English

Mobile technology as support to the diagnosis of Tuberculosis in childhood

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Abstract

Introduction: Mobile technology as support to the diagnosis of Tuberculosis in childhood. Mobile technologies have been increasingly used as a means of supporting medical education. In contrast to technological innovation, the diagnosis of tuberculosis in children is still a public health problem, especially due to the lack of specific profiling of the disease and the impossibility, in most cases, to bacteriologically confirm it in childhood. In this vision are inserted mobile technologies such as Decision Support Systems (DSS), defined as capable of promoting rapid access to information, as well as the automation of processes, in the case of health as support for decision-making in the face of a problem. Objective: This article aims to describe the development of a DSS, available in the application format, for automating the calculation of the score for the Diagnosis of Tuberculosis in Children, based on the Ministry of Health criteria. Method: Several steps: Search the Store and Apple Store for applications on Tuberculosis; Validation of concepts used for the development of DSS; Development of tools with proofs and corrections. Results: 42 applications were found in Tuberculosis. Of these, 28 provide general information, 11 do not address pathology, 4 are games, 3 multidrug-resistant tuberculosis and 1 alternative treatment. A DSS for childhood tuberculosis was developed. In addition to this main topic, other sessions will be available, as illustrative clinical cases, which help the professional to recognize signs and symptoms that alert to the suspicion of tuberculosis; radiological images, which allow the user to recognize the common changes in the pediatric patient; and georeferencing map, highlighting locations with the largest recorded cases. Conclusion: With the creation of DSS, it is expected to expand the diagnosis of Tuberculosis.

Keywords: *Medical education; Tuberculosis; Health applications; Mobile Applications.*

Resumen

Tecnología móvil como apoyo al diagnóstico de la Tuberculosis en la infancia.

Introducción: Las tecnologías móviles han sido cada vez más utilizadas como medio de apoyo a la educación médica. En contraflujo a la innovación tecnológica, el diagnóstico de la tuberculosis en el niño sigue siendo un problema de salud pública, sobre todo por las formas de presentación poco específicas de la enfermedad y por la imposibilidad, la mayoría de las veces, de comprobarla bacteriológicamente en la infancia. En esta visión, se insertan las tecnologías móviles como los Sistemas de Apoyo a la Decisión (SAD), definidos como capaces de promover acceso rápido a la información, así como la automatización de procesos, en el caso de la salud como apoyo a la toma de decisión frente a un problema. Objetivo: Este artículo tiene como objetivo describir el desarrollo de un SAD, disponible en el formato de aplicación, para automatización del cálculo de la puntuación para el Diagnóstico de la Tuberculosis en el Niño, basado en los criterios del Ministerio de Salud. Método: Varias etapas recorridas: Búsqueda en el Play Store y Apple Store de aplicaciones sobre Tuberculosis; Validación de conceptos utilizados para el desarrollo de SAD; Desarrollo de herramientas con pruebas y correcciones. Resultados: Se han encontrado 42 aplicaciones en Tuberculosis. De estas, 28 traen informaciones generales, 11 no dirigen a la patología, 4 son juegos, 3 Tuberculosis multirresistente y 1 tratamientos alternativos. Se desarrolló una SAD para la Tuberculosis en la infancia. Además de este tópico principal, otras sesiones estarán disponibles, como casos clínicos ilustrativos, que ayudan al profesional a reconocer signos y síntomas que alertan sobre la sospechosa de tuberculosis; imágenes radiológicas, que permiten al usuario reconocer los cambios comunes en el paciente pediátrico; y mapa de georreferenciación, destacando localidades con los mayores casos registrados. Conclusión: Con la creación del SAD se espera ampliar el diagnóstico de Tuberculosis.

Palabras-clave: *Educación para la salud; Tuberculosis; Aplicaciones de salud; Aplicaciones Móviles.*

Resumo

Tecnologia móvel como apoio ao diagnóstico da Tuberculose na infância.

Introdução: Tecnologias móveis têm sido cada vez mais utilizadas como meio de apoio à educação médica. Em contrafluxo à inovação tecnológica, o diagnóstico da tuberculose na criança ainda é um problema de saúde pública, sobretudo pelas formas de apresentação pouco específicas da doença e pela impossibilidade, na maioria das vezes, de comprová-la bacteriologicamente na infância. Nessa visão, estão inseridas as tecnologias móveis como os Sistemas de Apoio à Decisão (SAD), definidos como capazes de promover acesso rápido à informação, assim como a automação de processos, no caso da saúde como apoio à tomada de decisão frente a um problema. Objetivo: Este artigo tem como objetivo descrever o desenvolvimento de um SAD, disponibilizado no formato aplicativo, para automatização do cálculo da pontuação para o Diagnóstico da Tuberculose na Criança, baseado nos critérios do Ministério da Saúde. Método: Várias etapas percorridas: Busca no Play Store e Apple Store de aplicações sobre Tuberculose; Validação de conceitos usados para o desenvolvimento de SAD; Desenvolvimento de ferramentas com provas e correções. Resultados: Foram encontradas 42 aplicações em Tuberculose. Dessas, 28 trazem informações gerais, 11 não dirigem à patologia, 4 são jogos, 3 Tuberculose multirresistente e 1 tratamentos alternativos. Foi desenvolvido um SAD para Tuberculose na infância. Além desse tópico principal, outras sessões serão disponibilizadas, como casos clínicos ilustrativos, que auxiliam o profissional a reconhecer sinais e sintomas que alertam para a suspeita de tuberculose; imagens radiológicas, que permitem que o usuário reconheça as alterações comuns no paciente pediátrico; e mapa de georreferenciamento, destacando localidades com os maiores casos registradas. Conclusão: Com a criação do SAD espera-se ampliar o diagnóstico de Tuberculose.

Palavras-chave: *Educação médica; Tuberculose; Educação em Saúde; Aplicativos Móveis.*

Introduction

The mobile technologies in the application version promote quick and remote access to solutions that can support the user's continuing education and act as a means of supporting medical decision in the face of a diagnostic doubt[1]. The Decision Support Systems (DSS) are computer systems capable of promoting rapid access to information as well as automation of processes, in the case of health, as support for professional decision-making in the face of a diagnosis problem and / or clinical conduct[2].

In the planning of a DSS are used theoretical references, scientific, data analysis and even tacit knowledge based on the expert's experience, using a natura language[2]. Through this information selected on a specific topic, the computational system is able to provide diagnostic hypotheses to the user, hoping to contribute to the educational process and to decision making, since with the advent and rapid evolution of the network computers and speed in the publication of scientific articles, it becomes practically impossible to assimilate so much information and data specific to the most diverse topics of health[1]. The DSS, developed as mobile technology and made available as an application (APP), broadens the scope and adherence of the target audience. In addition, the Android system is the most prevalent among users of mobile devices and tablets[3,4].

In addition to providing up-to-date information, in a fast and automated way, DSSs also have the benefit of assisting the learning process in recognizing and managing pathologies and assisting the user in the clinical environment[1]. Despite the facilities, the DSS can, from probabilities of occurrence, propose hypotheses for the problem, which depend on the clinical evaluation of the user, since they do not explain the reason of the hypotheses generated. Being the critical analysis of the user in front of the exposed information, being the professional responsible for the conduct[1].

Tuberculosis (TB) is an old disease that remains a major and serious public health problem[5]. It is estimated that about one third of the world population is infected with M. tuberculosis and that every year, about 9 million of people develop the disease, of which 11% are children. Although there are public policies able to promote its control and the disease has been decreasing its incidence in some parts of the world, there is still no prospect of eradication in the near future, and thus control and eliminate TB is still a global health challenge[6].

In childhood, the WHO has drawn attention to the chronic neglect of TB in children possibly due to diagnostic difficulties. Among these difficulties, there is the fact that the signs and symptoms of TB in the child are nonspecific, which hinders clinical suspicion and delays the diagnosis of the disease. In addition, the clinical spectrum varies widely and ranges from asymptomatic forms to severe disseminated forms, with a high risk of evolution to death and radiological manifestations in the pediatric age group are peculiar and different from those of adults. The interpretation of chest radiography may be facilitated based on knowledge of the pathophysiology of primary tuberculosis, but the peculiarities of the manifestations in the pulmonary radiological image during the child's growth may interfere in the analysis of the criteria of childhood scores. On radiography the findings are nonspecific and the interpretation of chest radiography in the child is often susceptible to doubts that often delay the diagnosis of the disease and make difficult the therapeutic decision-making[7].

To facilitate this diagnosis at an early stage, some scoring systems have been proposed in recent years by researchers and / or health-related agencies in different countries. The scoring system recommended by the Ministry of Health is an important resource for the diagnosis of tuberculosis in children, validated and feasible in any Basic Health Unit (BHS), the main entry point of the Unified Health System (UHS). The use of mediation of technologies as educational and diagnostic support, especially mobile technologies, tends to be a great ally in medical education, therefore, as a support for the diagnosis and control of tuberculosis in childhood[8].

In this context, the objective of this study was to develop a DSS available in the application format for mobile devices, in order to strengthen the access to educational contents based on scientific evidence and to support the decision making of the doctor as a diagnostic criterion for tuberculosis in childhood.

Method

Target Audience

The application has as a priority target audience the professionals who work in the Entrance Doors of service to the population, aiming to serve as a means of quick access to educational materials, based on updated protocols of the Ministry of Health, by mobile technology, in the application format, as a support for the qualified diagnosis of tuberculosis in childhood.

Steps for developing the Application

Building the application followed the following steps:

1. Search the Play Store and Apple Store for applications with a theme in childhood tuberculosis, from December 2017 to February 2019, for the identification and survey of requirements and differentials for the development of this application.

2. Survey, description and validation of the requirements necessary for the design of the DSS to make available contents on children's TB and calculation of scores, with the phases:

a. Idealization: development of an APP concept that would meet the needs of the target audience.

b. Design: initial prototype of APP. This phase included graphic design and the distribution and organization of its functionalities.

3. Development of the automated calculation tool for the calculation of scoring scores based on the guidelines of the Ministry of Health[9,10], updated in 2018, and the Guidelines for Tuberculosis of the Brazilian Society of Pulmonology and Tisiology[11], with the steps:

a. Development: creation and development of the database and configuration of APP. Multiple factors such as multitasking, form, devices, and fragmentation of the operating system were considered to verify compatibility with the devices in which they will be used.

b. Tests: In-app usability tests were carried out during the development phase, considering the variety of mobile devices that can access the digital solution developed.

c. Corrections: all corrections identified as necessary were performed after the test step. At that time, several feedbacks were generated as suggestions for improvements.

The DSS was developed for mobile devices with Android operating system, in Studio version 4.0.3, in Java programming language. The Android system was chosen because it presents devices (phones and tablets) of greater use in the market, due to the cost benefit and diversity of models, that ranges from simple devices up to the most sophisticated ones.

The research was approved by the Ethics Committee of the State University of Rio de Janeiro, with the approval of the CAAE opinion: 90936218.9.0000.5282 and the product of its result registered at the National Institute of Industrial Property (NIIP) filed under the number BR512019000054-4.

Results

After performing a survey of the applications available in the Play Store12, the Android operating system's virtual store, 42 applications with the tuberculosis theme were found. Of these, 25 provide general information on tubercu-

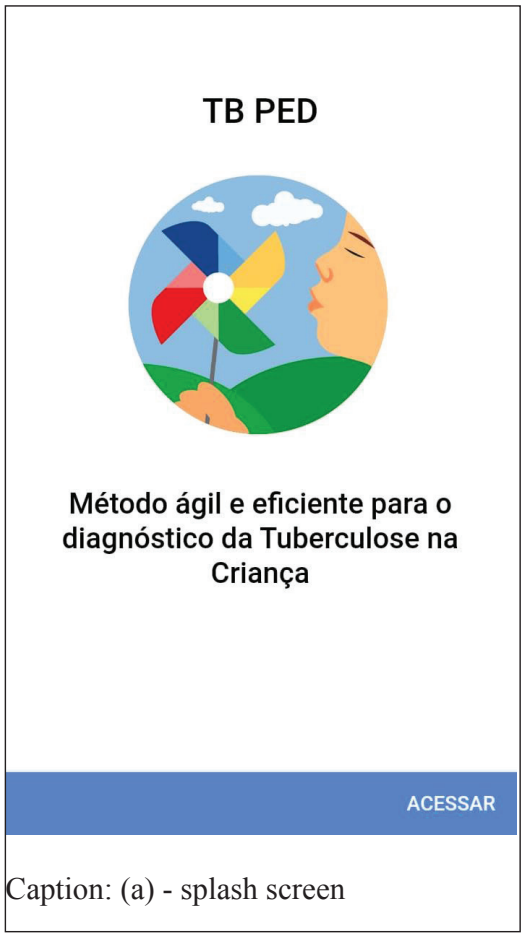
losis, not specified for pediatrics; 9 are not specifically targeted to the disease in question, addressing other infectious pathologies; 4 are games or quizz; 3 are focused on multidrug-resistant tuberculosis and 1 is focused on alternative treatment.

In the Apple Store, 5 applications were identified: 3 of these address general information on tuberculosis (SNTC, TB eReview: HIVTB, Explain TB) and 2 are not specifically targeted at TB, addressing other pathologies (Bronchiectasis and Emocha)[13] For comparison with the proposed APP, only those related to the theme and that are available in the Play Store were considered, taking into consideration that the APP will be available only on Android platform.

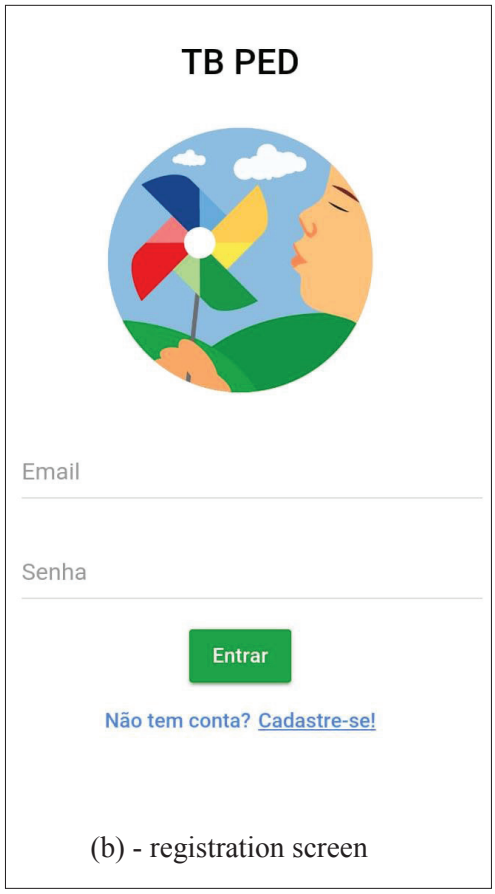
In view of the above, the application differs from the others because its objective is to approach the diagnosis of TB specifically in the child, aiming at the early identification of symptoms through the automation of the calculation of the scores.

Figure 1 shows the initial application screen (splash screen and registration screen), in which the user will have access to the content available. We opted for a simple and intuitive interface to promote easy access.

Figure 1 - Application access screens.



Caption: (a) - splash screen



(b) - registration screen

Source: Own elaboration, 2019.

For the first access, it is necessary that the professional provides his data making the adhesion. The information provided is the responsibility of the user. There are three options for the registration: 1st option: Medical professional, in which it will be necessary to inform, besides the general mandatory data (name, e-mail, CPF and password), the CRM, State and Municipality of actuation and CNES, related to the area of performance of the professional, to complete the georeferencing map. 2nd option: Other professionals, which include any professional of the Basic Health Unit (BHS), who wants to have access to the application, only needing the general information, being the CPF (Social Security Number) optional. 3rd option: Academics: same protocol for completing the 2nd option, differentiated in a subitem in order to possible later statistical survey on the professionals who accessed the application.

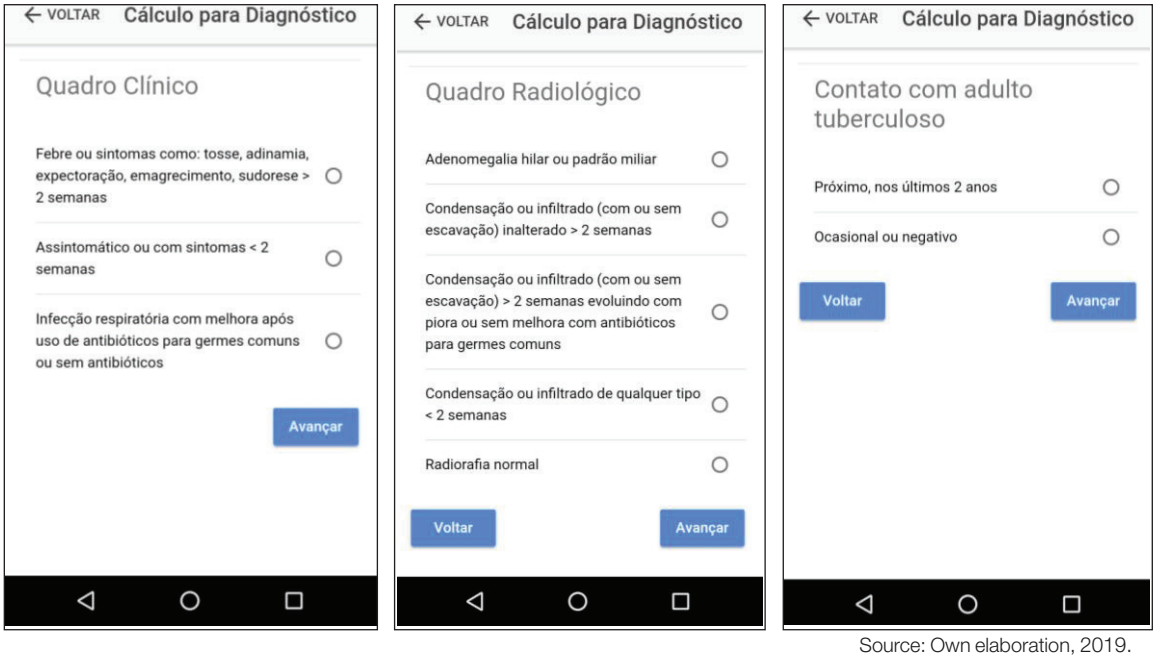
After completing the initial registration, which will occur only once, since the other times the registration will be saved, opening the splash screen and directed directly to the features that integrate the application, composed of the following options: automated calculation for the diagnosis, educational clinical cases, radiological images commented on, epidemiological map and information about APP, according to Figure 2.

Figure 2 - Application features presentation screen.

Source: Own elaboration, 2019.

For the automation of the calculation of clinical and radiological scores the medical user can choose between 'patient' or 'patient test'. The 'patient' choice allows the patient with a very probable and possible diagnosis, who has started the treatment, to be registered in the geo-referral map, counting as a case in the municipality where the professional is performing. The choice for 'patient test' allows simulation after access to educational materials. After this choice, the user will have access to the criteria for each score (Figure 3) and the automated calculation of the degree of risk for the disease (Figure 4). The other users (other professionals and academics) will not have this differentiation, being automatically directed to 'patient test', since they do not feed the georeferencing map, being allowed access to the map for consultation.

Figure 3 - Calculation Screen for Diagnosis.



Source: Own elaboration, 2019.

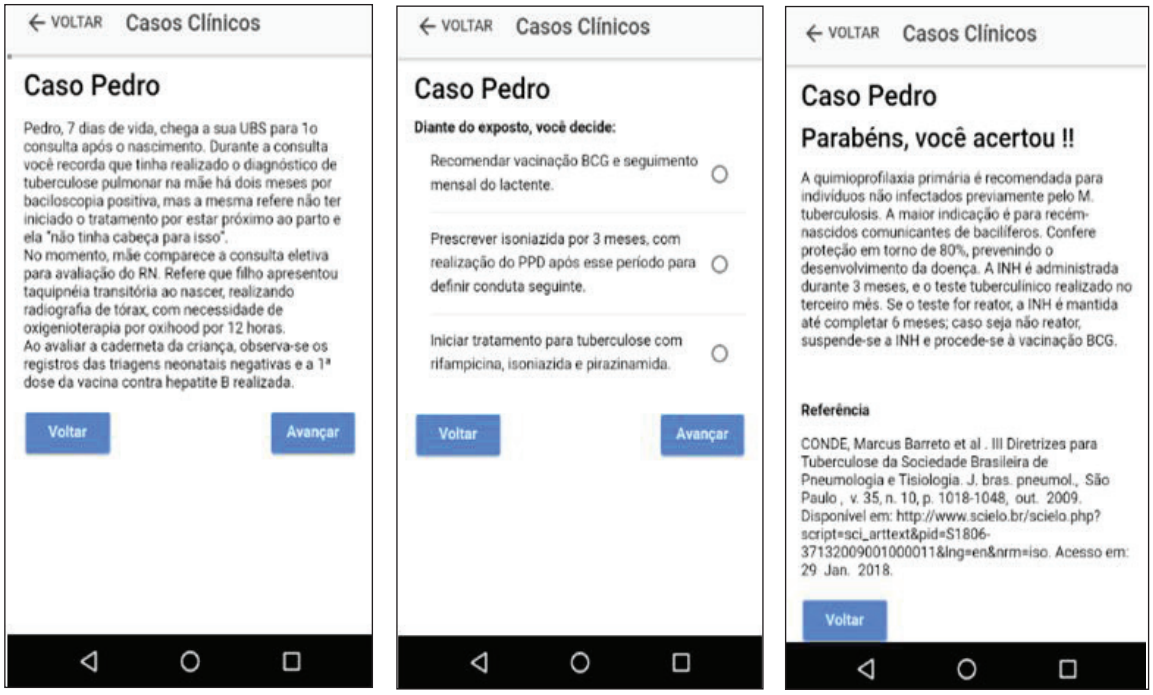
Source: Own elaboration, 2019.

Figure 4 - Screen of possible results.

Source: Own elaboration, 2019.

Another application feature, available in the initial menu, is the clinical cases, in a total of 4 cases, with description of anamnesis and physical examination, presentation of a radiological image and the options of the questions per case with the objective of presenting to the user the most common forms of presentation of the disease in the pediatric age group with their peculiarities. In addition, it provides feedback for educational purposes as shown in Figure 5.

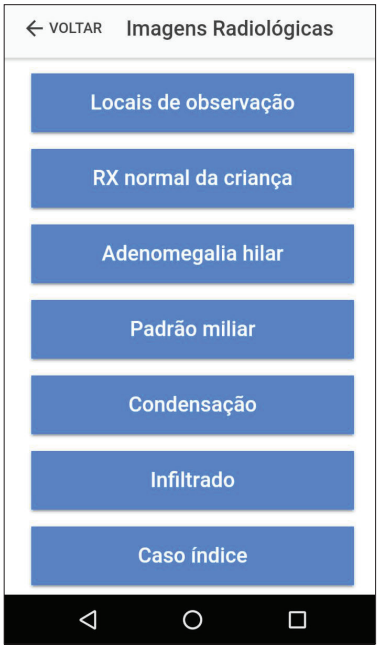
Figure 5 - Clinical Case Presentation Screen.



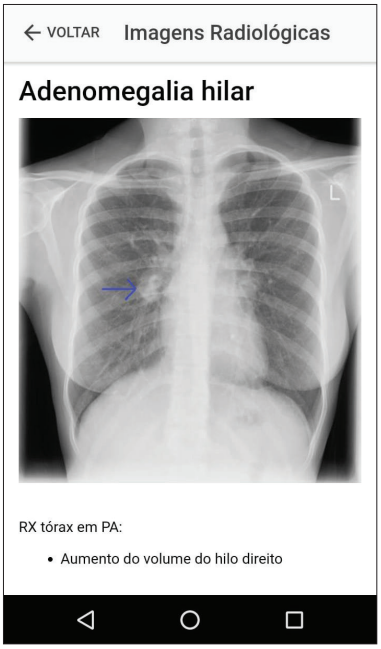
Source: Own elaboration, 2019.

For the same educational purpose, chest x-ray images will be available, evidencing the peculiar pattern of pulmonary involvement in the pediatric patient, in order to serve as a comparative basis for the patient in the analysis of the patient's radiography (Figure 6).

Figure 6 - Presentation screen of Radiological Images



Menu of the radiological imaging options that are available.



Example of a condensation image available in the file.

Source: Own elaboration, 2019.

Discussion

Although tuberculosis is still a serious public health problem, especially in childhood due to the peculiarities and limitations of the diagnosis, the potential of decision support systems as mobile technology for specific medical education seems to have been little explored. The decision support system in the application version developed in this study had the objective, exclusively, to act as an agile and effective alternative for medical education in the diagnosis of Tuberculosis in children; because it allows bedside learning and in real time supporting the doctor in clinical decision making as well as to increase his knowledge[14].

The fast development and innovation in technologies, increasing speed in the Internet network and access to this network are modifying paradigms for health education, being titled as mobile health and has been gaining more and more especially in Medicine. The universalization of access and connectivity are characteristics attributed to applications, which are allied in the development of mobile healthcare technologies such as disease prevention, diagnosis, treatment and surveillance. The number of applications developed in health has been increasing exponentially, as well as the potential to use the tool as health promotion[15]. Mobile applications also allow the dissemination and updating of knowledge in the health area, without restricting time and space, serving as an aid in decision making, an ally in clinical and educational practice[16].

The decision support system with mobile technology, in the application version, developed in this study, aimed to support the education and decision of the doctor for the specific diagnosis of Tuberculosis in the child, in an innovative way, and is in agreement with the guidelines of the Manual of the Brazilian Ministry of Health. In the system with mobile technology developed, in addition to the educational information content made available in an agile way, there are clinical cases and radiological images for the doctor's diagnostic exercise and the possibility of including the data of a clinical case in attendance for automated calculation of the probability of the disease and with the possibility of georeferencing with a view to contributing to the epidemiological mapping of tuberculosis in Brazil.

We hope with this solution to contribute not only to increase the effectiveness of the diagnosis of tuberculosis in Brazil, but, above all, to contribute to the incorporation of mobile technologies in the teaching, education and practice of the physician.

Conclusion

With the creation of an application specifically aimed at the diagnosis of tuberculosis in children, it is expected to increase the number of pediatric patients investigated for the pathology, as well as to allow early access to treatment.

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