



DEVELOPMENT OF A CHATBOT FOR THE INVESTIGATION AND TREATMENT OF TOXOPLASMOSIS DURING PREGNANCY*

ELABORAÇÃO DE *CHATBOT* PARA INVESTIGAÇÃO E TRATAMENTO DA TOXOPLASMOSE NA GESTAÇÃO

ELABORACIÓN DE *CHATBOT* PARA LA INVESTIGACIÓN Y EL TRATAMIENTO DE LA TOXOPLASMOSIS EN EL EMBARAZO

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How to cite: Zamboni RC, Lima EFA, Almeida MVS, Reis APC, Nascimento MGB, Primo CC, Prado TN, et al. Development of a chatbot for the investigation and treatment of toxoplasmosis during pregnancy. *Online Braz J Nurs.* 2026;25(1):e20266892. <https://doi.org/10.17665/1676-4285.20266892>

RESUMO

Objetivo: Descrever o desenvolvimento e a avaliação de um *chatbot* destinado a orientar enfermeiros quanto à investigação e ao tratamento da toxoplasmose na gestação, no contexto do pré-natal. **Métodos:** Estudo de pesquisa aplicada com enfoque em desenvolvimento tecnológico, conduzido em duas etapas: desenvolvimento de um *chatbot* e avaliação da experiência do público-alvo. A pesquisa foi realizada em um município do Espírito Santo, Brasil, no período de agosto de 2023 a julho de 2024. **Resultados:** O *chatbot* Toxobot foi desenvolvido com base em inteligência artificial e processamento de linguagem natural. A ferramenta é composta por 16 telas organizadas em sequência lógica, estruturadas para favorecer a interação humano-computador e a navegação orientada pelas informações. A usabilidade foi avaliada por 15 enfermeiros, sendo classificada como excelente, com pontuação total de 80,6 pontos. **Conclusão:** O uso do Toxobot possibilitou a disseminação de informações sintetizadas e adequadas sobre a investigação e o tratamento da gestante com toxoplasmose no pré-natal.

Descritores: Enfermagem; Gestante; Toxoplasmose; Tecnologia conversacional; Cuidado Pré-Natal.

ABSTRACT

Objective: To describe the development and evaluation of a chatbot designed to guide nurses regarding the investigation and treatment of toxoplasmosis during pregnancy in prenatal care. **Methods:** An applied research study with a technological development approach, conducted in two stages: development of a chatbot and evaluation of the target audience's experience. The study was carried out in a municipality in the state of Espírito Santo, Brazil, from August 2023 to July 2024. **Results:** The chatbot Toxobot was developed based on artificial intelligence and natural language processing. The tool consists of 16 screens organized in a logical sequence, structured to promote human-computer interaction and navigation guided by the information provided. Usability was evaluated by 15 nurses and was classified as excellent, with a total score of 80.6 points. **Conclusion:** The use of Toxobot enabled the dissemination of synthesized and appropriate information on the investigation and treatment of pregnant women with toxoplasmosis during prenatal care.

Descriptors: Nursing; Pregnant Woman; Toxoplasmosis; Conversational Technology; Prenatal Care.

RESUMEN

Objetivo: Describir el desarrollo y la evaluación de un *chatbot* destinado a orientar a enfermeros sobre la investigación y el tratamiento de la toxoplasmosis durante el embarazo, en el contexto del control prenatal. **Métodos:** Estudio de investigación aplicada con enfoque en desarrollo tecnológico, realizado en dos etapas: desarrollo de un *chatbot* y evaluación de la experiencia del público objetivo. La investigación se llevó a cabo en un municipio de Espírito Santo, Brasil, en el período de agosto de 2023 a julio de 2024. **Resultados:** El *chatbot* Toxobot fue desarrollado con base en inteligencia artificial y procesamiento de lenguaje natural. La herramienta está compuesta por 16 pantallas organizadas en secuencia lógica, estructuradas para favorecer la interacción humano-computadora y la navegación guiada por la información. La usabilidad fue evaluada por 15 enfermeros, siendo clasificada como excelente, con una puntuación total de 80,6 puntos. **Conclusión:** El uso de Toxobot permitió la difusión de información sintetizada y adecuada sobre la investigación y el tratamiento de la gestante con toxoplasmosis en el control prenatal.

Descriptor: Enfermería; Gestante; Toxoplasmosis; Tecnología conversacional; Atención Prenatal.

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What is already known:

- Toxoplasmosis during pregnancy can cause serious complications when not diagnosed and treated early;
- Health professionals face difficulties in following updated protocols in prenatal care;
- Chatbots show potential to support clinical practice and expand the dissemination of health information.

What this article adds:

- Develops and evaluates Toxobot, an artificial intelligence-based chatbot designed to support prenatal care;
- The technology facilitates rapid access to reliable information on the investigation and treatment of pregnant women with toxoplasmosis.

INTRODUCTION

Toxoplasmosis is one of the most prevalent chronic infections worldwide, affecting approximately one-third of the global population. An international meta-analysis estimated an overall prevalence of acute *Toxoplasma gondii* infection in pregnant women of 0.6% (95% CI 0.4%-0.7%), with approximately 201,600 annual cases of congenital toxoplasmosis in newborns⁽¹⁾. In Brazil, studies indicate high seroprevalence among women of reproductive age (50%-80%), which highlights the magnitude of the problem and the persistent risk of primary infection during pregnancy^(2,3).

Surveillance, early detection, and timely management of toxoplasmosis during prenatal care are essential to reduce or prevent fetal and neonatal complications, such as spontaneous abortion, stillbirth, prematurity, hydrocephalus, intracranial calcifications, chorioretinitis, seizures, delayed neuropsychomotor development, and permanent visual impairment⁽⁴⁾.

Improving the quality of prenatal care is part of national strategies aimed at reducing maternal and infant morbidity and mortality. These actions are currently reinforced by the Alyne Network, established by the Brazilian Ministry of Health, whose objective is to ensure surveillance of health conditions during pregnancy, prevent avoidable deaths, and improve professional practices, especially in addressing clinical conditions sensitive to prenatal care, such as congenital infections⁽⁵⁾.

Health professionals play a central role in the identification, treatment, and surveillance of communicable diseases during prenatal care⁽⁶⁾. However, weaknesses in their knowledge have been identified, including gaps related to transmission routes, the period of greatest gestational risk, interpretation of serological tests, indication of the IgG avidity test, and appropriate therapeutic management. Such limitations may compromise clinical decision-making and the effectiveness of actions aimed at preventing vertical transmission⁽⁷⁾.

There has been a growing incorporation of digital technologies in health care, particularly conversational agents (chatbots), recognized as promising tools for clinical decision support, continuing education, and improvement of health communication. Digital technologies have become increasingly present in the daily lives of individuals and organizations. Among them, chatbots stand out as effective resources for promoting interpersonal communication and educational applications related to human behavior^(8,9).

A chatbot is a conversational agent structured with clear and previously programmed messages, whose purpose is

to facilitate the transmission of information through text or voice⁽¹⁰⁾. In the health field, these resources have been used to organize care activities, support patient health education, prevent and control infections, and monitor diseases^(11,12). However, no conversational agents specifically aimed at guiding clinical practice related to the investigation and treatment of toxoplasmosis during pregnancy were identified in the databases consulted.

This study is justified by the need to strengthen qualified prenatal care, in line with the guidelines of the Brazilian Ministry of Health and the Alyne Network. In addition, it addresses the National Agenda of Priorities in Health Research, particularly in the areas of maternal and child health and communicable diseases, contributing to the achievement of Sustainable Development Goal 3, which aims to ensure healthy lives and promote well-being for all, with emphasis on reducing avoidable maternal and neonatal mortality.

Thus, the objective of this study was to describe the development and evaluation of a chatbot designed to guide nurses regarding the investigation and treatment of pregnant women with toxoplasmosis during prenatal care.

METHOD

This is an applied research study of technological development conducted in two stages: i) development of the chatbot and ii) evaluation of its usability by the target audience. The study was performed in a city in the state of Espírito Santo, Brazil, from August 2023 to July 2024.

The development of the technology followed four stages: i) content development; ii) definition of the items composing the script; iii) development of the chatbot structure and design; and iv) definition of interface alternatives and implementation on the platform.

In the first stage, the chatbot content was defined based on questions raised by physicians and nurses from primary health care (PHC) and forwarded to the municipal technical reference for toxoplasmosis over a 1-year period. Based on the questions received, the principal researcher, responsible for the city's technical reference, organized the content that subsequently composed the chatbot interaction flows.

The development of the content was based on technical notes, manuals, and protocols from the Brazilian Ministry of Health related to the investigation and treatment of toxoplasmosis during pregnancy in prenatal care⁽¹³⁻¹⁵⁾. The chatbot was developed using artificial intelligence (AI) and natural language processing (NLP).

The structure and design of the chatbot were developed using the Botpress platform, which was selected for offering free resources and its own implementation service. NLP

technology enabled the automation of natural language through algorithms incorporated into the system, allowing the recognition of keywords or entities, classification of questions into predefined categories, and conversational interaction with the user through previously structured responses based on the script developed for the investigation and treatment of toxoplasmosis during pregnancy in the prenatal care context.

The usability evaluation of the chatbot was conducted with PHC nurses from the municipality participating in the study. The sample was selected by convenience. Nurses with at least 1 year of experience in conducting prenatal consultations were included. As an exclusion criterion, professionals on vacation or leave during the data collection period were excluded. All nurses who met the inclusion criteria were invited to participate, totaling 15 participants, with no refusals recorded.

The nurses were contacted through a messaging group used for communication between the municipal technical reference and PHC professionals. An electronic form was sent via Google Forms containing an invitation letter describing the objectives and stages of the study, the informed consent form (ICF), and the link to access the chatbot. After signing the ICF, participants completed a characterization form including the following variables: age, gender, academic background, time since graduation, complementary training for the care of pregnant women with toxoplasmosis, and experience in prenatal care. They then completed the usability evaluation scale.

The usability of the chatbot was evaluated using the System Usability Scale (SUS), composed of 10 items that measure user experience in the use of digital technologies. The instrument uses a Likert-type scale ranging from 1 to 5 points, from “strongly disagree” (1 point) to “strongly agree” (5 points)⁽¹⁶⁾.

Data obtained from the SUS application were analyzed using descriptive statistics, considering the calculation of the total scale score and its interpretative classification. To calculate the SUS score, the responses to the odd-numbered questions (1, 3, 5, 7, and 9) were first summed, and the value 1 was then subtracted from this total, resulting in value X. Next, the responses to the even-numbered questions (2, 4, 6, 8, and 10) were summed, and the value 5 was subtracted from this total, resulting in value Y.

The sum of the scores (X + Y) was multiplied by 2.5, resulting in the final scale score, which ranges from 0 to 100 points. Based on this result, usability was classified as follows: 0-20.5 (worst imaginable); 21-38.5 (poor); 39-52.5 (fair); 53-73.5 (good); 74-85.5 (excellent); and 86-100 (best imaginable)⁽¹⁶⁾.

The study was approved by the research ethics committee involving human subjects under CAAE No. 81248224.4.0000.5060. To ensure greater reliability, validity, and quality in the preparation and reporting of the research, the Revised Standards for Quality Improvement Reporting Excellence was adopted as a supporting tool.

RESULTS

The theoretical content of the chatbot was organized into two main axes: disease description and therapeutic

options. The material covered all stages of pregnancy, from the first trimester to the time of delivery, with emphasis on screening pregnant women with infection and ensuring the necessary interventions. The content was synthesized in a clear and objective manner to facilitate understanding by health professionals and to support clinical decision-making.

Manuals, technical notes, and protocols from the Brazilian Ministry of Health were used in the development of the content, as they are official sources based on scientific evidence. Based on this synthesis, the interaction flows of the chatbot, named ToxoBot, were structured (Figures 1 and 2).

The flowcharts summarized the sequence of information and served as the basis for the development of the script and the chatbot screens. This structure provided a clear view of the simulated dialogues between nurses and the system, favoring the use of humanized language, an essential aspect for the effectiveness of virtual assistants.

After the development and organization of the content, the chatbot development process began. A guided interaction architecture based on previously structured dialogues was adopted for building the tool. This approach enabled continuous editing of the content, organized access to stored information, and clear presentation through the interface. In addition, it enabled intuitive navigation, providing a smoother user experience and facilitating interaction with the system.

To increase user engagement and the sense of realism in the interaction, the main character used was the nurse Flora, a member of the CuidarTech Laboratory. The character has already been used in other technologies developed by the laboratory to improve interaction between technology and the user, making the tools more attractive and promoting more humanized and welcoming communication (Figure 3).

Subsequently, the chatbot modules were developed in screen format following the informational sequence established in the flowcharts. In total, 16 screens were created, designed to optimize human-computer interaction (Figure 4). ToxoBot is available for consultation from <https://toxobot.crebs.dev>.

In the usability evaluation stage, 15 nurses participated. Most were women (73.3%), with a predominance of age between 31 and 40 years (53.4%). Regarding time since graduation, 53.3% had completed their degree more than 11 years earlier, and 86.7% had a specialization as their highest academic qualification.

Regarding complementary training for the care of pregnant women with toxoplasmosis, only one of the evaluators reported having specific training or updating in this area. Regarding experience in prenatal care, 41.6% of the participants had between 1 and 15 years of clinical practice.

Regarding the usability of ToxoBot, agreement above 80% was observed among evaluators regarding the functionality of the tool, which was considered useful for providing the information necessary for toxoplasmosis screening during care. All participants agreed that the system is easy to use, allowing its application in clinical practice without difficulty.

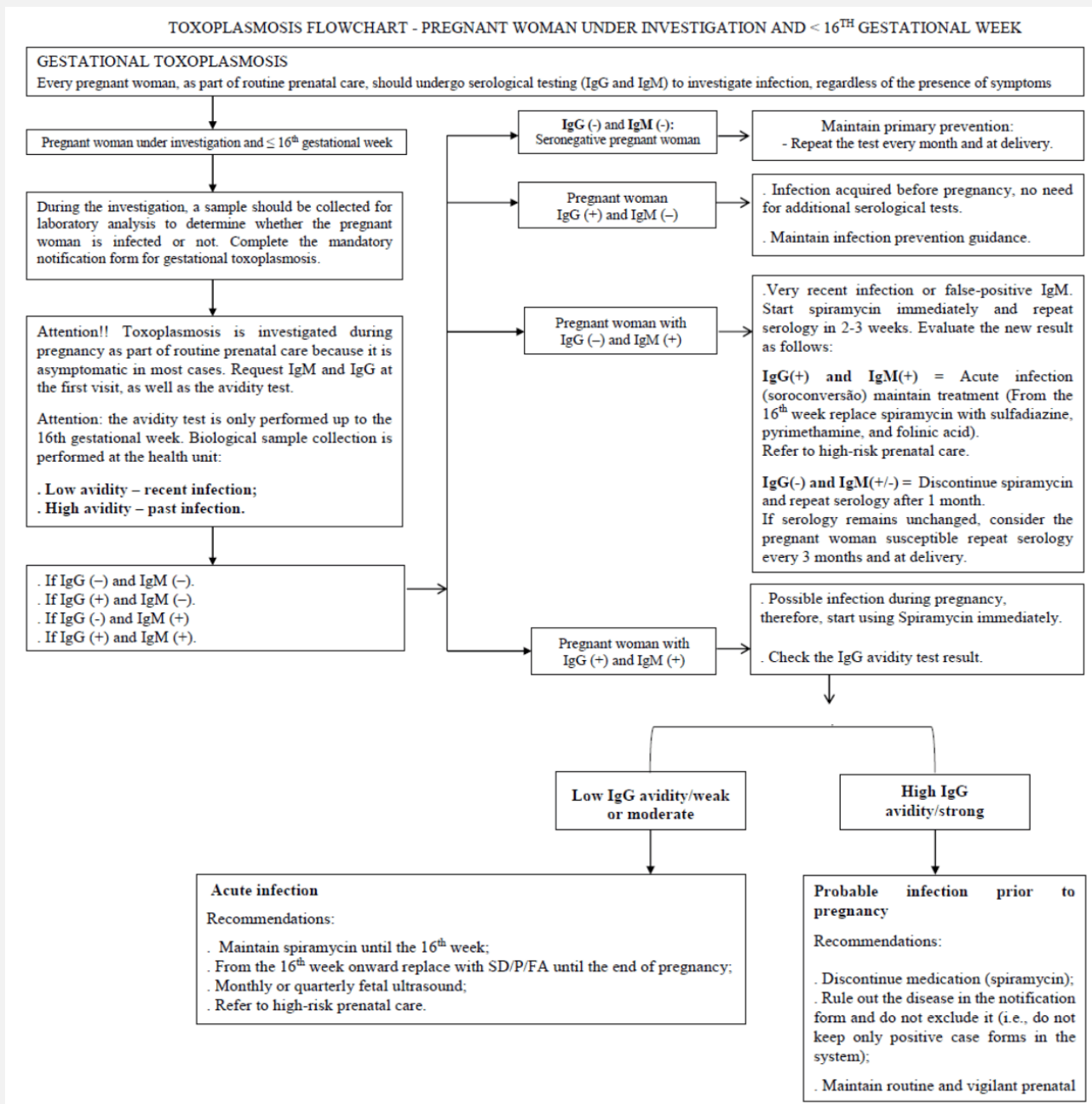


Figure 1 - Toxoplasmosis flow: pregnant woman under investigation and $\leq 16^{\text{th}}$ gestational week. Vitória, ES, Brazil, 2025
 Source: prepared by the authors, 2025.

The system's functionalities were also well evaluated. More than 83% of the nurses agreed that the features are well integrated and that the presented content is clear and understandable. When asked about frequency of use, 75% stated that they would use ToxoBot regularly, highlighting the tool's ability to provide direct and synthesized information.

Regarding the learning curve, 91% of the evaluators indicated that they would not encounter difficulties in learning how to use the chatbot and that the tool is aligned with the recommendations of the Brazilian Ministry of Health. The final score assigned to ToxoBot was 80.6 points, classifying its usability as excellent.

DISCUSSION

With advances in computational technologies, particu-

larly in the field of AI, chatbots have become increasingly present in people's daily lives, especially through instant messaging platforms⁽¹⁷⁾. In the health field, the use of conversational agents represents an emerging technology that is rapidly being incorporated into different care and educational contexts⁽¹⁸⁾.

These systems enable the development of innovative solutions in various environments, offering educational support in a more accessible, user-friendly, intelligent manner⁽¹³⁾. Recent studies highlight the positive impact of chatbots in supporting well-being and in the management of chronic diseases, demonstrating that these technologies can expand access to reliable and personalized information^(10-12,17-21). In addition to providing guidance and information, chatbots can function as tools to support health management, encouraging disease prevention and the adoption of healthy behaviors⁽²⁰⁾.

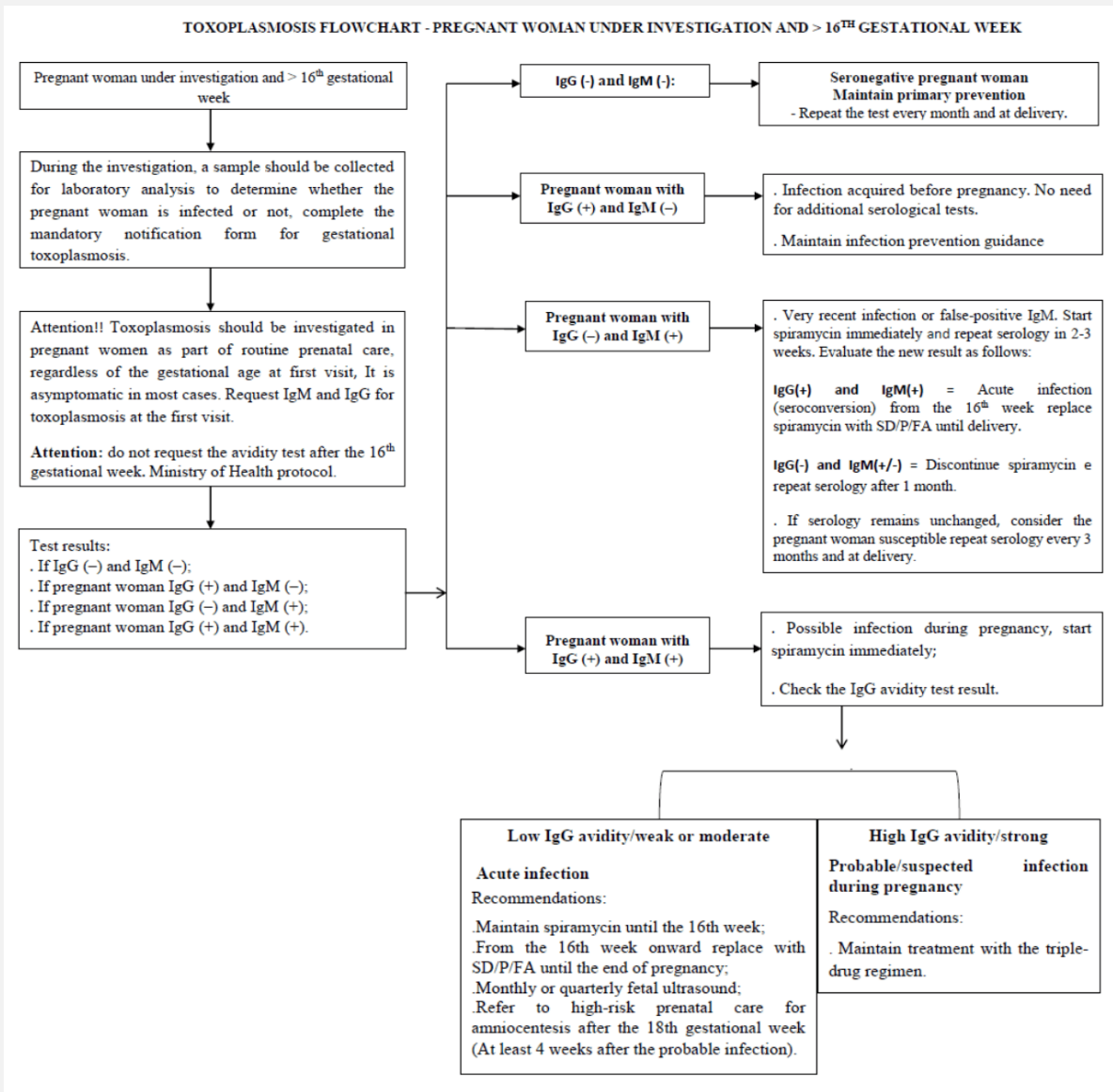


Figure 2 - Toxoplasmosis flow: pregnant woman under investigation and > 16th gestational week. Vitória, ES, Brazil, 2025
 Source: prepared by the authors, 2025.

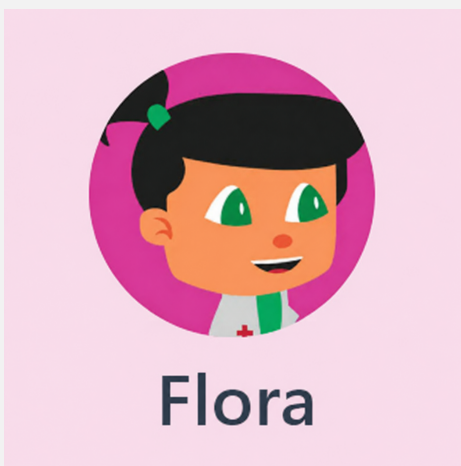


Figure 3 - Caricature of the character Flora from ToxoBot. Vitória, ES, Brazil, 2025.
 Source: CuidarTech, 2022.

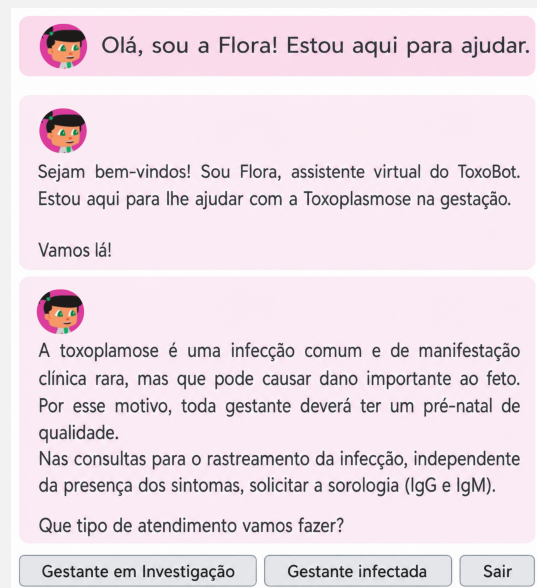


Figure 4 - Human-machine interactions in ToxoBot. Vitória, ES, Brazil, 2025.
 Source: prepared by the authors, 2025.

Literature reviews report the use of chatbots to assist patients in managing chronic physical and mental pain as well as to provide guidance on healthy lifestyles and the monitoring of vital signs, such as in pediatric patients with asthma. Applications are also described for the management of conditions such as sexually transmitted infections, obesity, Parkinson's disease, and cancer^(10,18-21).

In the context of prenatal care, chatbots have been used to support pregnant women by providing guidance related to health practices during pregnancy⁽²⁰⁾. Evidence indicates that the use of these conversational agents can contribute to reducing maternal anxiety and improving adherence to prenatal follow-up⁽²²⁾.

The chatbot ToxoBot presents an innovative approach by focusing on supporting health professionals, especially those working in PHC, by providing specific and updated information on the investigation and treatment of toxoplasmosis during prenatal care. To date, no similar tools specifically directed toward clinical support for the management of this condition have been identified.

Despite the existence of public policies aimed at the care of pregnant women with toxoplasmosis, the management of this condition still represents a challenge for health professionals. Studies demonstrate that physicians and nurses in PHC frequently present knowledge gaps related to the diagnosis, clinical management, and treatment of the disease^(7,23). This scenario highlights the need for tools that support clinical practice and contribute to improving the quality of prenatal care, benefiting both the mother and the newborn.

In this context, the use of digital technologies, such as chatbots, emerges as a promising alternative. For nurses and other professionals involved in prenatal care, the availability of technological tools that assist in the systematization of information and in the teaching-learning process is essential for promoting more efficient and evidence-based care^(24,25). These technologies can optimize clinical decision-making, reduce response time, and expand the coverage of care, strengthening nursing practice and contributing to improvements in the quality of care⁽²⁶⁾.

ToxoBot illustrates the potential of digital technologies in transforming clinical practice. Through the use of NLP, the chatbot establishes a dynamic interaction between the health professional and the system, ensuring that the information presented is clear, accessible, and objective⁽¹⁷⁾. By automating interactions and simplifying communication, ToxoBot helps reduce barriers to access to information and supports the appropriate management of toxoplasmosis cases during prenatal care⁽⁶⁻²⁷⁾.

Technologies of this type, by facilitating professionals' access to investigation steps and therapeutic options for toxoplasmosis, can become important instruments in the organization and qualification of health care⁽¹⁸⁾. The conversational interface used by ToxoBot enables more engaging

and interactive interactions, contributing to improvements in clinical practice and in the quality of care.

As a practical contribution, ToxoBot constitutes an interactive digital tool that compiles and organizes the content of the Brazilian Ministry of Health manual on the investigation and treatment of toxoplasmosis during pregnancy. In this way, it facilitates health professionals' access to the information necessary for managing the disease during prenatal care, reducing the complexity of consulting official documents.

It is expected that the results of this study will contribute to the incorporation of new technologies in the health field, particularly as information systems capable of supporting clinical reasoning, care planning, and the screening of infected pregnant women.

CONCLUSION

This study described the development of the ToxoBot chatbot, designed to support health professionals in the investigation and treatment of toxoplasmosis during pregnancy in prenatal care. The usability evaluation was conducted with 15 nurses, and the system was classified as excellent, with a total score of 80.6 points.

ToxoBot constitutes an innovative tool aimed at promoting knowledge and supporting clinical practice. The technology contributes to facilitating the care process during prenatal consultations by providing appropriate and synthesized information that supports decision-making and improves the effectiveness of care.

As a limitation of the study, the need for internet access to use the tool should be highlighted, which may restrict its use in contexts with connectivity limitations.

Future studies are recommended to evaluate the impact of ToxoBot use in clinical practice, particularly regarding health professionals' satisfaction and the effectiveness of the technology in the investigation and treatment of toxoplasmosis during pregnancy in prenatal care.

*This article was derived from the Master's dissertation entitled "Chatbot to support nursing consultations for pregnant women under investigation for toxoplasmosis and those infected," presented to the Graduate Program in Nursing at Universidade Federal do Espírito Santo, Vitória, Espírito Santo, Brazil, in 2024.

CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interest.

FUNDING

This study was supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior and the Federal Council of Nursing under process no. 8887.69064.2022-00.

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All authors are responsible for the textual preparation and critical revision of the intellectual content, for the final published version, and for all ethical, legal, and scientific aspects related to the accuracy and integrity of the study.



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