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The perception of health providers about an artificial intelligence applied to Tuberculosis video-based treatment in Brazil: a protocol proposal

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Abstract

Tuberculosis (TB) is an infectious-contagious disease that affects mainly the lungs, ranking in the 10 main causes of death in the world. Non-adherence or non-treatment of TB may prolong transmissibility, increase the risk of drug resistance and lead to patient death. One step forward is the use of smartphones for monitoring the medication intake via video (VDOT). VDOT is a more acceptable and cost-effective option than the traditional DOT (in person). However, the VDOT system requires a professional (verifying agent) to check all medication intake daily. Based on an initiative that aims to replace the verifying agent with an artificial intelligence tool capable of validating it automatically through computer vision techniques (AI-based VDOT), the main goal of this work is to measure the acceptance and perception of Brazilian health professionals on the AI-Based VDOT before implementing this technology by using a quantitative questionnaire as instrument. To achieve this, we have developed a proposal of study protocol that describes the steps to create, apply and validate this research.

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1. Introduction

Tuberculosis (TB) is an infectious-contagious disease that affects mainly the lungs, ranking in the 10 main causes of death in the world. In 2017, it is estimated that approximately 10 million people have developed tuberculosis disease worldwide, of which 1.6 million died [1]. In Brazil, a country with a population about 209 million, approximately 91,000 cases were reported, with 7,000 deaths.

Although TB is a curable disease if effectively treated with antibiotics, the treatment usually takes 6 months and may extend beyond 24 months for patients with drug-resistant TB. The treatment of the patient is preferably performed using the DOTS strategy, acronym for Directly Observed Treatment, Short Course. This strategy involves daily monitoring of patients with regular drug delivery. It is estimated that an appropriate diagnosis and treatment of TB has prevented 54 million deaths between 2000 and 2017.

There is a large gap between diagnosis and cure. Non-adherence or non-treatment of TB may prolong transmissibility, increase the risk of drug resistance and lead to patient death. In Brazil, TB treatment covers 87% of the population with a success rate of 72%. The WHO goal is to achieve more than 90% by 2025 for all countries, while concerns about the increase in drug-resistant (TB-DR) and extensively drug-resistant (TB-XDR) TB rates due to inadequate treatment has grown [1].

The use of digital technologies for treatment monitoring is not a novelty in several countries [2][3][4]. In Brazil, there are several initiatives related to the management and monitoring of data about TB treatment, such as computerized systems [5][6][7], proposals for systems interoperability[8] and interactive guidelines[9]. One step forward is the use of smartphones for monitoring the medication intake via video (VDOT). Story et. al. (2019) [10] shows that VDOT is a more acceptable and cost-effective option than the traditional DOT (in person). However, the VDOT system requires a professional (verifying agent) to check all medication intake daily. In order to optimize the time spent by this professional, there is an initiative [11] that aims to replace the verifying agent with an artificial intelligence tool capable of validating it automatically through computer vision techniques (AI-Based VDOT). The timeline of technologies in DOT is shown in Figure 1.

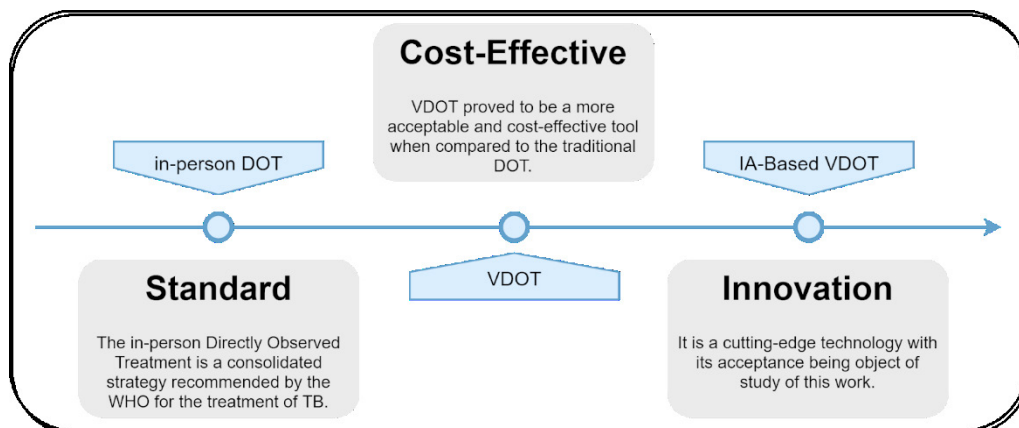


Fig. 1. Technologies in directly observed treatment.

The main goal of this work is to measure the acceptance and perception of Brazilian health professionals on the AI-Based VDOT before implementing this technology by using a quantitative questionnaire as instrument. To achieve this, we have developed a proposal of study protocol that describes the steps to create, apply and validate this research.

This study is organized as follows: in the next section, relevant principles for this study development will be described, such as the rationale for the perception of new technologies in health and the Brazilian Tuberculosis Research Network (REDE-TB). In third section, a methodology overview and the proposed protocol will be presented. Finally, in the last section, expected outcomes from the application of this protocol will be highlighted.

2. Background

2.1. The perception of new technologies in health

The use of digital technologies in primary health care services suggests a major impact on the interactions between health professionals and patients as we move from intra-institutional care to home care [12]. Understanding the perceptions of primary care professionals can generate knowledge and contribute to a strategic planning, that combined with the use of digital monitoring and management tools, can optimize the use of available resources and endorse better health outcomes [13].

Patient-centered care has been described as an approach to daily work that evolves from relationships involving health professionals, patients and other stakeholders. Thus, the use of mobile applications that support self-care and self-management can improve health outcomes for patients and allow a effective monitoring of their activities by health professionals. In addition, with an increased interaction between these actors, there is a notable promotion of self-efficacy and empowerment of the patient, contributing to a change in behavior about their health perspective [14].

The effects of using technology in digital health field are continuously studied. Many of these studies present several factors that influence the technology acceptance by health professionals, such as perception about usefulness, that can be highlighted as an expressive predictor for a good acceptance. On the other hand, ease of use is cited as a factor that does not affect the acceptance, considering that an adequate technical assistance is provided [12]. Moreover, a large part of the literature that addresses these factors, in diverse contexts, besides health, evidences the use of several models of acceptance. The TAM (Technology Acceptance Model) model is an example that has dominated the research landscape and comprises a wide range of variables that explain behavioral intentions and directly or indirectly use of technology (i.e., perceived utility, ease of use perception and attitudes towards technology), as well as external variables such as self-efficacy and subjective norms that facilitate the use of new technologies [15].

Table 1 presents the main characteristics from studies selected in the literature review on the perception and acceptance of technologies in health area.

Table 1. Key studies to evaluate the perception of the health professional.

Title	Year/Country	Goals	Findings/Conclusion
An adoption model describing clinician's acceptance of automated diagnostic system for tuberculosis [16]	2016/India	This study tried to find the factors that influence the clinician's acceptance and use of CMD system for TB by using a modified UTAUT model, and this model mainly focused on the prediction of two theoretical constructs: the usage intention and actual use of computerised TB detection system.	The study identified some determinants of intention and use for the hypothesis of the proposed research model, namely: Performance Expectancy, Effort Expectancy, Social Influence, Technological Trust, Usage Intention and Computer Skill. By understanding these key factors about adopting a new system, the development and implementation process will be accelerated.
User acceptance factors of hospital information systems	2017/Indonesia	Reviews the literature on the most important acceptance factors associated with Hospital Information Systems (HIS),	Acceptance models were a powerful approach to explain the intention to use and actual use of health technologies. However, these models with their

and related technologies: Systematic review [17]		which can assist researchers and hospital management staff to develop suitable acceptance models to improve the quality of HIS.	related factors should also be adapted to the characteristics of the organization and the development of technology.
A systematic review of the technology acceptance model in health informatics [18]	2018/Sweden	Reviews published research about TAM use in health information systems development and implementation, regarding application areas and model extensions after its initial introduction.	No optimal TAM version for use in health services has been established. It is suggested that the common investigated factors in the previous studies should be tested empirically in real settings. If these factors are confirmed, it is recommended that they will be applied as a basic model for each technological contexts and user groups.

2.2. The Brazilian Network for Tuberculosis Research (REDE-TB)

The Brazilian Network for Tuberculosis Research (REDE-TB) is a private non-profit and non-governmental organization (NGO). The mission of REDE-TB is to connect governments, academia, organized civil society and the industry for the control of TB. The organization has a network of researchers and health professionals who work actively in the fight against TB, assisting in the creation and validation of new drugs, vaccines, diagnostic tests and strategies for disease control. In 2018, REDE-TB had 320 members working in 65 distinct institutions spread across the Brazilian territory [19][20].

3. Protocol proposal

3.1. Overview

The first step of this work has consisted on a bibliographical review and selection of the characteristics present in the literature in order to map main concepts, to clarify research areas and to identify knowledge gaps through feasibility, significance and adequacy of the practice. The second step was to the workflow development of the proposed protocol based on prior knowledge obtained from the revision. The third and last step was effectively designing the protocol.

Studies found in literature review indicated that tools and the evaluation of digital technologies in health processes [6][14][16][17][18][21] focus on a basic process of analyzing results of the software implementation, or in the monitoring of indicators before and after implementation. Then, the software impact itself is measured. Thus, the research to be performed through the protocol presented here is positioned in an earlier stage, specifically, in the perception analysis of new digital technologies by the view of TB health professionals aggregated in REDE-TB structure.

A quantitative questionnaire was developed based on a Likert scale, aiming to perform a cost-effective evaluation to measure the perception of health professionals in a large scale and to produce a larger volume of data that can be easily quantified and compared at different moments in time [22]. This instrument will use, as a basis, characteristics of several models found in the literature, such as the varied forms of TAM and UTAUT [15][16] as well an additional free field so that suggestions, comments and criticisms can be evaluated subjectively.

3.2. The Protocol

The protocol consists of a sequence of phases which, in turn, have a sequence of well-defined execution steps, as shown in Fig. 2. The first stage is the research population definition, where the inclusion criteria and sample size will

be discussed. The second is the questionnaire development and validation as an instrument of perception analysis elaborated according to best practices present in the literature. At this stage, it is essential to have a working group composed by professionals from different areas of knowledge, such as physician, nurses, software engineers, biomedical informatics, psychologists, among others, all with adequate qualifications in TB and digital technologies in health.

Beginning with the questionnaire first version and in line with previously established psychometric metrics, the team will start the internal protocol validation phase. This phase consists in the application of the this first version to a small sample of researchers with previous experience in tuberculosis in order to optimize the tool before the large-scale research. At the next stage, the consent form will be elaborated for the research volunteers and the study proposal will be submitted for an ethics committee in order to certify that it complies with the standards of research ethics. In the fourth and last stage, the final questionnaire will be applied, followed by a results analysis and an elaboration of a findings report.

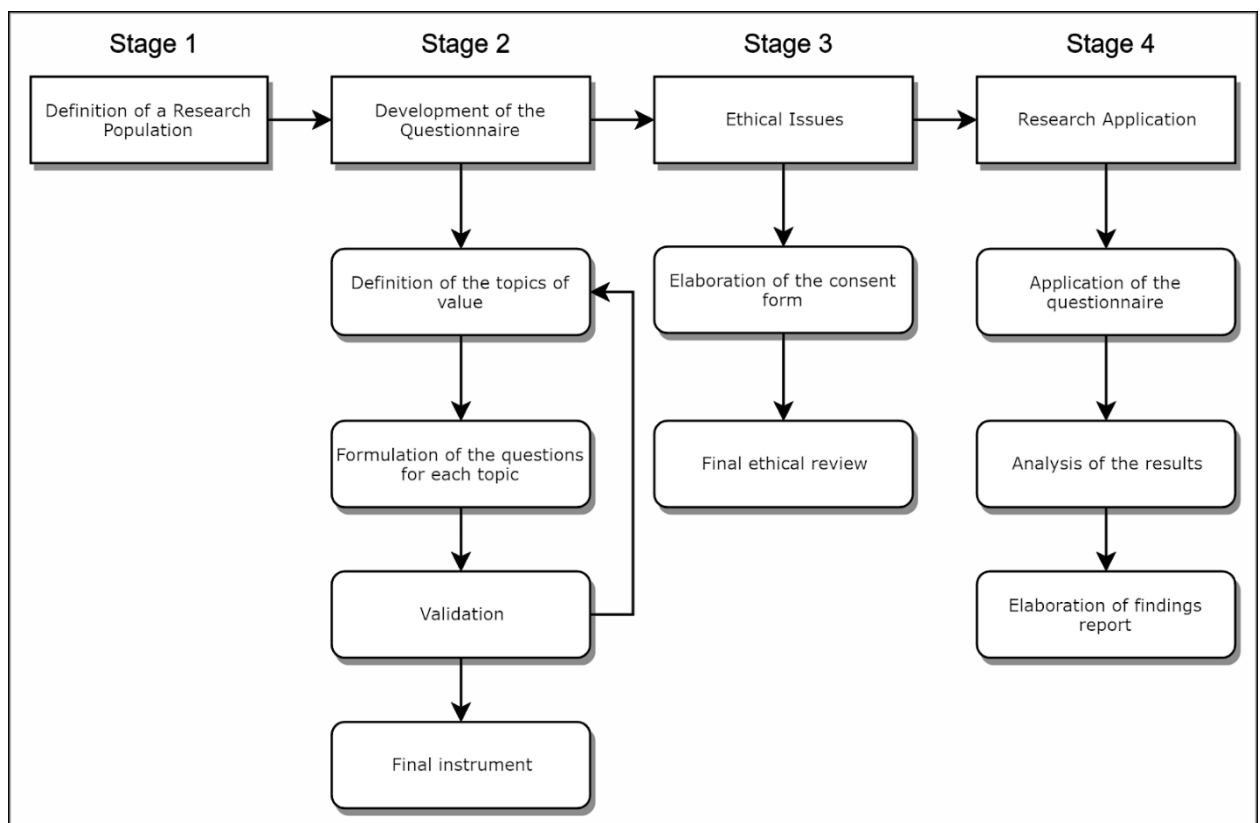


Fig. 2. Stages and steps of the proposed protocol.

4. Expected Results

Digital development in health centers is inevitable. However, some concerns regarding implementation and use of digital technology may inhibit its success. Thus, this study focused on elaborating a protocol for development and validation of an instrument capable of assessing the perception and acceptance of AI-Based VDOT in primary care by health professionals. This approach has provided an alternative perspective to clarify the literature based on consolidated acceptance and perception models and aims to reveal possible deadlocks and problems before implementation and even before the development of technological solutions, saving time and resources of health systems and developers.

The study contributes to aspects that guide and precede: (1) the construction of a new model on the perception of health professionals considering predictive factors discussed in the explanation of perception of use; (2) the lack of comparative instruments between different perceptions about use of VDOT embedded in models based on artificial intelligence; (3) perception factors that do not consider individual characteristics (e.g. resilience, level of education, interference of habits); (4) results for other stakeholders (e.g software engineer, health manager). Thus, by mapping the potential problems and risks of AI-based VDOT acceptance it is expected to anticipate, in a negative way, situations that interfere with the adherence of the use and consequently avoid the need to redesign the process of developing such systems. In an optimistic view of acceptance based on the proposed assessment, we expect the necessary adjustments to be minimal. Finally, this work represents the first academic study conducted in Brazil to evaluate the perception of VDOT by health professionals.

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