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Development of the @Antidotos_bot chatbot tool for poisoning management

Desarrollo del simulador conversacional o *chatbot* Antidotos_bot para el manejo de intoxicaciones

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Abstract

Objective: To describe the development of the Antidotos_bot chatbot tool, which is used to facilitate the search for information in the Antidote Administration Guide and to perform useful calculations in the use of antidotes.

Method: In January 2019, we proposed developing a freely accessible chatbot on Telegram® using Xenioo®. Software development defined the way it interacts with users and incorporated calculation functionalities. Internal validation was conducted and it was presented as Antidotos_bot in June 2019.

Results: Antidotos_bot included information in Spanish on 49 antidotes and 57 poisonings. Three types of calculations were provided and two treatment algorithms could be consulted. Consultation was possible through 332 questions. Internal validation needed five sets of training over 2 months. By July 2020, it had 415 users. The most frequently consulted antidotes were glucagon, penicillin G, protamine, n-acetylcysteine and flumazenyl. Regarding monthly activity, there was an average of 29 calculations and an average of three new users and three queries per user.

Conclusions: Antidotos_bot is a poisoning management decision-making tool that provides up-to-date information in a user-friendly manner. It could contribute to improving the quality and safety of care in emergency situations.

Resumen

Objetivo: Describir el desarrollo del simulador conversacional Antidotos_bot, para facilitar la búsqueda de información en la Guía de Administración de Antídotos y realizar cálculos útiles en el uso de antídotos.

Método: En enero de 2019 planteamos el desarrollo de un simulador conversacional de libre acceso en Telegram®, empleando la plataforma Xenioo®. En el desarrollo del *software* se definió la forma de interacción con el usuario y se incorporaron funcionalidades de cálculo. Se realizó una validación interna y en junio de 2019 se presentó Antidotos_bot.

Resultados: Antidotos_bot incorporó información en castellano sobre 49 antídotos en 57 intoxicaciones, permitiendo realizar tres tipos de cálculos y consultar dos algoritmos de tratamiento. La consulta fue posible mediante 332 preguntas. La validación interna precisó cinco entrenamientos diferentes durante 2 meses. En julio 2020, Antidotos_bot tenía 415 usuarios y los antídotos más consultados fueron glucagón, penicilina G, protamina, n-acetilcisteína y flumazenilo. Mensualmente fueron realizados 29 cálculos, el número medio de nuevos usuarios fue de 3 y el número medio de consultas por usuario fue de 3.

Conclusiones: Antidotos_bot es una herramienta de apoyo en la toma de decisiones en intoxicaciones, que proporciona información actualizada de forma ágil, y podría contribuir a mejorar la calidad y seguridad asistencial en situaciones de emergencia.

KEYWORDS
Artificial Intelligence; Poisoning; Antidotes; Medical informatics applications; Emergency care.

PALABRAS CLAVE
Inteligencia artificial; Intoxicación; Antídotos; Aplicaciones informáticas en medicina; Tratamiento de emergencia.

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Introduction

The ongoing development of health care technologies has led to improve medical assistance and health in the general population. For this reason, international organizations are promoting the development and implementation of information systems by health care institutions to enhance personalized medicine, streamline processes and achieve better quality, efficiency and the sustainability of the health care model[1,2].

Artificial intelligence (AI) is a science dealing with the design of software capable of displaying characteristics that we associate with intelligence in human behaviour[2]. Conversational systems (CS) or AI-based chatbots are computer programs designed to simulate a natural-language conversation with users through an interface. They do not need to be installed on a device and involve a short learning curve[3,4]. CS can understand users' intentions and respond with recommendations, calculations or new questions. They can converse using different channels (text, image, voice), so it is common to deploy them to instant messaging applications, web pages or mobile applications[3-6].

The second edition of the Antidote Administration Guide (AAG) was published in 2018. It includes the antidotes available in our hospital and information on their indications, mechanism of action, dosage, route of administration and observations. We decided to make its consultation easier by developing a freely accessible CS[7]. In doing so, we enable the permanent updating of the information in the AAG and allow direct consultations over the users' smartphones.

The aim of our work is to describe the development of the Antidotos_bot CS, which was designed to make consultation with the text of the AAG easier and perform useful calculations in the use of antidotes.

Methods

In January 2019, we proposed developing a tool to facilitate consultation with the AAG content for health care professionals potentially involved in the management of poisonings in our hospital (approximately 200 users)[7].

In collaboration with an external company, we used the Xenioo® platform to create a Spanish language multiplatform CS, selecting Telegram® as the channel due to its compatibility with Xenioo® and its privacy terms and conditions.

During software development, the text understanding method employed machine learning combined with natural language processing, and text generation was performed using the fixed output method extracted from the AAG text. The form of interaction was defined using the rule-based method—which relies on predefined keywords (intentions and entities) and commands programmed by the developer—to establish connections and provide answers or different response options that could be selected by users in the dialogue (Figure 1). Intentions were understood as collections of expressions used to perform a specific request and entities were understood as specific parts of these "intentions" detectable by the AI engine[4,5]. Questions such as "What is the antidote?" were identified as intentions and poisons and antidotes were identified as entities. Finally, calculation functions and the available treatment algorithms were incorporated. Figures 1 and 2 show examples of the conversation flow on antidotes and calculations.

Subsequently, the internal validity of the CS was assessed, requiring a minimum success rate of 95% in the responses. To this end, the tool was tested to ensure that it provided the correct information on the indication, mechanism of action, dose, route of administration and observations for each antidote, recognizing both the commercial presentation and the name of the active ingredient. Likewise, we verified that the antidote or antidotes to be used in each poisoning had been identified.

After training and fine-tuning, in June 2019, the free access chatbot Antidotos_Bot was presented as operational through Telegram®.

Results

The CS was developed between February and March 2019. It included 57 poisons and 49 antidotes, which could be identified as 210 different entities if possible the consultation using synonyms of poisons and antidotes, such as the active substance and trade names. The CS also incorporated two treatment algorithms in .jpg format: the management of bleeding or invasive procedures in patients treated with direct-acting anticoagulants and the management of acetaminophen poisoning; it also included the option to perform calculations (glomerular filtration using the Cockcroft-Gault formula, n-acetylcysteine dose according to the plasma level of acetaminophen, and antidigoxin antibody dose in acute and chronic digoxin poisoning in adult or pediatric patients). The system used seven algorithms to provide answers: the number of possible questions and answers was 332 and 362, respectively. Two answers per drug were possible.

Internal validation was conducted by two pharmacists over April and May 2019. During the process, 462 questions were asked and incorrect answers were detected. To correct these errors, we analysed the intentions and results with the aim of increasing the collection of intentions. In order to achieve final validation, we had to repeat the training sets and the analysis of new errors five times.

Data confidentiality was guaranteed with the unique registration of the user name, which was automatically deleted after 30 days to make the interaction as user friendly as possible.

Analysis of the results obtained up to July 2020 showed that Antidotos_bot had 415 users. The most frequently consulted antidotes were glucagon, penicillin G, protamine, n-acetylcysteine and flumazenil, while the most frequently used calculations were antidigoxin antibody dosage and glomerular filtration rate. Regarding the monthly activity of the CS, there was an average of 29 calculations (456 in total), an incoming/outgoing message flow of 57/60 respectively and an average of three new users and three consultations per user.

Figure 1. *Examples of the conversational flow of questions and answers (directed or multiple-answer) according to the user's intention: mushroom poisoning and treatment with silybilin; cyanide poisoning and treatment with 3% sodium nitrite; and indication for immunoglobulin (IgG) antidote specific against the Rh or D antigen of human erythrocytes.*

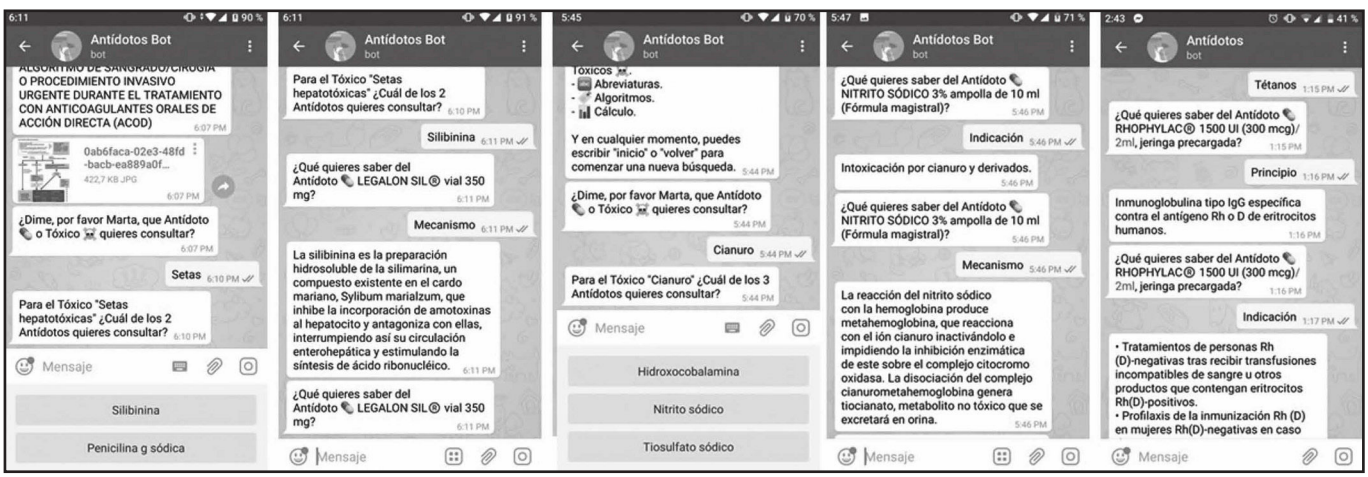

Figure 2. *Examples of calculations made by Antidotos_bot based on user's responses: anti-digoxin antibody dose; indication for intravenous n-acetylcysteine administration in acetaminophen poisoning; n-acetylcysteine dose; creatinine clearance calculation.*

Discussion

Antidotos_bot allows directed consultations through questions for decision-making assistance in poisoning (selection of the ideal antidote, dosage, route of administration and posology). Information is presented on smartphone screens, thus avoiding searches in potentially obsolete documentation, on the Internet or in outdated pre-installed applications in smartphones. In our opinion, Antidotos_bot is easy to use, optimizes resources and could reduce waiting times and medication errors, thereby improving the quality and safety of care in emergency situations. The tool also generates consensual and well-documented recommendations, in line with the available scientific evidence[8].

The effectiveness of CSs is based on their capacity for interaction, which facilitates user commitment and motivation, promoting their repeated and long-term use[9]. Adapting CSs to the field of health care can facilitate access to medical assistance, improve patient-physician communication and help in clinical management[10]. In our setting, where clinical management guidelines are constantly changing and being revised, CSs can act as sources of up-to-date information for health care providers or patients, avoid the use of rapidly outdated printed editions and facilitate user-directed access to the most current information[8].

Some of the most popular CSs are Siri, Amazon Alexa, or Google Assistant[5]. Although we are unaware of other experiences with CSs in the setting of hospital pharmacy medication use is a potential area of application this tool. For example, they could be used to help health care professionals in their search for reliable information, to obtain patient-reported outcomes regarding their therapies or to monitor therapeutic adherence. Some examples of CSs in health care and health promotion are MSD Salute Bot, Babylon Health, Dejal@Bot, and Wysa[11-14].

Free access is key to the popularity of Antidotos_bot. Thus, the estimated number of potential users of our AAG doubled with Antidotos_bot because access only required a smartphone with Telegram®.

However, Antidotos_bot has some limitations: it uses Spanish as the communication language; it requires an internet connection and Telegram® user account; there are hindrances to its transferability and applicability to other hospitals by the availability of different antidotes not integrated into Antidotos_bot; and there is the need to continuously revise and update the information. Furthermore, Antidotos_bot cannot be accessed from personal computers or from other platforms such as Whatsapp®, which is the most widely used instant messaging application in Spain, by preventing it the user confidentiality by following the rules of Facebook®[15].

Some areas for improvement of Antidotos_bot include increasing the list of antidotes and poisonings, translating the content into English, integrating the CS with an intelligent voice assistant and enhancing the use of the tool by health care professionals, who are not use to using CSs in the workplace for now.

Antidotos_bot introduces the concept of AI into the process of prescription and validation of poisoning management and facilitates access to the information contained in the AAG through an instant messaging platform by means of user-directed questions.

Funding

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Conflict of interest

No conflict of interests.

Contribution to the scientific literature

The novelty of this tool lies in the use of directed questions to access up-to-date and reliable information on antidotes via Telegram®.

Antidotos_bot can optimize resources and could contribute to the decrease medication errors in poisoning management.

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