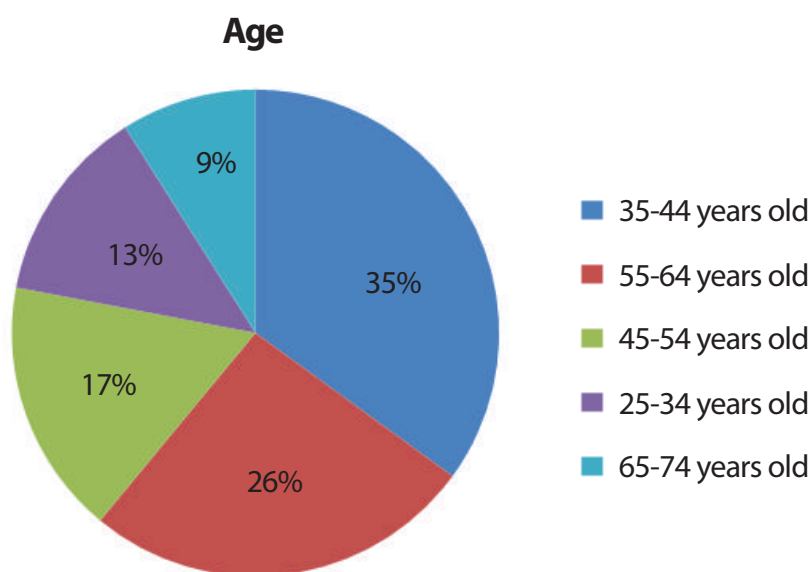
Feasibility and Acceptability of evriMed devices and 99DOTS platform: analysis of HCWs' interviews

Participants demographic and professional profile and locations

Totally, 23 health workers and local officials were interviewed. Data collected from HCWs was structured to demonstrate their demographic profile, gender disaggregation, education level, workload, location, and other relevant parameters, illustrated by the following diagrams below:

Gender

19%

81%

■ Men

■ Women
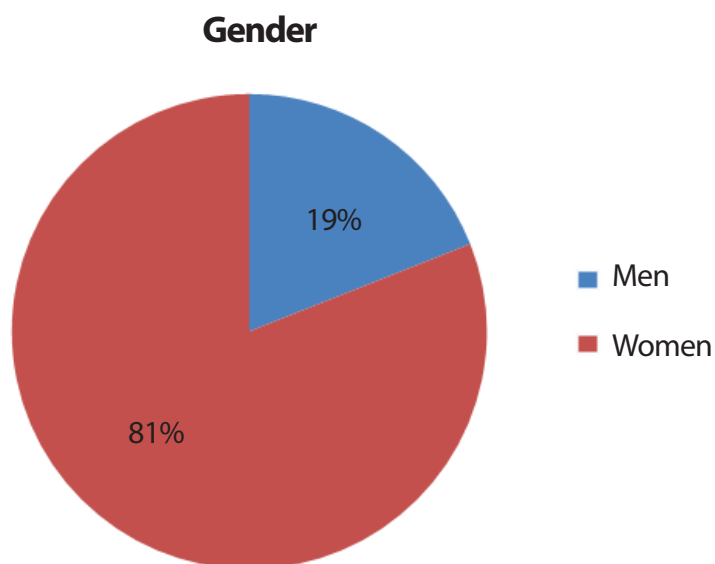
The majority of HCWs respondents were female (81%), with an average age of 40 years. This represents a typical demographic profile of a rayon TB doctor.

Age

9%

13%

17%

35%

26%

■ 35-44 years old

■ 55-64 years old

■ 45-54 years old

■ 25-34 years old

■ 65-74 years old

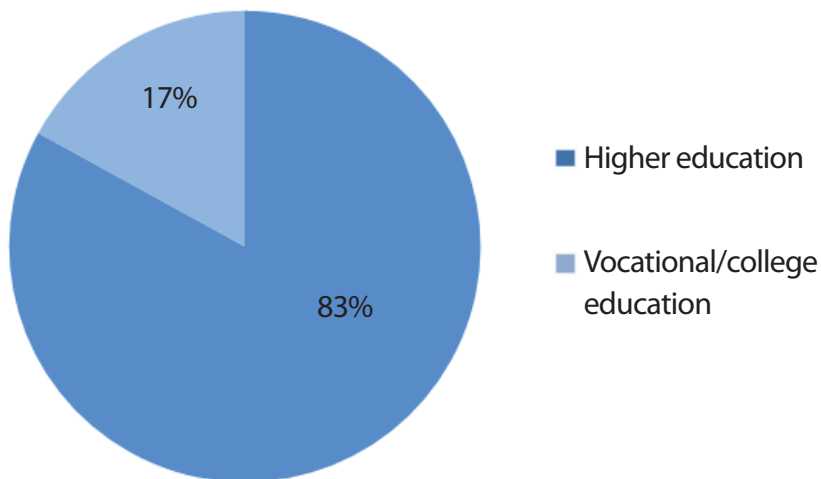## Role in TB health care

- TB Doctor
- Medical nurse
- Deputy Head doctor of TB clinic
- Chief manager
- Head of Regional TB M&E department

52%
24%
4%
5%
5%

HCWs education level

- Higher education
- Vocational/college education

83%
17%

Workload: number of patients per day

- More than 10
- 6-10 patients
- 3-5 patients
- 1-2 patients
- 0 patients

55%
10%
30%
5%
0%
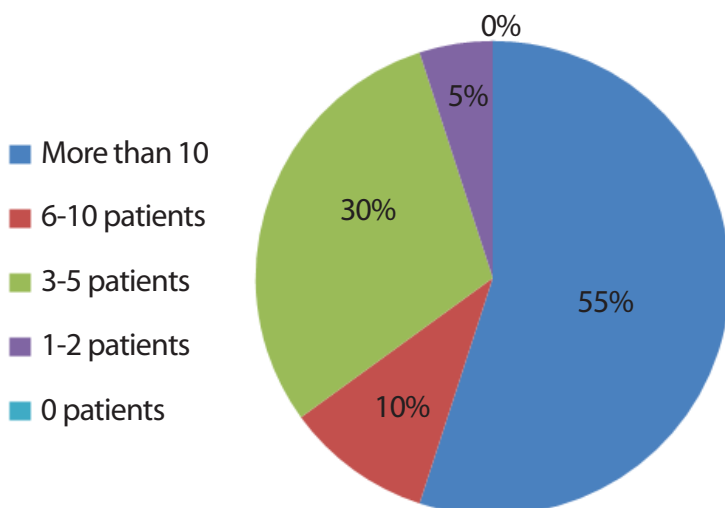
The majority of HCWs had a high workload. 52,4% (n=11) reported seeing more than 10 TB patients per day. 9,5% (n=2) were seeing 6 to 10 patients per day; 28,6% (n=6) seeing from 3 to 5 patients per day; with one participant seeing 1-2 patients per day, and one no patients.

Acceptability of smartboxes and 99DOTS app in TB care based on the HCWs' feedback: quantitative data analysis

Questions 6-10 in the survey sought to learn about participants' experience with digital technologies, and Questions 11-17 asked for participants' experience of using evriMED smartbox.

The survey quantitative data were descriptively analyzed, based on the scores on the preference scale that assessed the satisfaction and acceptability.

Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree

Data reflecting on participants' skills, access to smartphone and/or computer and familiarity of using them in real-time situations is presented in diagrams below.

Mobile-phone availability and literacy

Out of 23 HCWs who participated in the survey, 22 already owned a smartphone that nobody else used; and 21 (over 90%) reported always having positive balance of their cell phone account.

As to the literacy: all HCWs taking part in the survey were computer literate. Nevertheless, when devices were provided and consistent training in place, even those TB doctors of elderly age can successfully master the technology or find a way to manage it (involve the nurse, for example). This became visible in responses to the question about the ease of learning how to use EvriMED and 99DOTS.

"Overall, our staff quickly learned and started to work with technologies." (part. 23)

User's skills

When asked whether they understood how smartboxes and 99DOTS app worked, out of 23 HCWs surveyed, three (3) agreed somewhat and 20 strongly agreed.

I understand the evriMED system and how it works

- 13% Somewhat agree
- 87% Strongly agree
- Strongly agree
- Somewhat agree
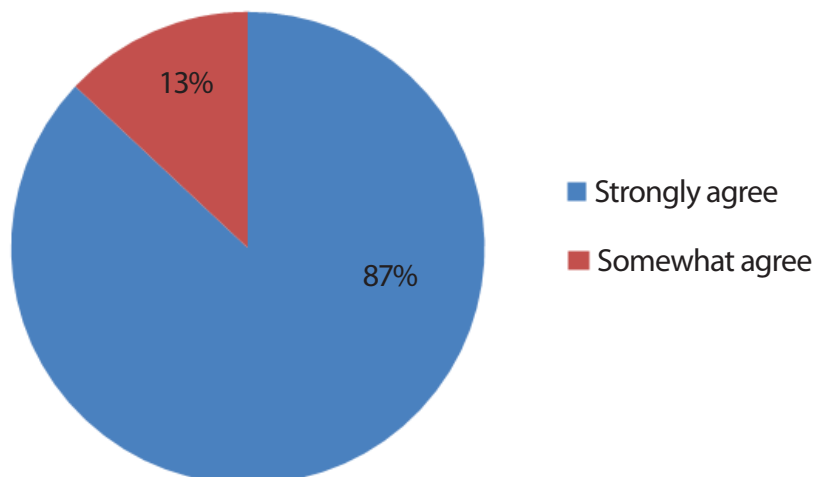
DAT experience

As to their DAT experience, 22 out of 23 HCWs reported receiving patient adherence information via 99DOTS app.

The majority of HCWs reviewed on a daily basis information on patients using evriMED boxes – as reported by 19 HCWs out of 23 interviewed.
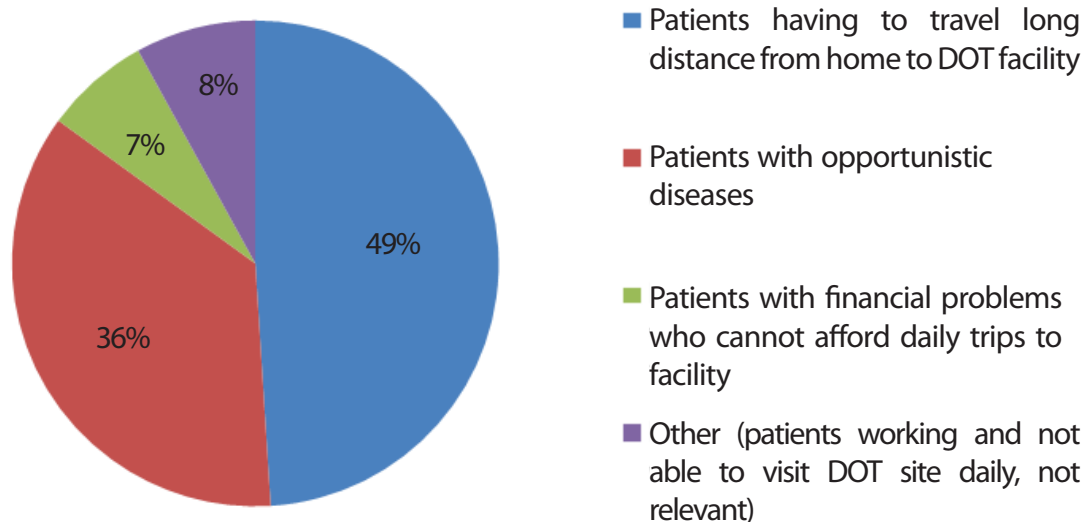
To assess adherence, HCWs used the following methods:

- Phone call;
- Communicated with patients' family members;
- Used mobile app;
- Used video DOT monitoring (not common).

Criteria for inclusion of patients

Question 21 asked about criteria that HCWs used to include TB patients to use DATs at the outpatient treatment stage. Multiple options were allowed, therefore the number of answers exceeds the number of respondents. Answers were distributed as follows (see the diagram below):

Patient inclusion criteria

- 49% Patients having to travel long distance from home to DOT facility
- 36% Patients with opportunistic diseases
- 7% Patients with financial problems who cannot afford daily trips to facility
- 8% Other (patients working and not able to visit DOT site daily, not relevant)

The most common reasons for patient inclusion were long distance from home to the DOT facility and opportunistic disease coinfection (e.g. HIV), while having financial problems, having work, and having alcohol or drug dependency were each mentioned by only one respondent.

Using evriMED adherence data

Several questions were asked to HCWs to find out their opinion on using evriMED adherence data. All respondents agreed that evriMED helped them to provide better support and counseling to their patients.

EvriMED adherence data helps me provide better support and counceling to my patients

- **Somewhat agree** (26%)
- **Strongly agree** (74%)
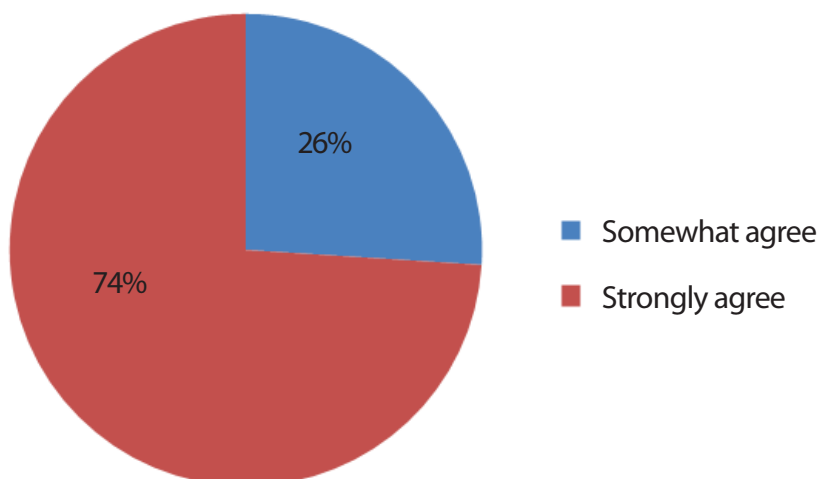
All HCWs 'strongly agreed' or 'somewhat agreed' about patients liking smartboxes.

My patients like using evriMED

- **Strongly agree** (65%)
- **Somewhat agree** (35%)
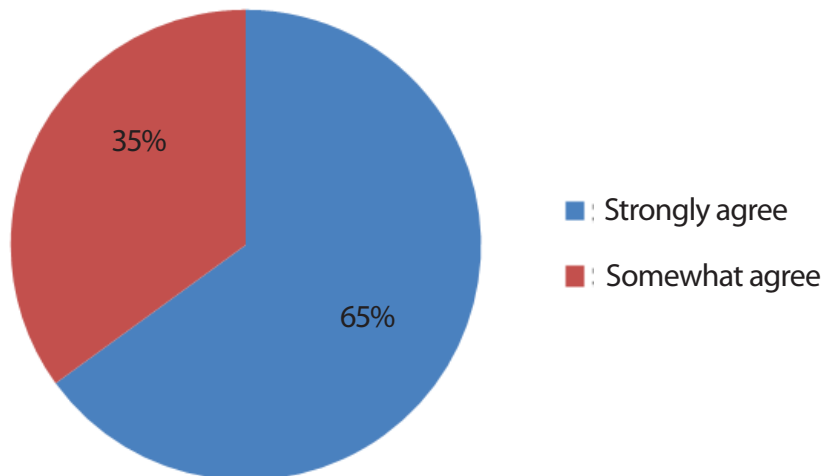
HCWs reported using data from smartboxes and 99DOTS app for evaluation or managing the medication flow for patients:

"I use 80-90% for evaluation and 10-20% to develop treatment adherence of a patient." (participant 11)

"We [can] count doses taken, so this is very convenient. We know how much longer is left for the patient to take pills." (participant 10)

It was noted, however, that not everybody has access to 99DOTS app, particularly in rural areas:

"Only I have it, and district doctors in those districts where they are being implemented… so usually [they are used by] doctor or medical nurse who are responsible for this area. But widely, it is not available" (part.23)

"Only the doctors who worked on your project. Others are not engaged in this" (part.22)

"There is no access at FAPs[16]. If the patient did not take the pills, the curator contacts HCW at FAP, who needs to find the patient. If there is no direct contact between curator and patient, then FAP HCW needs to locate the patient"(participant 23)

[16] FAP - Feldsher Acusher Post (Feldsher offices) in rural areas in Ukraine.

Evaluating satisfaction and acceptability of using smartboxes and 99DOTS app: qualitative data analysis

As noted above, transcripts were subjected to thematic analysis, in which the basis for an initial coding structure was formed from interview guides, with more themes added to account for relevant content. Key themes and subthemes were summarized and reviewed to allow the linkage of quantitative and qualitative data.

The following **key themes** were identified in the course of context analysis:

Ease of use

Most common feature liked by HCWs in using smartboxes and 99DOTS app, was their ease/convenience of use.

Usefulness, ease, convenience

> *"As to 99DOTS app: in one application I can review all my patients, regardless of whether I am at home or out of the hospital visiting patients. The ease of use - I can call to the patient as soon as I see that no signal coming from the patient's EvriMED box. Thanks to this device the patients have higher treatment adherence." (participant 10)*
> *"I like [device's] usability, convenience for the patient."*

Reduction of number of patients' visits to TB facility

Meanwhile, some others noted the suitability of smartboxes for patients living in distant areas and for those leaving on business trips:

> *"It is good to give [smartboxes] to people who live in distant regions and are on long business trips" (participant 18)*

> *"It was not convenient for patients to take smartboxes on vacation or business trips because of a great amount of other luggage". (participant 19)*

A number of HCWs expressed an opinion that DATs is appropriate for a right level of TB treatment control:

> *"EvriMED box helps to some extent to control treatment. The technology itself is interesting and innovative in comparison to the classic treatment approach." (participant 11)*

Meanwhile, some others considered the use of smartboxes as a bonus to motivate adherence:

> *"I motivate patients to be adherent: patients start treatment using regular DOT, later EvriMED box is offered as a bonus for being adherent".*

Smartboxes increased confidentiality for patients taking TB medications, which led to less stigmatization:

> *"Patient is less stigmatized." (participant 23)*

Another concern was that 99DOTS app was not aligned with national TB E-Manager:

> *"It would be great if data from 99DOTS platform could align into e-TB Manager, to avoid manual input. For now, the doctor needs to transfer patient data from e-TB Manager into 99 DOTS but has this info in front of him. On the one hand, it is some improvement. But I would recommend integrating 99DOTS platform and e-TB Manager, so that everything would be in one big system" (participant 24)*

Features that participants did not like in evriMED and 99DOTS app included the following:

- Box material (cardboard)

> *"Cardboard box needs to be replaced by a plastic box. Uncomfortable to plug in the battery."(part 13)*

> *"Did not like that smartboxes were made of cardboard, they get damaged fast, get dirty, and cannot be reused. Especially for XDR-TB patients, who may need to use the box for a year, or 8 months, the material wears out really quickly." (participant 7)*

- Device not always detecting pills taken by a patient:

> *"Sometimes the signal does come of taken doses" (participant 6)*

> *"…patient opened the smartbox, but the signal did not come" (participant 9)*

> *"From time to time, there were missed pills taking detected, with patients claiming they had taken pills; Daily SMS may come that do not match information about consumed doses; Some older patients or those with dementia sometimes are not able to understand how to use the smartbox at all."(participant 19)*

- Excessive text messaging to doctors, not used to this:

> *"I do not like SMS notification that comes in the morning, it is not always correct. For example, I come to my office in the afternoon, it is marked [on 99DOTS app] that patient has taken the dose, however, at 8:30am, SMS came that said the patient did not take it" (participant 19)*

Some participants noted problems created by self-administration of drugs by patients, especially when patients were not very good with technology and did not use the device properly:

"There are problems with batteries. Even though we inform patients how to charge them, they do not always pay attention. One patient had a device uncharged for a long time; he either lost the charger, or left it at home, and was afraid to tell me. Finally, he told me, and got a new charger, but I couldn't monitor his drug intake for the whole month.. If a patient had not been made responsible for device and would come to me to charge it, it would be better".(participant 19)

Participants outlined a number of **technical issues** with the smartboxes:

- Battery is not charging or charging badly.

"Some devices charge badly, and some are not charging at all. Needed to explain what to do, how to charge correctly" (participant 7)

"Technical issues (smartbox stopped working after a few days; battery dying fast; there were several smart-boxes not working for unknown reasons" (participant 9)

A number of participants noted problems with using 99DOTS platform:

"SMS is coming to my phone, telling that patient didn't receive treatment, while in the program it is confirmed that the treatment taken. The patient took treatment, but no mark of that was made in the system. There were cases of patients lost from 99DOTS app" (participant 18)

"What I did not like was the technical side. It may happen that I open the tablet [to go to 99DOTS app] and see that the line is empty [patient did not take dose]. I call the doctor: - "How can this happen? You have input the patient, but those ones… [lines] are red. She responds: "Really? I am talking to him, and he is taking [pills]. I do not know why it does not work. I input manually." So I understand that maybe it is imperfect now, but will improve with time….I see in my smartphone… a week has passed, and all lines are red, so I am asking the doctor, "Why did you take the box? In order for it to stay open?" –"No, she says, I open the box, but something does not work right. But I called the patient. So at least they stay connected, and I am sure the patient is taking pills" (participant 23)

"Sometimes the device is not working and malfunctions of EvriMED box appears: the signals are not coming into 99DOTS platform, incorrect battery calibration, the time settings in the program do not match with the local settings, change the units of battery capacity measurement and specify the % of charge left". (participant 11)

Problems with devices' replacement

"It's difficult to assemble the boxes… It takes a long time and is very difficult to plug in the battery into the device". (participant 3)

Recommendations on improvement

Participants suggested a number of practical measures to improve the use of smartboxes:

"[It is needed] to turn off SMS - information by phone, because the doctor can check pills consumption through 99DOTS platform; To turn off the yellow signal, no one uses it, because patients can see by themselves when it is necessary to refill the box" (participant 19)

"I would improve the box itself (better fixation of the electronic device is required, I would make the box of other material (for example, plastic); the [battery] charge lasts for a short time, something should be done with this problem." (participant 9)

Some participants suggested video monitoring at drug uptake from the smartboxes would be a plus to monitor adherence:

"It would be good to have a video on a smartbox: once the box is opened, the drug uptake can be filmed in real time." (part. 9)

It was noted that the application use could be extended beyond managing TB patients, also to monitor ART adherence:

"Can be used not only for patients from e-TB [Manager] but also for ART therapy control as well" (participant 7)

Feasibility and Acceptability of evriMed devices and 99DOTS platform: analysis of patients' survey responses
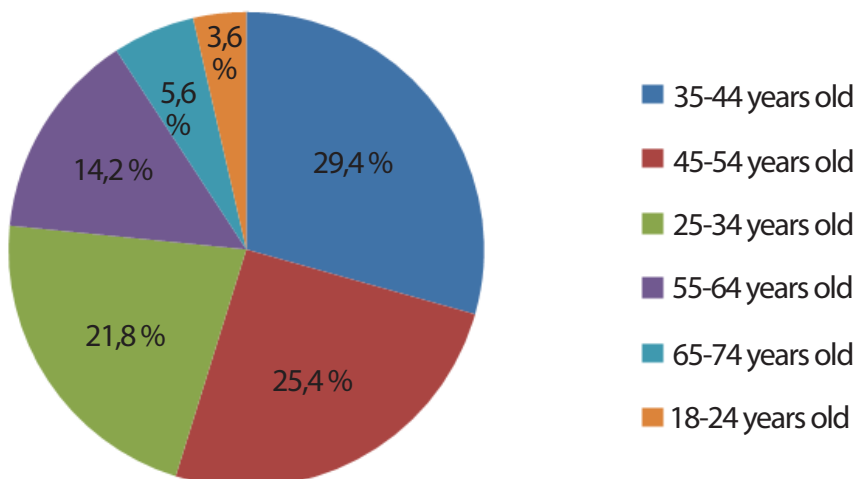
The study sample is comprised of 200 patients. Among them there were 61.5% of patients with a drug-sensitive form of TB, and 38.5% with drug-resistant tuberculosis. Patients were interviewed at different stages of their TB treatment. Particular attention was paid to patients at the 7th month of treatment (24.1%), and to those who had already completed the course of treatment (41.1%), to provide more opportunity for experienced patients' opinions on the use of EvriMed smartbox.

Respondents' numbers according to "Month of treatment" in %

16,1 %

41,2 %

18,6 %

24,1 %

- Treatment completed
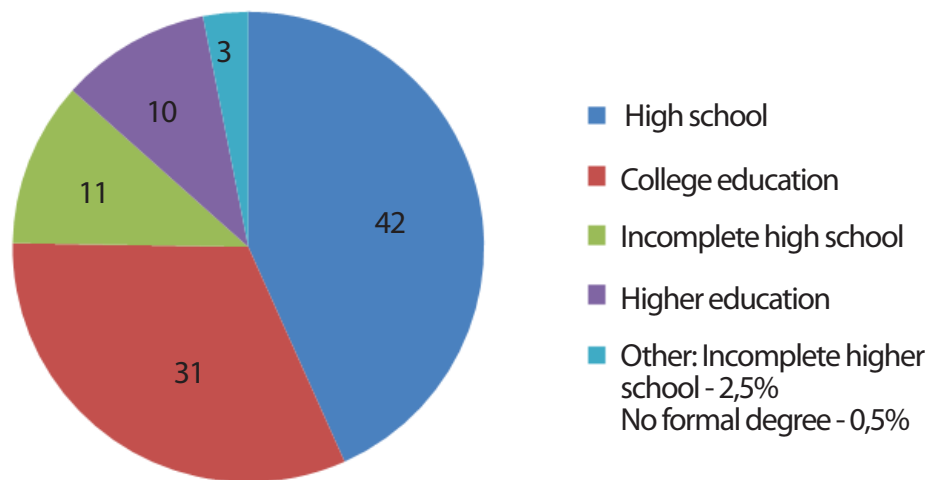- 7 months or longer
- 1-4 months
- 5-6 months
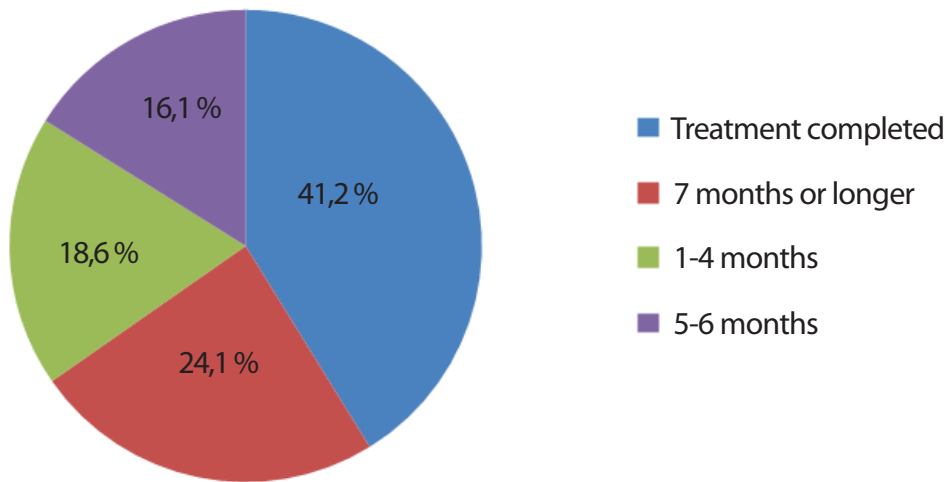
Data collected from patients using EvriMed to demonstrate their demographic profile, gender, location, and other relevant parameters, illustrated by the diagrams below:

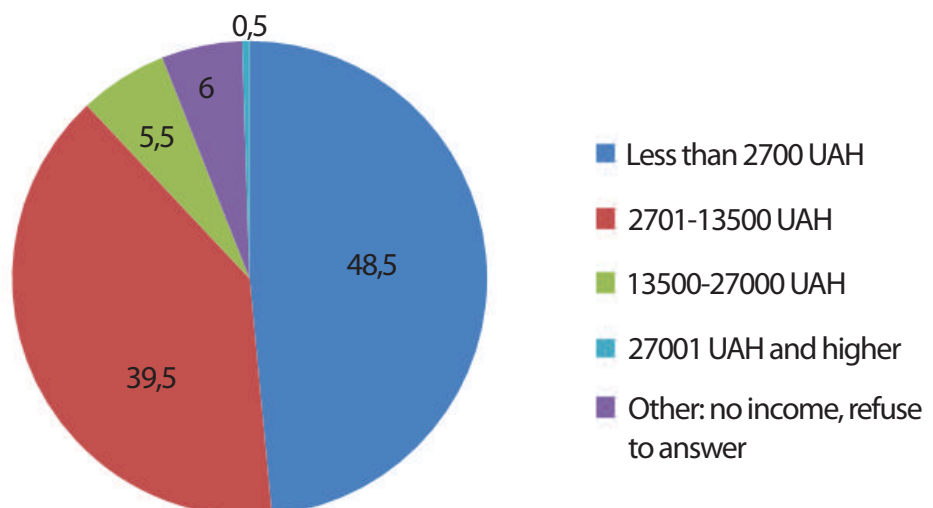### Age of patient respondents

3,6 %

5,6 %

14,2 %

29,4 %

21,8 %

25,4 %

- 35-44 years old
- 45-54 years old
- 25-34 years old
- 55-64 years old
- 65-74 years old
- 18-24 years old

Gender: 50,5% of patient respondents were men and 49,5% women.

Education level of respondents in %

- High school — 42
- College education — 31
- Incomplete high school — 11
- Higher education — 10
- Other: Incomplete higher school - 2,5%
  No formal degree - 0,5% — 3

Disaggregation by education suggests that respondents with high school (42%) and college education (31%) were the most vulnerable among the populations susceptible to TB, indicating that respondents with this level of education do not always have access to proper working conditions, may have a harmful environment and lack appropriate medical support.

Respondents' income level in %[17]

- Less than 2700 UAH — 48,5
- 2701-13500 UAH — 39,5
- 13500-27000 UAH — 5,5
- 27001 UAH and higher — 0,5
- Other: no income, refuse to answer — 6

Almost half of the patients (48.5%) earn less than 2,700 UAH (103 EUR) per month, and their economic vulnerability might cause the higher likelihood of the disease and reduces the possibility of effective TB prevention; and 39.5% earn in the range from 2701 UAH (103 EUR) to 13500 UAH (517 EUR) per month. The data on income demonstrates that TB remains the disease of the poor in Ukraine.

[17] In Ukrainian Hryvnias (UAH), 100 UAH = 3,83 EUR as of 18/12/2019

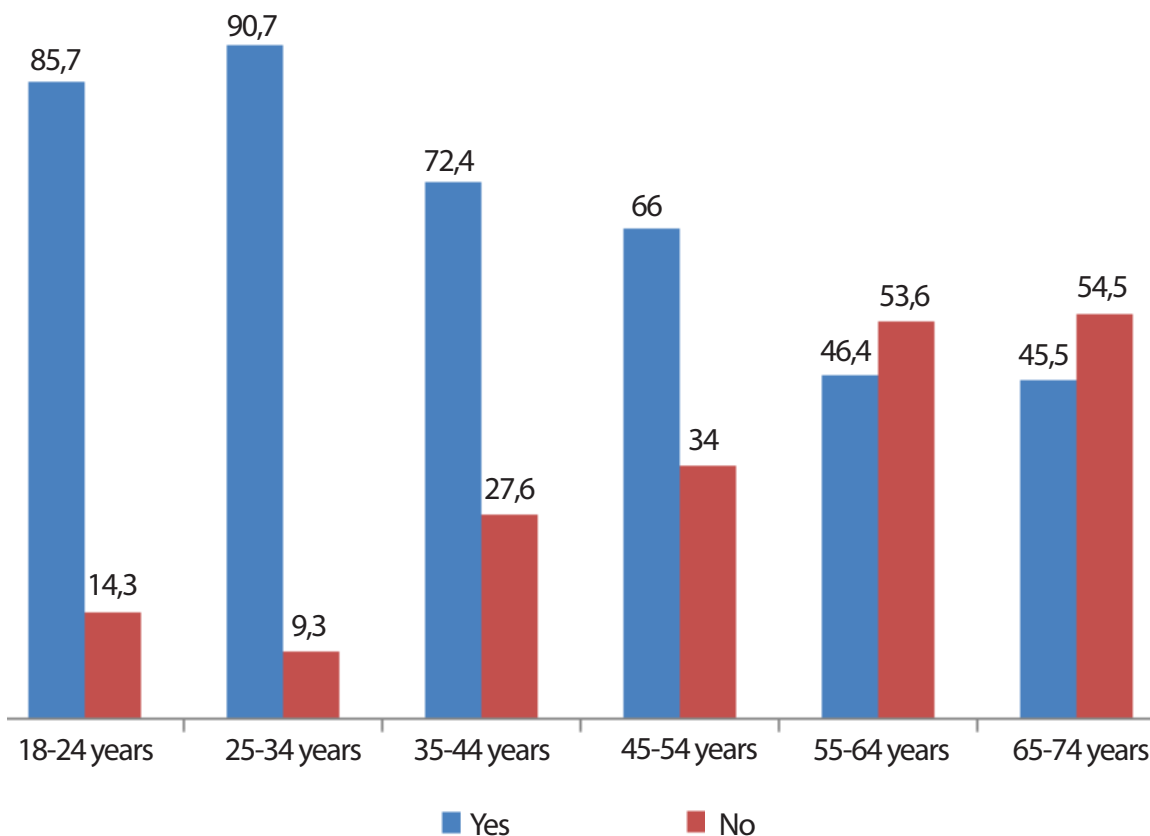## Characteristics and technical skills of EvriMed smartBox users

"Is your phone a smartphone?" in %

Yes
70,5%

No
29,5%
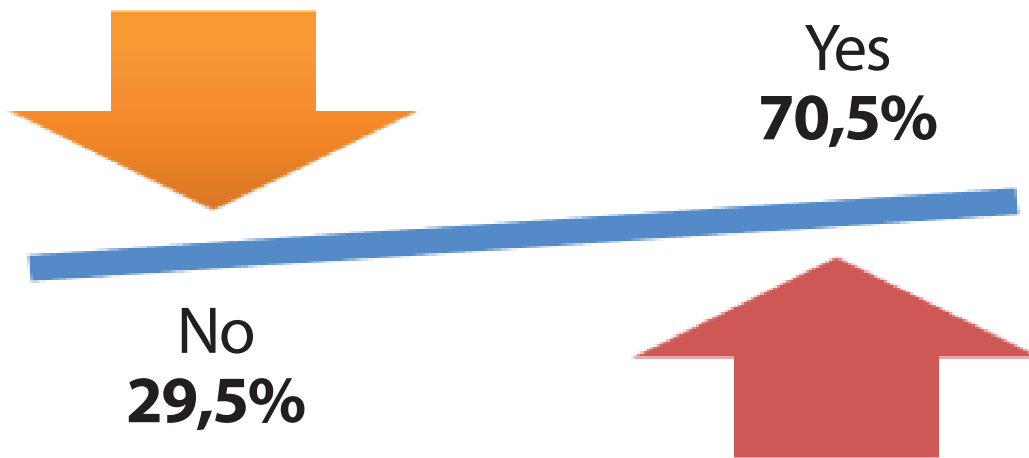
70.5% of respondents use a smartphone, which allows the patient and the doctor to communicate more effectively, and install various phone applications and reminders.

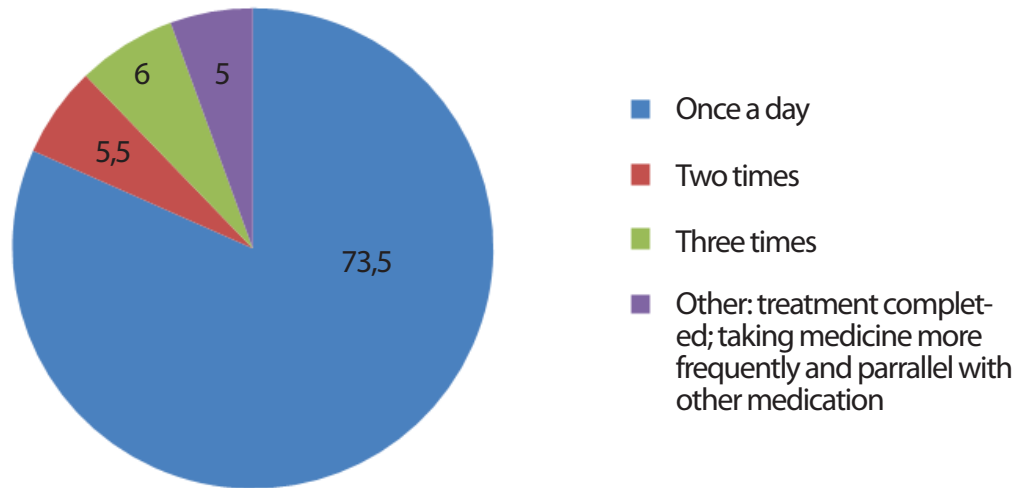The use of smartphone correlates with age: the older the patient, the less he/she uses the smartphone or reports having it:

"Is your phone a smartphone?" in % by age group

Age group	Yes	No
18-24 years	85,7	14,3
25-34 years	90,7	9,3
35-44 years	72,4	27,6
45-54 years	66	34
55-64 years	46,4	53,6
65-74 years	45,5	54,5

■ Yes   ■ No

Patient experience with EvriMed smartbox

"How often do you take TB drugs?" in %

- Once a day
- Two times
- Three times
- Other: treatment completed; taking medicine more frequently and parrallel with other medication
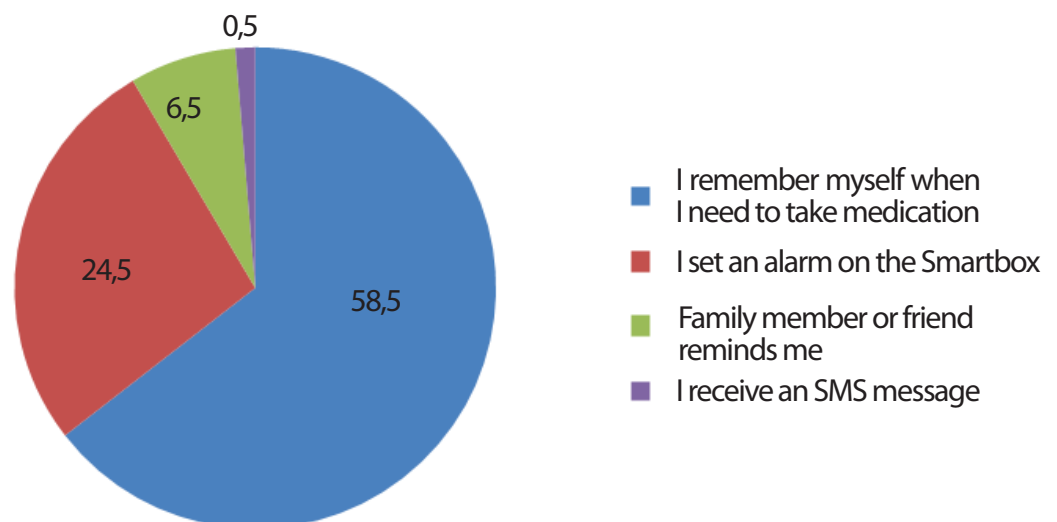
The majority of respondents (73.5%) use a smartbox once a day for drug intake, 5.5% take drugs twice, and 6% - three times a day. In open-ended questions, patients taking the drugs more than once a day, noted that spreading out the drug intake due to the use of smartboxes allowed them to undergo the treatment more comfortably and made it easier to endure the drugs side effects (more detail is provided in open-ended responses analysis section below).
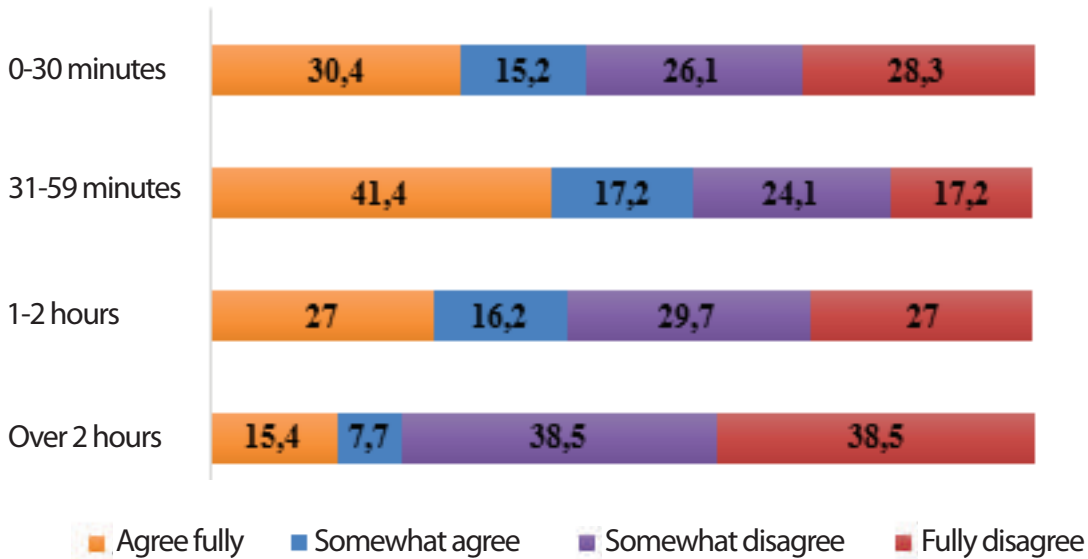
The answers to the question **"What reminds you to take TB drugs?"** distributed as follows (in %):

"What reminds you to take TB drugs?" in %

- I remember myself when I need to take medication
- I set an alarm on the Smartbox
- Family member or friend reminds me
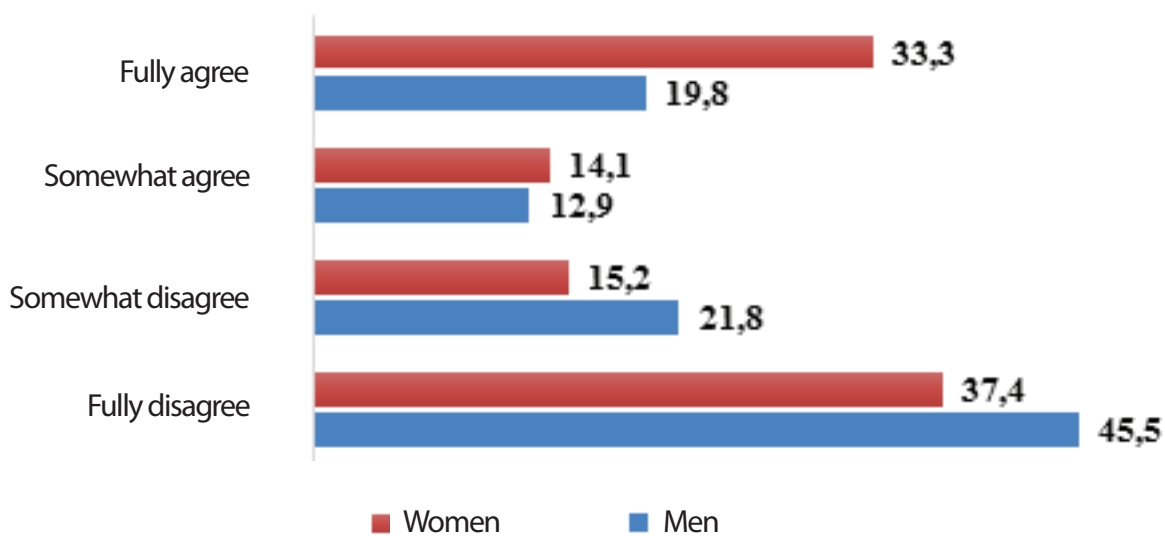- I receive an SMS message

Patients' own motivation and self-management came first as the answer to this question. 58.5% of respondents remember themselves when they need to take their medication or know the required schedule. 24.5% set an alarm on the smartbox. Only 6.5% of patients are reminded by family or friends. The data suggest a high level of self-motivation of the respondents.

Responses to the statement "I'm comfortable using the smartbox in front of other people" correlation with the time needed to travel to TB facility, in %

	Agree fully	Somewhat agree	Somewhat disagree	Fully disagree
0-30 minutes	30,4	15,2	26,1	28,3
31-59 minutes	41,4	17,2	24,1	17,2
1-2 hours	27	16,2	29,7	27
Over 2 hours	15,4	7,7	38,5	38,5

Mostly, patients feel uncomfortable to take TB drugs (use their smartboxes) in front of other people. Those who live far from treatment facilities and spend more than 1 hour to get there, are more concerned about other people seeing them taking medications.
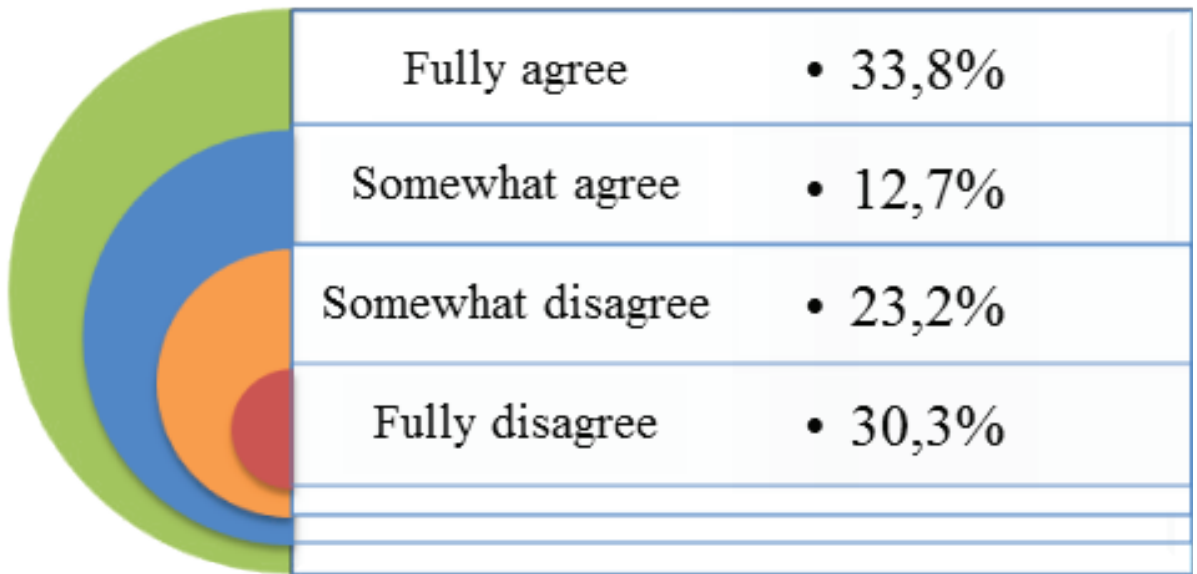
Responses to the statement "I am concerned that because I use a smartbox, people will find out that I have TB" correlate with gender (%)

	Women	Men
Fully agree	33,3	19,8
Somewhat agree	14,1	12,9
Somewhat disagree	15,2	21,8
Fully disagree	37,4	45,5

In this context, the gender difference in responses is notable. Almost half of women with tuberculosis (47.4%) are concerned that the use of smartboxes may make others aware of their disease, while only 32.7% of men pay attention.
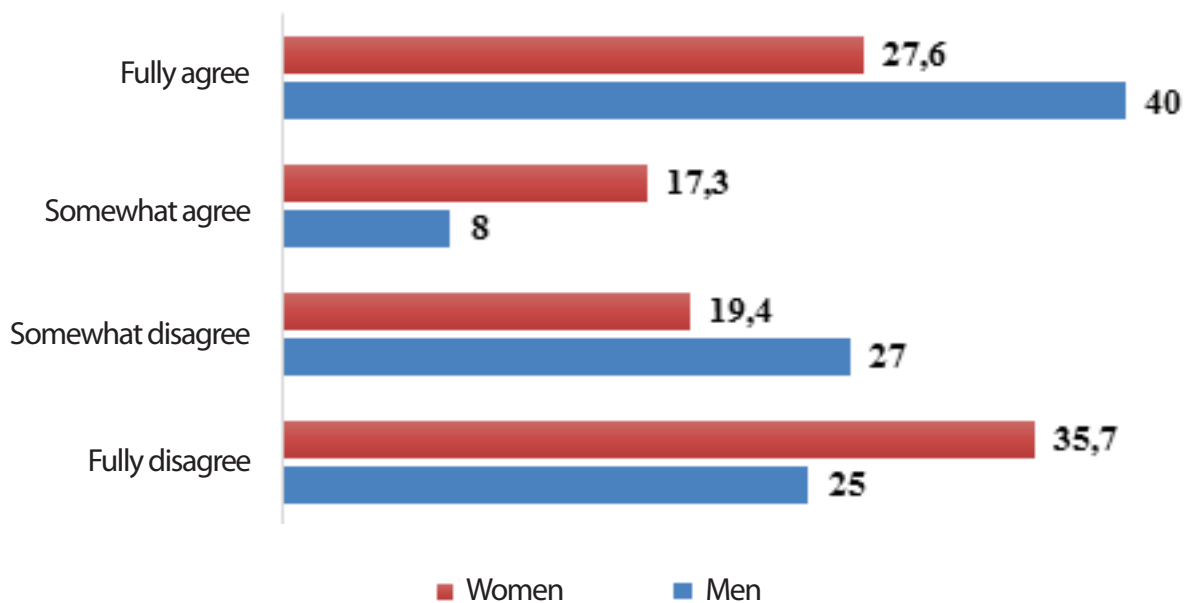
As noted earlier, one of the most common recommendations for improving smartboxes was to make them smaller, and it can be assumed that probably the size of a smartbox can cause a discomfort for women.

"I am comfortable using the smartbox outside the house" in %

Fully agree	• 33,8%
Somewhat agree	• 12,7%
Somewhat disagree	• 23,2%
Fully disagree	• 30,3%

Responses on the convenience of using the smartbox outside the house were polarized, with more patients noting some degree of inconvenience (53,5%), while 46,5% responded feeling comfortable.
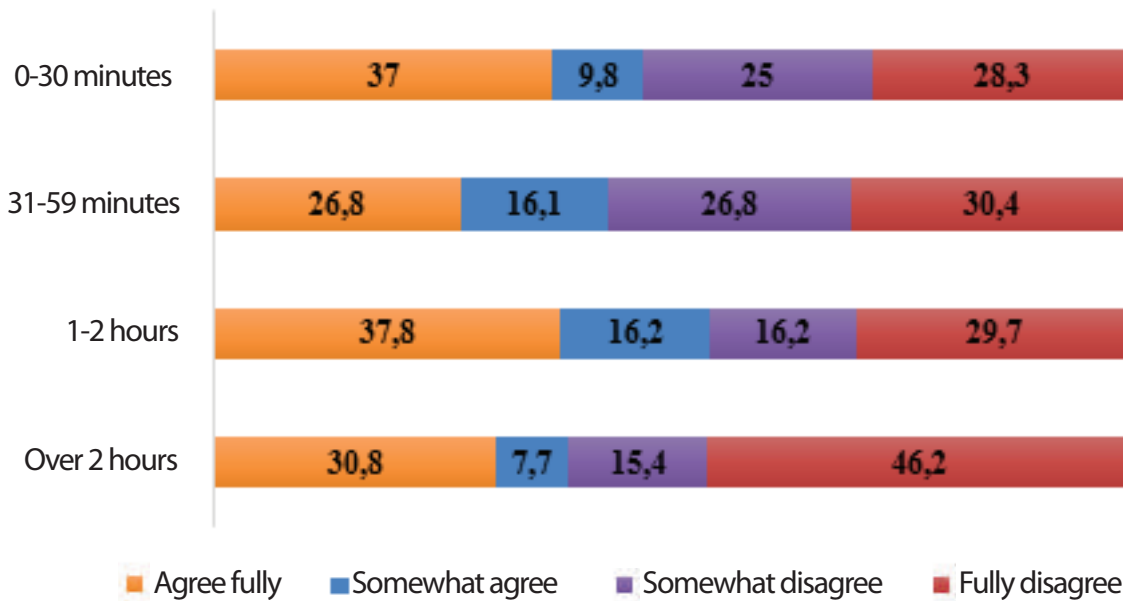
**Responses to the statement
"I am comfortable using the smartbox outside the house" by gender, in %**

	Women	Men
Fully agree	27,6	40
Somewhat agree	17,3	8
Somewhat disagree	19,4	27
Fully disagree	35,7	25

Data shows that men feel more comfortable to use the smartbox outside the home than women. This may be because women are more concerned that their environment does find out about their disease.

Responses to the statement
"I am comfortable using the smartbox outside the house" by the time needed to travel to TB facility, in %

|	Agree fully	Somewhat agree	Somewhat disagree	Fully disagree
0-30 minutes	37	9,8	25	28,3
31-59 minutes	26,8	16,1	26,8	30,4
1-2 hours	37,8	16,2	16,2	29,7
Over 2 hours	30,8	7,7	15,4	46,2

The same trend is observed mentioned above, i.e. the more time a person spends travelling to TB facility, the less convenient it is for the person to use the smartbox out of the house.

Employment status
The pool of the respondents was divided almost equally into employed and not employed:

Employed
49%
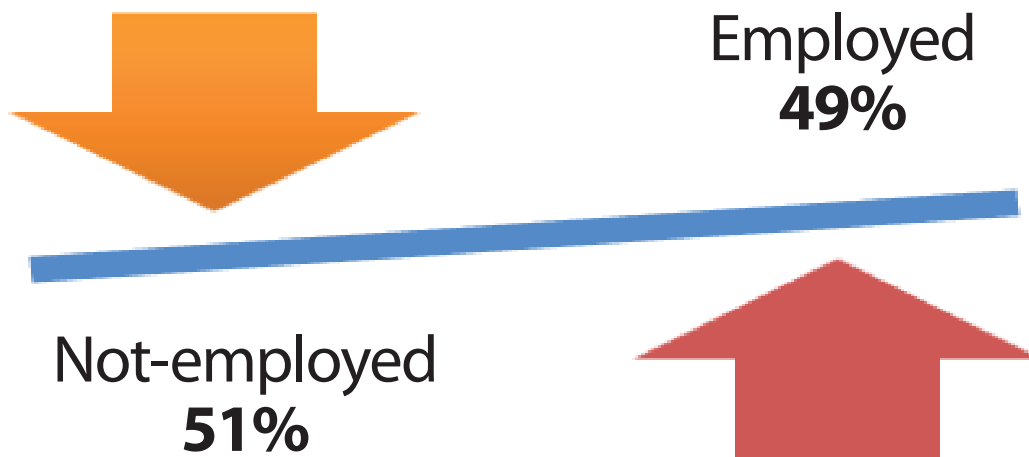
Not-employed
51%

Several correlations were notable in regard to patients' employment status.

For instance, not employed respondents have a higher tendency to conceal their TB diagnosis from others:
"Do people who live with you know that you are taking TB medication?"
by employment status, in %
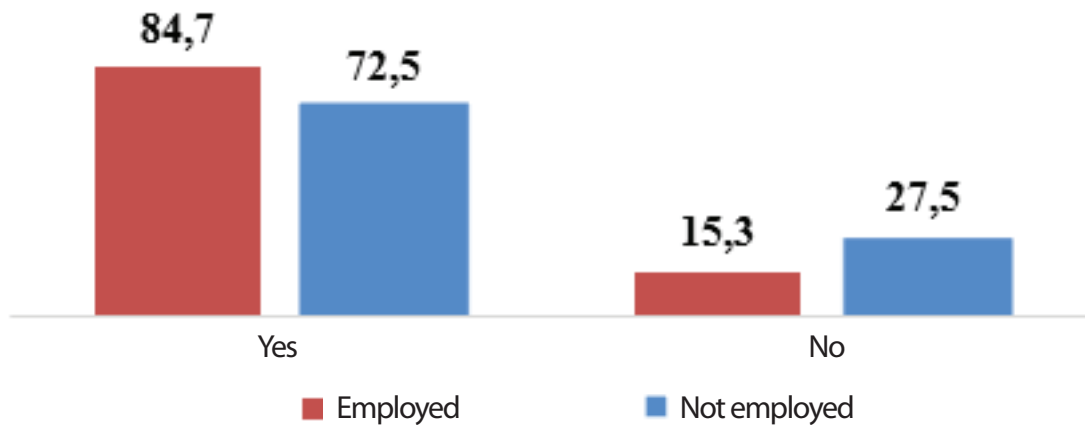
Employed people more openly tell people who live with them about taking tuberculosis medications (84.7%). Not employed people are more likely to hide their disease.

At the same time, not employed people were slightly more hopeful that using a smartbox would allow them to complete successfully treatment:

"Using a smartbox will help me successfully complete my treatment",
by employment status, in %
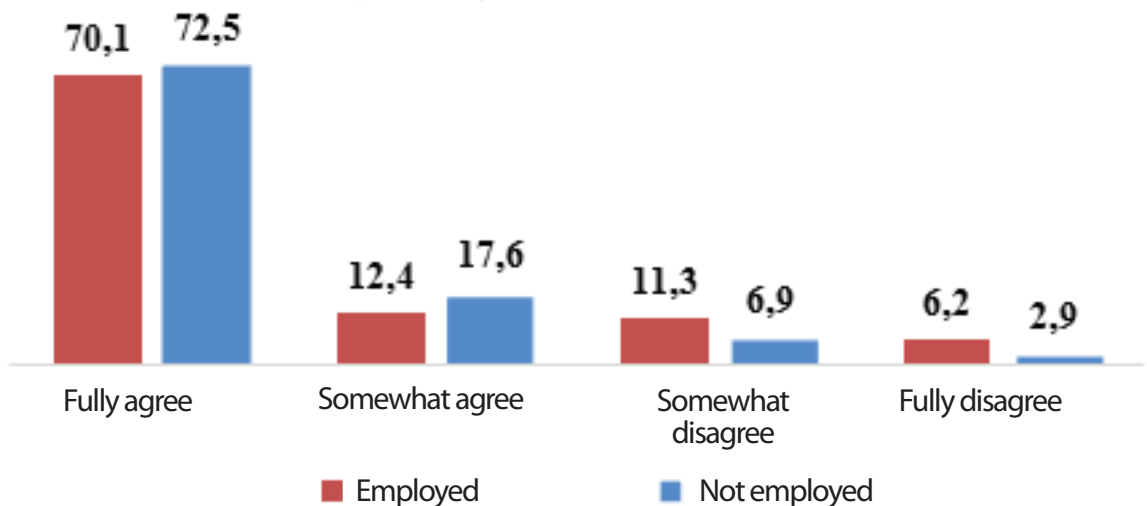
Not employed respondents expressed more hope that using a smartbox will help them successfully complete treatment. That is because they consider the use of the device as an opportunity to return to their usual way of life and, possibly, to employment.

Overall, the majority of respondents feel better connected to their doctor through the smartbox and report that DAT allows them to make fewer visits to the hospital. These answers suggest the device is a tool to establish effective communication between the patient and the doctor.

The majority of the respondents indicate that using the device will help them to complete their treatment and become healthier. In other words, the use of the Smartbox has both positive clinical and psychological effects, and strengthens confidence in recovery, this was particularly noted by patients who completed treatment.

Totally, 90.5% of EvriMED smartbox users are ready to recommend a smartbox to anyone with TB. This indicates a high level of satisfaction with the use of the device.

Confidentiality

Respondent's attitude to confidentiality significantly influenced the way they use smartbox.

Not all users tell others that they are taking TB medication. Almost half of those surveyed say that they are uncomfortable taking medicines in front of other people, this is especially true in patients with drug-sensitive TB.

The greatest level of discomfort and concern is indicated by people who need to spend more than one and two hours on a trip to the doctor. 62.8% of those surveyed who conceal their disease said they were uncomfortable using the device in front of others.
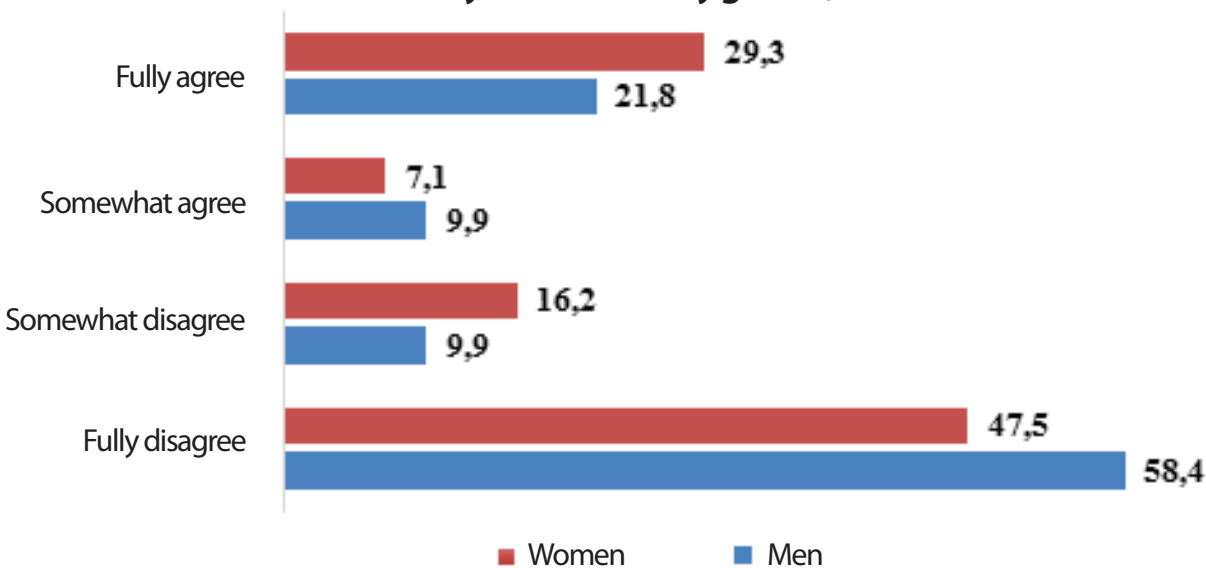
"I am concerned about the confidentiality of my health information collected by a smartbox" in %

Fully agree	• 25,5%
Somewhat agree	• 8,5%
Somewhat disagree	• 13%
Fully disagree	• 53%

However, concerns about the confidentiality of a respondent's health information collected by a smartbox cause less concern than using it publicly.

Of those surveyed, only 34% have some concerns about collecting personal information. This may be because respondents trust the doctor more than other people.

"I am concerned about the confidentiality of my health information that is collected by a smartbox" by gender, in %

Fully agree: Women 29,3 — Men 21,8
Somewhat agree: Women 7,1 — Men 9,9
Somewhat disagree: Women 16,2 — Men 9,9
Fully disagree: Women 47,5 — Men 58,4

■ Women   ■ Men

Women experience a greater level of discomfort when using smartboxes outside the house, which may be due to the uncomfortable size of EvriMED, as it was repeatedly pointed out by respondents. Moreover, women express a significant level of concern about collecting sensitive information about their illness.

Open-ended responses

Of a total of 200 patients who took part in the survey, 30 patients answered the qualitative part of the multi-method survey. Following below is the analysis of open-ended responses. Illustrative quotes are given. Numeration is separate from numeration used in quotes from HCWs interviews.

Purposes of using smartbox as seen by patients

Among the purposes of using smartbox identified by patients are:

- To remind you to take medication

"To not forget to take medication by young and old, and easy to store" (participant 1)

"First of all, it was a reminder, because there is an alarm. Initially, I forgot [to take pills] when I first started to use it" (participant 13)

- To save time and money for patient to travel to DOT site

"For convenience sake, and to save time, not to mention 1200 hrivnas[18] spent to travel [to DOTS site] every month" (participant 5)

"To save time and not to go to hospital every day. It is more convenient" (participant 22)

"For convenience sake. When I was on treatment before, I used to go every day for pills. This takes time, and spoils your day planning. Now I know that [device] will remind me every morning, and I can plan my whole day and save time" (part.30)

- To enable the doctor to monitor drug intake

"To remind, and for the doctor to see that a person is taking medication"(participant 29)

"Additional reminder, and control on the side of the doctor" (participant 20)

Among the features liked by patients, the following ones were mentioned:

- Convenience of use:

"Compact" (participant 2); "small, compact, has a lamp"(participant 9); "Convenient, portable" (participant 6); "Convenient thing" (participant 5)

- Light weight: *"Cardboard, light"* (participant 4)

- Allows for in-home treatment:

"…possibility to treat at home." (participant 11)

- Alarm reminding to take medication

"I like the box beeping – the reminder signal" (part.13)

"I liked that it reminds when it's time to take pills" (participant 26)

- Saving time on doctor's visits

"Convenient, practical, no need to go to doctor every day" (participant 28)

"I like that I do not need to run to doctor all the time, it saves time" (participant 24)

"Saving time" (participant 25)

Features of smartbox that patients did not like

Among the features that patients disliked in smartboxes, were:

Patient is ready to undergo treatment with evriMED smartbox.

---

[18] 1200 hryvnas is roughly equivalent to 40 EUR that can be a significant burden for an average Ukrainian. Remember from earlier in the report that almost 50% of TB patients has an income of just about 100 EUR

- Did not allow for visual contact with doctor

"No visual contact with the doctor" (part.18)

- Box made of cardboard

"Cardboard box, and not closing tightly" (participant 2)

"Made of cardboard" (part. 1)

"… I am concerned that it's cardboard and I cannot take it out with me" (part.15)

- Size and material of the box

"Large size" (participants 3,6, 11);

"[Box] material – not durable enough.. Don't like box design… size too large" (part.30)

"Material of the box – I am afraid to put it on top of something, or spilling something and spoiling it" (participant 25)

"Design makes it inconvenient to take it out with you" (part.28)

".. too big" (part.18)

- smartbox getting dirty

"Gets dirty fast, requires wiping all the time" (participant 8)

"Cardboard surface gets dirty" (part.5)

- Box not closing tightly:

"not closing tightly" (participants 1, 2)

"Top not closing tightly" (part.18)

"not possible to close [box] tightly" (part.5)

Although many patients did not report any difficulties when using evriMED, some still experienced technical problems. Among the problems that patients experienced with smartboxes, were:

- Battery may discharge

"Afraid that battery will discharge" (part.19)

"Battery died" (part.6)

- Bad network coverage

"Bad mobile connection because my house is badly located" (part.20)

- Device making noise

"Device beeped all the time" (part.4)

- Notification not going out after pills taken

"Signal did not go out after I took medication" (part.21)

"when visiting parents in the village, the con-

nection was bad there, so signal did not go to the doctor, showed a missed dose" (part.30)

To resolve these issues, most patients contacted the doctor for help: "charged the device together with a doctor" (part.12); "a doctor gave me a charger" (part.6); "I gave it to health workers to charge, they replaced with a new one" (part.4); "Took to the doctor, the module was replaced with a new one" (part.30).

Patients articulated the following suggestions on improvement of evriMED

- Improving the design and size of the smartboxes

"To make the [box] color brighter" (participant 7)

"Make them brighter and not getting dirty fast" (participant 12)

"Add the 10th section for the medication dose [19]" (participant 7)

"[To] change size" (part.10)

"I was saying that color should be darker" (part.19)

"To make a smaller size box" (participant 3, participant 6)

- Replacing cardboard with plastic

"Cardboard box needs to be replaced by plastic, and it should be easier to close it" (part. 2)

"I think all will agree that the material of the box should be changed" (part.25)

- To add video monitoring

"To have a video [monitoring]" (part.18)

"Video camera should be installed" (part.27)

One question asked about whether patients consider the device useful even after long use. Patients who had longer treatment term, and used the smartbox longer, reported getting used to the device, not paying much attention. Most said they could not do without it now.

"At first, we were very happy, it was like getting a new phone, but now relate to it as a usual thing." (part.17)

"Smartbox are convenient and allowing not to visit a [DOT] facility" (participant 4)

"it [smartbox] feels like a buddy" (participant 10)

"useful, and I am glad that such a thing is available" (participant 11)

---

[19] Boxes used in project had dividers, making the total number of sections nine. Having an extra section/s will increase the number of days the patient will take medication at home.

In the meantime, there were responses that using smartbox did not make much difference, or it was the same with or without smartbox:

> "I can do without it. It does not provide control as such" (part.26)
>
> "No change, I can get treated without smartbox, but with smartbox, the doctor can monitor, so all depends on a person's motivation" (part.27)
>
> "My attitude is neutral, I feel so I can get treated with [device], or without it. But more comfortable, with device" (part.28)

One patient linked the use of smartbox with feeling better and gaining weight after starting treatment, as well as having a more relaxed regimen of medication intake:

> "When I first got the device, my weight was 53 kg, and now it is 62 kg, all because of using it. Before, I was taking all pills at once, and felt bad afterward. Then doctor said that I could take two pills every two hours, so I can do this at home, and not run every two hours to the doctor" (part.24)

Different patients' attitudes to smartbox use

One of the questions asked was whether the patients told anybody about the smartbox. Based on the patients' responses, there were two different types of reactions:

> a) Positive, supportive attitude in patient's family and social circles:

> "I told friends, acquaintances – all reacted positively" (part.19)
>
> "I told mom that this box is to treat me, there was no unusual reaction, normal reaction" (part.13)
>
> "Yes, I told, all were interested and liked it" (part.4)
>
> "Told all like it was – the box is to store pills, to show doctor that I have taken them, and everybody reacted normally" (part.28)

b) Stigmatization fears, the need to conceal status or limit the number of people who knew about the smartbox:

> "Did not tell anybody" (part.14)
>
> "Didn't tell anybody, as I am worried all will turn away from me" (part.17)
>
> "Told my children that these were mom's vitamins" (participant 7)
>
> "Told nobody – less they know, better they sleep" (part.16)
>
> "Except my wife, did not tell anybody. She was with me during all doctor's visits, and we think this is the best device" (part.24)
>
> "Told that it is a "chest for pills". I try not to have contact with people" (part.30)
>
> "I told my friend, did not tell others – why tell? They may find out [diagnosis] and will ask odd questions." (part.29)

Discussion

Patient inclusion criteria to use DAT: equity issues

Initially, HCWs were very careful with patient selection, trying to avoid device loss or damage by patients. This may represent a potential challenge, when devices will be funded through local budgets. Over the few months of DAT implementation, this issue was resolved, and HCWs offered devices to almost all their patients. Patients at higher risk of treatment interruptions, including those from distant rural areas, socially disadvantaged groups etc., have received TB treatment using smartboxes as well.

'Reliable' versus 'less reliable' patients

Analysis of the HCWs responses and project team interviews suggest that smartboxes are restricted initially to patients with perceived high adherence. Criteria used in selecting patients suggests some degree of doctor's discretion. Later on, during the project implementation, more patients were trusted to use the devices, conditions for such loosening were not always clearly articulated. While this survey is not focused on patient exclusion criteria, it is clear that 'less reliable patients' would still need different approaches, including classical DOT or VOT. In resource-constrained settings, this means that as resources are saved by using digital monitoring, more resources can be focused on 'less reliable patients' who will most benefit from focused counseling or selective DOT, as has been suggested in some studies[20].

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[20] Moulding TS: Viewpoint: Adapting to New International Tuberculosis Treatment Standards With Medication Monitors And DOT Given Selectively. Tropical Medicine & International Health: TM & IH 2007, 12(11):1302-1308.

Project specialists made their monitoring visits through Mykolaivska in Odes'ka oblasts.

"They first conduct a questionnaire on adherence, so therefore, the patients with low adherence will not get smartboxes. We use a developed adherence questionnaire that is administered at the beginning of treatment. Different questionnaires are used at different stages of treatment. So [smartbox] is offered to [patient] with high adherence. So, we watch, that patient visits regularly, and then we may offer [smartbox]. Sometimes we give on the first day… counseling is constantly offered… smartbox is not given to everybody in a row. The terms are defined for control [TB] tests, and communication constantly continues with patient about sideeffects. If the patient experiences side-effects, they will themselves come early, not waiting when the pills run out"(HCW participant 24)

Dominance of 'High Satisfaction' in HCWs responses and concerns

All HCWs highly praised the use of the DATs and declared smartbox as a useful device. However, it was unclear, with exception of few respondents who provided detailed responses, what were the actual problems that HCWs experienced, as their responses were mostly 'praising all' statements with very little detail of problems. Most responses were 'Somewhat Agree' or 'Strongly Agree'. Nobody expressed disagreement.

Common responses about the training on using the DATs included many statements such as:

"I liked everything"(participant 10)

"Cool! Everything was great!" (participant 8)

"Wonderful impressions. Information accessible. Material presented quite informatively, theoretically and in the slides" (participant 17)

As to the patients' responses, they seemed to lean towards a more positive reflection. Most critical comments on the devices related to the technical side of issues – such as battery charge, design of smartboxes, mobile network connection, etc.

Data confidentiality

DAT usage approach is based on securing anonymity of patients who receive treatment. However, reservations were expressed by few participants regarding ability to protect patient data in digital systems. When answering the questions about possible problems with patient data safety, or having doubts about data storage/safety, some worrying responses were recorded:

"I already said, there is no [data] privacy in our country, and never was. Everybody knows who has TB diagnosis, or AIDS, etc., and it's not a secret to anybody" (part.23)

"I am not worried… I don't think anybody wants to know [diagnosis] ..of course, there is medical confidentiality, so if somebody takes a tablet, and there are names recorded there, so they will be able to find out that such person has TB, so this is not permitted, of course, this is disclosure of diagnosis… But this is unlikely to happen. Only if somebody steals your tablet" (participant 19)

Sustainability of DATs systems

Questions about sustainability of the DATs use after the project's end were added to the HCWs survey that including some local health officials. There were concerns expressed about possibility of funding the approaches through local budgets:

"I do not know really… Local [budgets] not likely. Because of finances, financial [problems], this is what's most important." (participant 7)

"Now people work on tablets given by the project. If somebody will be able to provide [them], I would be happy, but I won't be able to purchase tablets [for doctors]" (participant 23)

Conclusions and Recommendations.

While findings from perceptions studies on new innovative technology-mediated health projects may not be readily generalizable, such studies generate learnings transferable to other settings by drawing attention to the range of factors that may impact adoption and interaction. In these ways, perception studies that 'localize' understandings of how theoretically promising new technologies work in specific locales have an important role to play in informing evidence-based guidance for context-sensitive implementation and scale-up of programs such as EvriMed introduction in resource-limited settings.

Drawing from the experience of the W6 TB REACH project in Ukraine, the DATs perception study provides a snapshot of contextual factors that may affect target population support and intended interactions within the healthcare system.

Based on available documents analysis and analysis of the participants' responses of HCWs and patients, this study concludes that using smartboxes can be an effective approach to measure TB treatment adherence and may improve adherence. Project implementation has demonstrated that evriMED devices could be useful to patients and HCWs, and represent a convenient and cost-saving alternative to visits to DOT facility, particularly from the patient's perspective. However, there were patients who preferred to continue visiting healthcare facility and denied using the smartbox.

99DOTS platform can be used as an online platform to monitor adherence data captured by smartboxes. As of the date for this assessment, the platform was not yet fully adopted, and required some improvements. Essential step could be the integration of adherence platform and e-TB manager.

Regarding the sustainability of using the DATs or regarding their funding from state or local budgets in Ukraine, reservations were expressed, illustrated by the following responses:

"I have considerable doubts regarding financing [these approaches] from the local budget, as at my level, I deal with many other issues of communal financing of health services and so on. Because I am sure that this may be put on the local budgets [for TB], and maybe this will happen, however, I cannot

be sure. When our facility finally becomes a separate entity and will earn money independently, I will be able to find resources to continue – maybe from PATH or [other implementing organization], or through grants from other donors. Or I may take resources from the budget of the [TB] hospital, to enable these activities to continue. I also understand that we will need to pay for mobile connection… And you are leaving us these… devices… tablets. I do not know how long they will continue to work, but will try my best so that they… [continue]" (participant 22).

"We are now undergoing [health] reform. And which services will be covered or not, I am not able to answer now. Local budgets, they are quite different now, there are districts where hospitals do not know where else to spend their money on, and there are ones that cannot even provide elementary emergency services. From April 1, we are under state of reform. There is a list of services guaranteed by the state, and there is list that will not be covered. Therefore, concerning local budgets, whether they would be ready to provide for someone, it is hard to say. All depends on how much it will cost. If this [cost] would be included in service, if someone would calculate the cost of this service, how much it will cost. So this needs to be approached analytically, and do cost analysis, how much it will cost if a patient will come to [DOTS] unit, how much smartbox will cost. So for all this data, analysis is needed." (participant 23)

DAT (in particular, evriMED device) is an acceptable, feasible, and accurate tool which could become a part of standard practice in TB management and treatment.

This study results suggest DAT technologies to be used widely in Ukraine and internationally, to benefit both TB patients and HCW. Also, more in-depth research to get better data is needed to understand DATs' influence on TB patients outcomes.

This project implementation was built on a patient-centered approach with differentiated care. Digital medication monitors can be used to identify 'reliable patients,' so that resources can be focused on 'less reliable patients' who will most benefit from classic DOT, or will require Video DOT.

References used in the report

Arcady Group,
'Global Access for Technology–Enabled Medication Adherence Monitoring and Differentiated Care of Tuberculosis Patients in Resource-Limited Countries,' available at: http://thearcadygroup.com/polaris/wp-content/uploads/2017/08/Global-Access-Strategy_FINAL.pdf

Bionghi N, Daftary A, Maharaj B, Msibi Z, Amico KR, Friedland G, et al.
Pilot evaluation of a second-generation electronic pill box for adherence to Bedaquiline and antiretroviral therapy in drug-resistant TB/HIV co-infected patients in KwaZulu-Natal, South Africa. BMC Infect Dis. 2018;18(1):1–9.

Chowdhury MRK, Rahman MS, Mondal MNI, Sayem A, Billah B.
Social impact of stigma regarding tuberculosis hindering adherence to treatment: A cross-sectional study involving tuberculosis patients in Rajshahi City, Bangladesh. Jpn J Infect Dis. 2015;68(6):461–6.

Hargreaves, J.R., et al.,
`The Social Determinants of Tuberculosis: From Evidence to Action´ (2011) 101 American Journal of Public Health, 4, 654.

Khan, A., et al, (2019) *'Acceptability and Feasibility of Digital Adherence Technology (DAT) in TB REACH projects,'* April 15, 2019.

Kipp AM, Pungrassami P, Stewart PW, Chongsuvivatwong V, Strauss RP, Van Rie A.
Study of tuberculosis and AIDS stigma as barriers to tuberculosis treatment adherence using validated stigma scales. Int J Tuberc Lung Dis. 2011;15(11):1540–5.

Liu, X, Lewis JJ, Zhang H, et al.
'Effectiveness of electronic reminders to improve medication adherence in tuberculosis patients: a cluster-randomised trial'. PLoS Med 2015;12:e1001876 10.1371/journal.pmed.1001876

MOH of Ukraine,
Unified Clinical Protocol for Primary, Secondary (Specialized) and Tertiary (Highly Specialized) Medical Care for Adults with Tuberculosis. 04 September 2014. № 620 https://zakon.rada.gov.ua/rada/show/v0620282-14#n20

Moulding TS: Viewpoint: Adapting To New International Tuberculosis Treatment Standards With Medication Monitors And DOT Given Selectively.
Tropical Medicine & International Health: TM & IH 2007, 12(11):1302-1308.

Priedeman Skiles M, Curtis SL, Angeles G, Mullen S, Senik T (2018)
Evaluating the impact of social support services on tuberculosis treatment default in Ukraine. PLoS ONE 13(8): e0199513. https://doi.org/10.1371/journal.pone.0199513

References used in the report

Public Health Centre of the Ministry of Health of Ukraine TB Statistical Report 2018,
https://phc.org.ua/sites/default/files/users/user90/TB_surveillance_statistical-information_2018_dovidnyk.pdf

Vrijens B, Tousset E, Rode R, Bertz R, Mayer S, Urquhart J. (2005)
Successful projection of the time course of drug concentration in plasma during a 1-year period from electronically compiled dosing-time data used as input to individually parameterized pharmacokinetic models. J Clin Pharmacol. 2005; 45(4):461–7.

WHO Global Tuberculosis Report 2018.
https://www.who.int/tb/publications/global_report/en/

WHO Global Tuberculosis Report 2019
https://www.who.int/tb/publications/global_report/en/

World Health Organization. *Guidelines for treatment of drug-susceptible tuberculosis and patient care (2017 update). April 2017. Geneva, Switzerland.*
https://www.who.int/tb/publications/2017/dstb_guidance_2017/en/

WHO. Global tuberculosis report 2016.
 http://www.who.int/tb/publications/global_report/en/.

World Health Organization.
Tuberculosis country profiles.
http://www.who.int/tb/country/data/profiles/en/

Mykolayiv oblast TB program 2013-2019.
https://www.mk-oblrada.gov.ua/UserFiles/File/program/r10_40.rar

Mykolayiv oblast health department Order No 167-Л as of 14 March 2016 on TB out patient treatment models
http://oblzdrav.mk.gov.ua/images/stories/nakazi/nakazy2016/167-L_14.03.2016.doc

Odesa oblast Strategy on socially dangerous deseases reform, including tuberculosis 2016-2020.
http://oblrada.odessa.gov.ua/wp-content/uploads/279-VII.pdf

Odesa oblast health department Order No 1 as of 02 January 2018 on patient-centered TB out patient treatment models.

Yeleneva I. et al. (2018)
Barriers to TB detection and out-patient treatment at the level of primary health care and recommendations to address them. Study report. Labor and Health Social Initiatives. Kyiv. Ukraine   www.lhsi.org.ua