Original article

Received: April 7,2025
Revised: Sept. 9, 2025
Accepted: Nov. 5,2025
Published: Dec. 15,2025

The Development of Chatbot Intents for Preventing and Controlling Drug-Resistant Bacterial Infections

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Abstract

The growing threat of drug-resistant bacteria (DRB) constitutes a major public health challenge at both global and national levels, particularly within hospital environments. In Thailand, the increasing prevalence of DRB has been associated with higher mortality rates and significant economic losses, underscoring the urgent need for effective infection control measures. Communication strategies, especially those targeting healthcare personnel, have been recognized as a critical component in strengthening infection prevention and control practices.

This study was undertaken to design chatbot intents for delivering educational content on the prevention and control of drug-resistant bacteria (DRB). The chatbot was developed using Dialogflow and integrated into the LINE application. The educational content was aligned with the guidelines of the Centers for Disease Control and Prevention (CDC) and the Ministry of Public Health of Thailand, and its accuracy and completeness were systematically evaluated through the Google Apps Script platform.

The findings of this study highlight the potential of conversational AI as an innovative tool for enhancing knowledge dissemination and supporting DRB prevention among healthcare professionals, while also offering promising opportunities for further development and application.

Keywords: Chatbot, Line Developer, Drug-Resistant Bacterial Infections , Google Apps Script

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Introduction

The rapid emergence and spread of drug-resistant bacteria (DRB) represent one of the most critical global public health challenges of the twenty-first century. This phenomenon is largely driven by the misuse and overuse of antibiotics in healthcare systems and agricultural practices, resulting in the development of multidrug-resistant (MDR) and extensively drug-resistant (XDR) strains [1–4,7]. These resistant organisms, particularly the ESKAPE pathogens, have evolved multiple mechanisms to evade antimicrobial activity, including genetic mutations, horizontal gene transfer, biofilm formation, and efflux pump systems that actively expel antibiotics from bacterial cells [1–4,7].

Environmental contamination and industrialization further exacerbate the spread of antimicrobial resistance by facilitating the dissemination of antibiotic resistance genes within the human microbiome and across ecosystems [4,8]. Alarming resistance patterns have been reported worldwide, including high resistance rates among Escherichia coli and Staphylococcus spp. to commonly prescribed antibiotics, highlighting the urgent need for novel antimicrobial agents and strengthened antimicrobial stewardship strategies [2,3]. The consequences of DRB extend beyond clinical outcomes, contributing to increased morbidity, mortality, and healthcare expenditures. Projections suggest that antimicrobial resistance may push millions of people into extreme poverty by 2030 if effective interventions are not implemented [4,8].

Advances in genomics, particularly next-generation sequencing, have enhanced understanding of resistance mechanisms and supported the development of targeted interventions [2,4]. Nevertheless, the continued rise of MDR organisms underscores the necessity for sustained surveillance systems, reinforced infection prevention and control measures, and the exploration of innovative therapeutic approaches [9,10]. These challenges highlight the importance of coordinated global efforts that integrate scientific research, public policy, and health education to mitigate the escalating threat of DRB [8].

In Thailand, DRB pose a major public health concern, with resistant strains widely detected across diverse bacterial species and environments. A nationwide surveillance study reported that approximately 50% of Gram-negative bacterial isolates exhibited critical drug resistance, with Escherichia coli and Klebsiella pneumoniae showing particularly high resistance to extended-spectrum cephalosporins and carbapenems [7]. The burden of DRB in Thailand has been substantial, with significant mortality and economic losses reported. Although Thailand has developed a National Strategic Plan on Antimicrobial Resistance, its effectiveness has been constrained by fragmented implementation and limitations in surveillance systems [8].

Internationally, antimicrobial stewardship programs and infection prevention and control measures are recognized as key strategies for combating DRB. Evidence from peer-reviewed studies demonstrates that interventions such as hand hygiene, contact precautions, and educational programs significantly reduce healthcare-associated infections and improve compliance among healthcare workers [9,10,13].

Thailand has adopted a multifaceted approach to DRB prevention by integrating national strategies with infection prevention and control measures. The Thailand Antimicrobial Resistance Containment and Prevention Program established the foundation for national AMR surveillance and promoted responsible antibiotic use under the One Health approach [9]. Furthermore, adaptations of infection prevention guidelines to local healthcare contexts have proven effective. For example, Thammasat University Hospital successfully contained the transmission of carbapenemase-producing Enterobacteriaceae through isolation, enhanced contact precautions, active surveillance, and continuous education of healthcare personnel [10].

Problem Statement

Despite the availability of guidelines and national initiatives, the prevention and control of drug-resistant bacteria (DRB) in healthcare settings remain challenging. Ineffective communication within and between healthcare facilities has been identified as a key contributing factor to ongoing transmission. A study conducted in Oregon demonstrated that inadequate inter-facility communication regarding patients infected with extensively drug-resistant Acinetobacter baumannii facilitated pathogen spread across healthcare settings [11]. Educational interventions, such as fact sheets and toolkits, have been shown to improve healthcare workers' knowledge of carbapenem-resistant organisms [12], while studies in Europe indicate that knowledge levels vary according to professional role, training, and workplace environment [13].

In Thailand, existing communication channels often fail to deliver timely, consistent, and accessible information on DRB to healthcare personnel. Traditional training approaches are constrained by workload, staffing limitations, and inconsistent access to updated resources. Although digital health technologies gained prominence during the COVID-19 pandemic, their application in DRB prevention and control remains limited.

Chatbots have emerged as a promising tool for health communication by enabling real-time, standardized information delivery and reducing the workload of healthcare providers [14]. Recent studies have highlighted the potential of chatbots to improve access to public health information and support health services in diverse settings [15,18–20]. In Thailand, chatbots were used to support risk communication and service delivery during the COVID-19 pandemic; however, evidence regarding their effectiveness in infection control and antimicrobial resistance remains limited [18–20].

Although chatbots have been applied to address public health communication challenges, few studies have specifically examined their role in preventing and controlling drug-resistant bacterial infections. Existing literature emphasizes the need for high-quality research to evaluate chatbot effectiveness and refine implementation strategies in public health contexts [18–20]. Given the widespread use of smartphones and the LINE application in Thailand, there is significant potential to leverage this platform for healthcare communication.

General objective

To develop chatbot intents on the LINE platform, integrated with Dialogflow, aimed at providing healthcare personnel with knowledge and practical guidelines for the prevention and control of drug-resistant bacterial infections (DRB), and to evaluate the accuracy and completeness of the chatbot's responses using Google Apps Script.

Specific objectives

- To develop chatbot intents based on the infection prevention and control guidelines for drug-resistant bacteria (DRB) provided by the Centers for Disease Control and Prevention (CDC) and the Ministry of Public Health of Thailand.
- To develop a chatbot on the LINE platform, integrated with Dialogflow, to provide knowledge and guidelines for the prevention and control of drug-resistant bacterial infections (DRB)
- To evaluate the accuracy and completeness of the chatbot responses using Google Apps Script.

Research Method:

Study Design

This study employed research and development (R&D) design with a system development and evaluation approach. The methodology focused on the structured development of chatbot intents and the subsequent evaluation of their accuracy and completeness in delivering educational information related to the prevention and control of drug-resistant bacterial infections.

Content Review and Intent Design

The chatbot development process began with a structured review of educational content related to the prevention and control of drug-resistant bacterial infections. Authoritative guidelines and recommendations issued by the World Health Organization (WHO) and the Ministry of Public Health were selected as primary reference sources to ensure the accuracy, reliability, and relevance of the information.

Based on the reviewed documents, key topics and learning objectives were identified and organized into a predefined set of informational domains. These domains were subsequently translated into chatbot intents, each designed to address a specific informational need of healthcare personnel. The intent design emphasized clarity, consistency, and alignment with current infection prevention and control guidelines, while avoiding unnecessary technical complexity to ensure ease of understanding.

Chatbot Intent Development

Following content validation, the reviewed materials were used to develop chatbot intents using Dialogflow as the natural language understanding platform. The chatbot was integrated with the LINE messaging application to facilitate user interaction through a widely adopted communication channel in Thailand.

Each intent corresponded to a specific topic derived from the reviewed guidelines and was mapped to representative user queries and predefined responses. This approach enabled the chatbot to recognize both structured and free-text inputs and to deliver appropriate, evidence-based information in a consistent manner. The system architecture was designed to support iterative refinement of intents based on evaluation findings.

Evaluation of Chatbot Intent Accuracy and Completeness

The accuracy and completeness of the chatbot intent development were evaluated through systematic functional testing. Testing the functionality of a chatbot system is a critical step in assessing its ability to respond accurately, completely, and consistently to user inputs, particularly in health-related applications where information reliability is essential.

To support this evaluation, an automated testing framework was developed using Google Apps Script, which was selected for its compatibility with Dialogflow and its seamless integration with Google Sheets. This framework enabled efficient data handling, real-time result analysis, and systematic performance evaluation.

A predefined set of test cases was prepared in a Google Sheets document. Each test case consisted of a sample user query and its corresponding expected intent. Google Apps Script sequentially processed the test cases by sending input queries to the Dialogflow agent via the Dialogflow API. For each query, the Dialogflow agent returned the detected intent, confidence score, and system-generated response, which were automatically recorded in Google Sheets.

Accuracy was defined as the proportion of correctly detected intents compared with the expected intents specified in the test cases. Completeness was assessed by examining whether the chatbot responses contained all predefined key informational elements associated with each intent.

Discrepancies between expected and detected intents were identified and reviewed to inform iterative refinement of the chatbot design. This automated, data-driven evaluation approach minimized human error, enhanced scalability, and provided a structured mechanism for continuous improvement of the chatbot system.

Ethical Considerations

This study involved system development and functional evaluation only and did not include human participants, patient data, or personal identifiers. Therefore, ethical approval was not required.

Results:

Integration of Reviewed Content into Chatbot Intents

Content derived from the literature review on drug-resistant bacteria (DRB) and infection prevention was systematically translated into structured chatbot intents using the Dialogflow platform. Based on evidence from peer-reviewed studies and official guidelines issued by the Centers for Disease Control and Prevention and the Ministry of Public Health of Thailand, the chatbot knowledge base was organized into three primary intent categories: social interaction, DRB-related knowledge, and infection prevention measures.

Social interaction intents were developed to support conversational flow and system usability, including the Default Welcome Intent, Finishing Intent, and Default Fallback Intent. These intents enabled appropriate handling of conversation initiation, termination, and unrecognized or ambiguous user inputs.

Intents related to DRB knowledge were designed to provide structured information on commonly encountered drug-resistant pathogens and their modes of transmission. In addition, prevention-related intents were implemented to deliver practical guidance on infection prevention and control practices, including hand hygiene, use of personal protective equipment, environmental cleaning and disinfection, patient isolation, use of dedicated equipment, and patient care during transport.

Results of Automated Test Case Execution

A total of 300 automated test cases were executed to evaluate chatbot performance, with 20 test cases assigned to each intent. System-generated responses were compared with predefined expected outputs to assess intent classification accuracy, response completeness, and confidence scores.

Overall, intent classification accuracy ranged from 65% to 100%, while response completeness ranged from 65% to 100%, depending on the intent category. Confidence scores across all intents ranged from 66% to 95%.

The Default Welcome Intent demonstrated the highest performance, achieving 100%

accuracy and completeness, with a confidence score of 95%. The Default Fallback Intent showed slightly lower performance, with 90% accuracy, 85% completeness, and a confidence score of 78%.

For DRB-related intents, accuracy ranged from 89% to 95%, completeness from 84% to 90%, and confidence scores from 86% to 92%. Intents associated with the selection of specific bacterial topics consistently demonstrated high recognition performance.

In contrast, prevention-related intents exhibited comparatively lower performance. Accuracy ranged from 65% to 79%, completeness from 65% to 77%, and confidence scores from 66% to 78%. Among these, the intent related to personal protective equipment achieved the highest performance within the prevention category.

Summary of Chatbot Performance

Overall, the chatbot system demonstrated strong performance in recognizing and responding to social interaction and DRB-related queries, while moderate performance was observed for intents related to infection prevention measures. The automated evaluation indicates that the chatbot is capable of delivering accurate and structured information on drug-resistant bacteria across a range of user query formulations.

Discussion:

This study evaluated the performance of a health education chatbot designed to provide information on drug-resistant bacteria (DRB) and infection prevention using an automated, intent-based evaluation framework. The findings indicate that the chatbot demonstrated strong performance in social interaction and DRB-related intents, while comparatively moderate performance was observed for intents associated with infection prevention measures.

The high accuracy achieved by social interaction intents is consistent with previous chatbot research, which has shown that system-level intents often yield higher recognition performance due to their limited semantic variability and predictable user expressions. Similarly, DRB-related intents demonstrated high levels of accuracy and completeness. This outcome likely reflects the structured nature of the content and the use of authoritative sources and standardized terminology derived from established public health guidelines, which may facilitate more reliable intent recognition.

In contrast, the lower performance observed for infection prevention–related intents may be attributed to the broader scope and contextual diversity of preventive practices. Such practices often involve multiple actions and situational factors, resulting in more varied user expressions and overlapping intent boundaries. This challenge has been noted in earlier studies examining chatbot applications in behavior- and practice-oriented health domains. Within this category, the relatively higher performance of the personal protective equipment intent suggests that topics with more clearly defined boundaries and standardized language may be more amenable to accurate intent classification.

Taken together, these findings reinforce existing evidence that chatbot performance is closely influenced by the specificity and structural clarity of the underlying knowledge domain. The automated testing approach employed in this study enabled systematic and reproducible performance assessment and provided an efficient means of identifying strengths and areas for improvement within the chatbot system. However, several limitations should be acknowledged. First, the evaluation was based on predefined test cases, which may not fully capture the diversity and complexity of language used in real-world user interactions. Second, the confidence scores reported reflect internal estimations generated by the platform and may not directly correspond to user-perceived response quality.

Future research should therefore incorporate real user interactions and qualitative feedback to complement automated evaluation metrics. In addition, further refinement of intent design, expansion of training phrases, and incorporation of contextual cues may help improve performance, particularly for prevention-related intents. Such efforts may enhance the practical applicability of chatbot-based systems as supplementary tools for delivering structured health education on drug-resistant bacteria and infection prevention.

Conclusion:

This study demonstrated that a health education chatbot developed using an intent-based framework can effectively deliver structured information on drug-resistant bacteria (DRB). The chatbot showed strong performance in handling social interaction and DRB-related queries, while moderate performance was observed for intents related to infection prevention measures, reflecting differences in the specificity and contextual complexity of the underlying content.

The findings suggest that chatbot performance is closely associated with the clarity and structure of the knowledge domain, with more narrowly defined and standardized topics yielding higher recognition accuracy. The automated evaluation approach provided a systematic and reproducible method for assessing chatbot performance and identifying areas requiring further refinement.

Overall, the results support the potential role of chatbot systems as supplementary tools for disseminating public health information on drug-resistant bacteria and infection prevention. Further development and evaluation incorporating real user interactions may enhance the practical applicability and robustness of such systems in health education contexts.

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