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Review Article

Effectiveness and Acceptability of Video-Observed Therapy for Tuberculosis Treatment Monitoring: A Scoping Review

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Abstract

Background: Tuberculosis (TB) control programs confront a significant challenge in ensuring patients fully adhere to their treatment regimens. Video-observed therapy (VOT) is an alternative digital technology for monitoring tuberculosis treatment that may potentially improve adherence and clinical outcomes. However, there is limited evidence supporting the effectiveness and acceptability of VOT. This scoping review aimed to summarize the characteristics of existing evidence-based VOT for tuberculosis treatment monitoring and to describe the evidence for their effectiveness and acceptability.

Methods: This review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension for scoping review protocol in Jan 2023. Three databases, namely PubMed, Web of Science, and SCOPUS, were used in this review.

Results: The search identified 170 articles, and after the identification and screening process, 22 articles were included in this review. The findings were categorized into effectiveness and acceptability.

Conclusion: There is a progressively growing body of evidence, particularly in treating and monitoring TB using VOT, which has a positive impact on improving effectiveness regarding health outcomes and is widely accepted to implement. Future studies, such as non-inferiority trials and cost-effectiveness evaluations, will help improve tuberculosis strategies and management.

Keywords: Video-observed therapy; Effectiveness; Adherence; Acceptability

Introduction

According to the Global Tuberculosis Report 2020, 10.0 million individuals had tuberculosis (TB) in 2019, and 1.4 million died from it (1). Mycobacterium tuberculosis drug-susceptible strains account for most TB-related deaths. Adherence to tuberculosis treatment is crucial to ensure a success rate and avoid developing drug resistance, making the treatment process much more challenging (2). The World Health Organization recommends direct observational treatment (DOT), a widely established technique, to help persons with tuberculosis (TB) receive the proper care and recover quickly over the long term (3).

With a global success rate of 75% for new and relapsed TB cases in 2014, inadequate adherence

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to TB therapy is nevertheless frequent, despite long-standing support for monitoring, like direct observation, to assist patients in finishing their treatment (4). Although DOT can be administered in clinics, community, or home settings, it inconveniences patients and service providers. Some patients in treatment often fail to adhere to medication due to the distant location and the high cost of travel to treatment centers (5). Moreover, people who work on daily wages often miss treatment at primary health clinics due to financial constraints. Although using health services is free, indirect travel costs are significant and burdensome for low-income TB patients. Patients receiving anti-TB drugs are impacted by various social issues, such as the stigma associated with taking medication in front of medical professionals and the fear of spreading the disease to others (6).

To ensure the End TB Strategy's objectives are met, creative methods for enhancing care and prevention must be investigated. Digital health initiatives can support TB treatment success. Developments in digital technology have increased the chances of video-observed treatment (VOT) as an alternative approach to DOT. The VOT method is also known as electronic DOT (eDOT), virtually observed therapy (VOT) and mobile DOT (mDOT). This monitoring method can be carried out synchronously involving simultaneous video calls, and health personnel review transmitted images in real-time. In contrast, asynchronous video allows videos to be recorded, uploaded, and reviewed at a separate time, providing greater flexibility to patients and healthcare professionals. Several studies have explored alternatives that employ VOT, using the technical capabilities of smartphones, which are less disruptive to the patient's work and family life, more cost-effective, and improve the patient's access to doctors (7,8).

Several key concepts, principles and theories explain the evaluation of effectiveness including treatment adherence rates, patient outcomes, and the reduction in transmission risk, while acceptability refers to the extent to which patients and healthcare professionals find VOT appropriate and suitable for their needs (9). VOT acceptability assessments can be guided by models, such as the Health Belief Model that highlights patients' perceptions of the severity of TB, susceptibility to the disease, and the benefits of adhering to treatment can influence their willingness to engage with VOT (10). The Technology Acceptance Model (TAM) typically assess "ease of use" (i.e., how simple it is for users to learn the VOT) and "perceived usefulness" (i.e., if users believe it is useful for treating TB), while The Unified Theory of Acceptance and Use of Technology (UTAUT) explain that social support from peers and medical professionals can increase acceptance in the case of VOT, and favorable circumstances like device access and internet connectivity are essential for successful deployment (11).

In response, there has been a rapid increase in digital health interventions, particularly VOT, in healthcare services. However, there is a limited comprehensive review summarizing the scope and use of VOT for this population. According to a recent systematic review, there is still limited data about how digital health technology affects tuberculosis outcomes (12,13). Therefore, this scoping review summarizes the evidence on VOT's effectiveness and acceptability as alternative monitoring in tuberculosis management. Conducting a scoping review gives a broader appraisal of current evidence and gaps in literature and provides opportunities for intervention development among TB patients.

Methods

This scoping review was conducted in accordance with the Arksey and O'Malley's scoping review framework, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines (14).

Research question formulation

This review uses the Population, Intervention, and Outcome (PIO) framework to formulate the

research question (15). Based on this framework, three significant aspects were included: tuberculosis patient (Population), video-observed therapy (Intervention), effectiveness, and acceptability (Outcome), which were then combined into the main research question, "What is the effectiveness and acceptability of VOT for monitoring treatment of tuberculosis patient?"

Data source and search strategy

The literature search was conducted on 1 Jan 2023 until 31 Jan 2023. For a comprehensive search, related articles were searched from three databases (Web of Science, PubMed, and Scopus) using keywords: "tuberculosis" OR "pulmonary tuberculosis" OR "active tuberculosis" OR "TB" AND "video observed therapy" OR "video directly observed therapy" OR "virtually observed treatment" OR "video monitoring" OR "video conferencing" OR "webcam" OR "videophone".

Eligibility Criteria

Types of populations

The population of interest was adult tuberculosis patients, including various tuberculosis such as active or latent TB, pulmonary or extrapulmonary. This review will include other study participants, such as healthcare providers, caregivers, and community DOT volunteer workers.

Types of Intervention

The review focused on interventions designed through digital technology, specifically VOT. The interventions include synchronous or asynchronous VOT. Synchronous will capture live video, while asynchronous VOT allows the patients to record the video and upload it through a smartphone, computer, tablet, or webcam were eligible for inclusion. Any other digital health technology such as short message service (SMS) or electronic medication monitors (MMs), will be excluded.

Type of studies

To be included, studies should have evaluated VOT with at least one form of evaluation, such as effectiveness, acceptability, or feasibility. Studies using mixed, qualitative, or quantitative methodologies could all be included. The review did not require the inclusion of comparators or control groups. The review excluded protocols that described an intervention without conducting any evaluation. Research discussing the early conception of an intervention or research assessing the idea of video-observed therapy, in general, was not eligible. Other papers that were not included in this review were conference proceedings, viewpoints, commentary, opinions, reports, systematic reviews, and meta-analyses. No specification was made for the study's location.

Types of Outcomes

For studies evaluating effectiveness, the outcome includes treatment completion, medication adherence, or clinical outcome. For studies evaluating acceptability, at least one index of these factors (e.g., surveys of participant experiences, challenges, focus group discussion, in-depth interviews, or semi-structured interviews) must have been reported.

Study Selection

The chosen articles are limited to the past ten years, published between 2012 and 2022. The result obtained from the electronic search was downloaded into a reference manager library (Mendeley). Two independent reviewers looked over the titles and abstracts after the duplicate publications were removed to establish the study's eligibility requirements. After retrieving the whole texts of the pertinent studies and the content was assessed to meet the study's eligibility. The third reviewer was assigned to resolve disagreements between the first two reviewers.

Data Extraction and Analysis

Data extraction was conducted by two reviewers, and any discrepancy pertinent to data extraction was discussed to reach a consensus. The collected information was summarized in Excel form and included the following items: 1) general information (including authors, publication date, and country); 2) study characteristics (including the type of intervention and population); 3) method-

ology (including study design); 4) outcome information (definition and measurement) and 5) key findings. A narrative summary was conducted, and the findings were categorized into effectiveness (outcome), and acceptability.

Results

One hundred seventy articles were identified from the literature search conducted in Scopus, PubMed, and Web of Science. After removing 100 duplicates, 70 articles were screened, and 34 full-text articles were reassessed for eligibility. Twelve review studies were excluded. The final 22 articles were included in this review. Figure 1 summarizes the results of the literature search and the selection processes. Overall, 13 of 22 studies (59%) were conducted in high-income countries (including the United States of America, England, Norway, and Australia), followed by two studies each from China and Uganda, one each from Moldova, Vietnam, Nigeria, India, and Thailand. There was a variety of study designs, including randomized controlled trial [5], prospective cohort study with control [5], prospective single-arm cohort study [8], retrospective cohort [1], mixed-method [2], and qualitative study [1]. Table 1 shows the findings on the effectiveness of VOT. Table 2 shows the findings related to the acceptability of VOT.

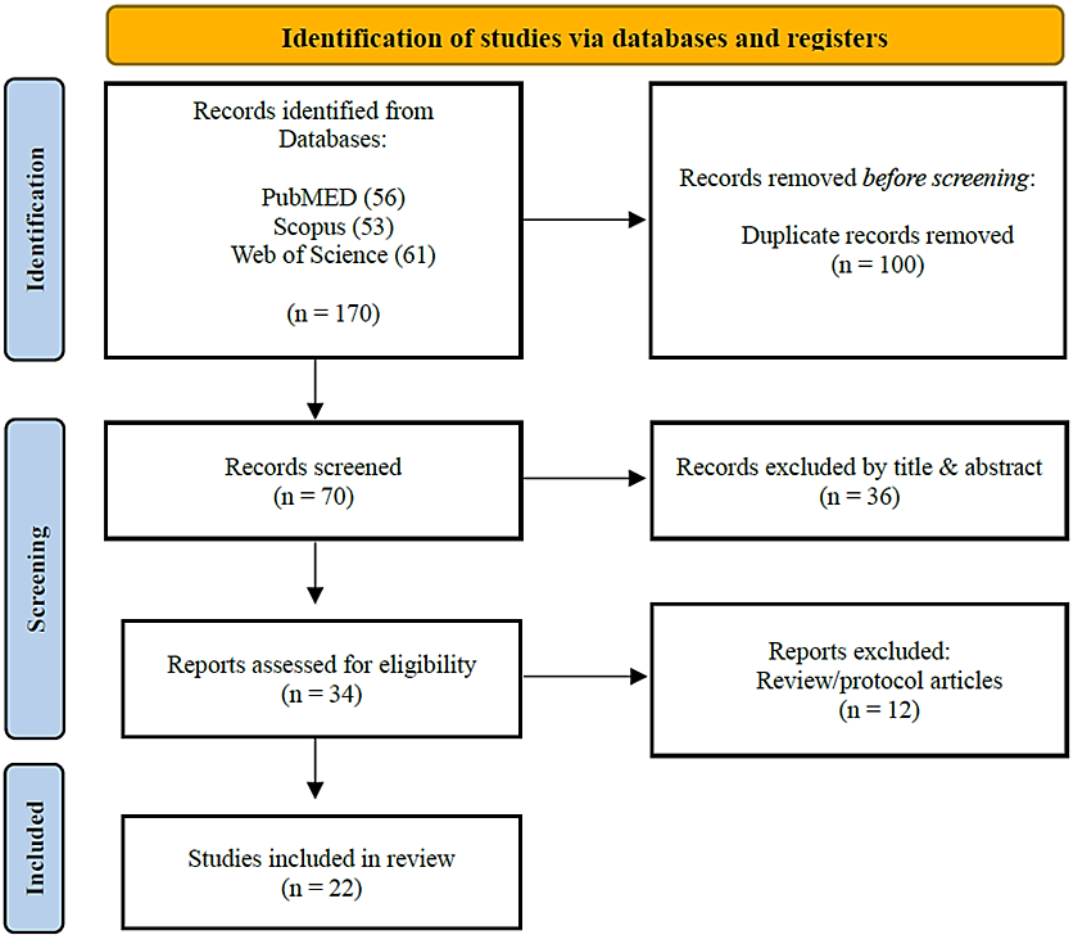

Fig. 1: Search flow diagram for selecting sources of evidence.

Type of intervention

Fifteen studies evaluate asynchronous VOT (n=15, 68%), such as using mHealth application, miDOT, and web-based monitoring platforms, while another six studies evaluate synchronous VOT (n=6, 27%), including smartphone applications, desktop videophone, video conferencing, and video (16-21). One study evaluated both live and recorded VOT (n=1, 5%) (22).

Table 1: Summary of points on the effectiveness of VOT

Measurement	Findings from Studies
Medication adherence	The proportion of doses observed, the fraction of expected doses observed (FEDO) and the proportion of complete doses were significantly higher in VOT than in DOT (8, 19, 23–28)
	The proportion of missed observations was lower in VOT compared with DOT (16, 23).
	Observations of treatment failure every 2 weeks showed that VOT significantly reduced non-adherence by 4 days (29).
	Percentage of completed doses under electronic DOT was noninferior to that under in-person DOT (22)
Medication adherence (single arm studies)	The median fraction of expected doses observed (FEDO) was 85% and this significantly differed by follow-up duration (32)
	The median fraction of expected doses observed (FEDO) was 88%, which did not differ by city (33)
	Number of medication doses observed in videos, divided by the expected number of doses during the treatment period. Mean adherence was 93% in San Diego and 96% in Tijuana (30)
	A proportion of patients completing all doses of self-administered treatment, videos uploaded and discontinuing using VDOT. 27 (71.1%) of patients took all required doses. A median of 88.4% of doses were correctly recorded and uploaded (34)
Treatment completion	Higher proportion of treatment completion between patients with VOT compared with DOT (8, 17, 31)
	Similar treatment completion between patients with DOT and VOT (19, 26)
Treatment completion (single arm studies)	With cure outcomes, all patients finished their treatments; with a 97% compliance rate (18). Forty-five (87%) participants used VDOT until they completed treatment (30)
Bacteriological resolution after treatment	No difference in sputum conversion after completed treatment between VOT and DOT (17, 23, 25, 29) and sputum culture (8, 26)

Effectiveness of Video-observed therapy

Nineteen studies that evaluated the effectiveness of VOT were reviewed in this study. There was consistent evidence from several studies concerning the effectiveness of VOT interventions, especially on the improvement of medication adherence among tuberculosis patients. Eight studies demonstrated that the medication adherence in VOT was significantly higher than in DOT (8,19,23-28). Two studies identified that the proportion of missed observations was lower in the VOT group than in the DOT (16,23). Ravenscroft et al. defined medication adherence as failure observed every two weeks and reported that VOT significantly decreased non-adherence by four days per 2-week period (29). Additionally, medication adherence measured by percentage of completed doses demonstrated that the percent-

age difference between DOT and VOT consistent with a conclusion of noninferiority (22).
Treatment completion was reported in 7 studies (8,17-19,26,30,31), and 3 studies showed a higher proportion of treatment completion among patients with VOT compared with DOT. Four studies reported sputum conversion after completed treatment (17,23,25,29), and two studies reported sputum culture (8,26). However, treatment outcome was similar in all studies (no difference in sputum conversion or culture between VOT and DOT). In a single-arm study, the median fraction of expected dose observed (FEDO) was 85%, has significantly differed by the duration of follow-up, which the longer the duration, the higher the FEDO among VOT patients (32). Similarly, a study showed the FEDO was 88% (33).

Table 2: Summary of points on acceptability of VOT

Findings of Studies
Convenient and flexibility (17, 18, 30–33, 37)
Recommended as an alternative (17, 18, 21, 24, 30, 32–34)
Confidential and privacy (24, 28, 33, 35)
Minor challenges (such as interruption of video and audio connectivity) (19, 21, 30, 32–35)

Acceptability of Video-observed therapy

Sixteen of 22 studies evaluated VOT's acceptability; four were pilot studies. The findings from all sixteen studies indicated that VOT was widely accepted. Six studies also demonstrated that most of the patients were satisfied using VOT (17,18,29,30,32,33). Most studies showed that the VOT method was convenient, increasing treatment flexibility for the patients and healthcare providers. Additionally, most patients utilized VOT would recommend this therapy to other TB patients (17,18,21,24,30,32-34). Moreover, four studies demonstrated that VOT was more confidential and increased patient privacy than the conventional method (24,28,33,35). Sekandi et al. reported conflicting opinions regarding privacy and confidentiality concerning the use of Video Directly Observed Therapy (VDOT). Nevertheless, although VOT increases patients' autonomy and privacy, some patients expressed concerns regarding the unintentional revelation of their medical condition that could result in stigma (36). The experience of challenges faced when employing VOT was minor, explored in eight studies (19,21,30,32-35). Technical problems such as video and audio connectivity interruptions were VOT's most familiar challenges (19).

Discussion

Non-adherence to treatment remains an obstacle to tuberculosis (TB) control worldwide because it impacts the treatment outcome and particularly reduces the cure rate. Moreover, it extends infectiousness and contributes to the development of acquired multidrug-resistant strains (2,38). The End TB Strategy's objectives must be realized by investigating novel techniques to enhance care and prevention (39). Various settings increasingly use digital health initiatives to support TB treatment (12). Therefore, in the present review, all observed evidence related to the effectiveness and acceptability of the implementation of VOT is summarized. This scoping review included up-to-date evidence, including twenty-two studies comprising RCTs, observational studies, and a mixed-method approach.
The review identified several types of VOT designed to improve health in tuberculosis monitoring treatment, depending on resources and population settings. Development of web-based applications, usage of smartphones, and high penetration of the internet have shown effectiveness in improving health outcomes in this group. VOT

has demonstrated improved treatment adherence and a higher proportion of observed doses, but there was no difference in treatment completion compared with in-person DOT. VOT significantly reduces time and costs for both patients and healthcare providers (40,41). Patients benefit from lower transportation costs and less time spent on treatment monitoring (23,29), while VOT results in cost savings per person (28) including direct medical costs, and labor costs, offering greater flexibility to both patients and healthcare providers leading to better medication adherence and satisfaction (24,28,29).

Moreover, the purpose and methods of holistic TB treatment involving Video-Observed Therapy (VOT) must be clearly defined to evaluate treatment outcomes effectively. This includes prioritizing individuals based on dose histories and addressing non-adherence through tailored interventions. The study's purpose and available resources will influence both its methodology and the assessment of health outcomes. In cohort studies, researchers evaluate whether health outcomes meet the basic requirements of standard TB programs. However, historical data may be prone to inaccuracy and provide an inadequate baseline for understanding VOT's relative advantages. More relevant evidence regarding outcome changes may emerge from quasi-experimental designs that compare outcomes before and after implementing a VOT-based intervention. Nevertheless, these results may be influenced by concurrent changes in TB care. The most robust evidence of VOT's impact on health outcomes comes from randomized trials assigning patients or larger care units to VOT.

In addition to demonstrating potential for effectiveness, VOT is generally acceptable and feasible. A key aspect of its acceptability is maintaining privacy and confidentiality regarding a patient's TB diagnosis, as stigma can lead to discrimination or impair a patient's coping ability (42). Confidentiality risks arise if unauthorized individuals access digital adherence data, particularly in settings where laws or regulations governing electronic health data are insufficient or poorly enforced. Furthermore, while mobile phone use may be common in the general population, it may be less prevalent among TB patients, especially those with poor treatment outcomes (43). Therefore, for decision-makers and policymakers planning to implement VOT, investing in digital technology is essential to ensure the intervention's sustainability. Overall, this review's findings are promising for the continued development of VOT, with clear opportunities for advancing research, such as refining study designs, enhancing technological infrastructure, and addressing ethical challenges like privacy.

Strengths and Limitations

This review provides a comprehensive overview of video-observed therapy's effectiveness and acceptability as an alternative for monitoring tuberculosis treatment. Thus, the result of this present review shall yield a rigorous analysis of the implementation of VOT, as well as the experience and challenges. Nonetheless, this review only focused on the published literature due to the peer-reviewed status; any findings from grey literature will be missed. An added limitation is that by focusing on studies published within ten years, from 2012 to 2022, we may have missed several related studies that were conducted earlier.

Conclusion

There has been a progressively growing body of evidence during the past ten years, particularly in treating and monitoring TB using VOT. VOT in TB management could positively improve effectiveness in health outcomes, and it is widely accepted and feasible to implement. Future studies, such as non-inferiority trials, practical trials, and cost-effectiveness evaluations, will help to improve tuberculosis strategies and management.

Journalism Ethics considerations

The authors have entirely observed ethical issues (including plagiarism, informed consent, miscon-

duct, data fabrication and/or falsification, double publication and/or submission, and redundancy).

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Conflict of Interest

The authors declare no conflict of interest.

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