Review
Sciences of Pharmacy

Chatbots in Pharmacy: A Boon or a Bane for Patient Care and Pharmacy Practice?

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Abstract: Chatbots in pharmacies have gained popularity in recent years, potentially revolutionizing patient care and pharmacist workflow. However, whether chatbots are, a boon or a bane for the pharmacy profession remains. This review article aims to comprehensively analyze the literature on chatbots in pharmacy, including their benefits, limitations, and future directions. Findings suggest that chatbots have the potential to improve medication adherence, provide patient education, and streamline pharmacist workflow. However, there are limitations to their use, such as the need for robust natural language processing algorithms and concerns regarding patient privacy and security. Furthermore, the lack of regulatory oversight and standardized development processes may hinder their widespread adoption. Overall, while chatbots have the potential to improve certain aspects of pharmacy practice, caution must be taken to ensure their accuracy and safety. Moreover, chatbots should be viewed as a tool to support pharmacists in providing high-quality patient care rather than replacing the valuable expertise and human connection pharmacists provide. Further research is needed to explore the full potential of chatbots in pharmacy practice and to address the limitations and concerns highlighted in this review.

Introduction

Chatbots in healthcare have rapidly gained popularity over the last few years, with numerous studies demonstrating their potential to improve patient outcomes and reduce healthcare costs (1, 2). Chatbots are computer programs that use artificial intelligence (AI) and natural language processing (NLP) technologies to interact with users through text or voice-based communication (3). Chatbots have been developed in pharmacies to support medication adherence, provide drug information and counseling, and assist in medication management (4-7). With the increasing demand for healthcare services and the shortage of healthcare professionals, chatbots can potentially alleviate some of the burdens on the healthcare system and improve patient access to care.

Chatbots in pharmacies have emerged as a potential solution to several healthcare challenges. One of the main advantages of chatbots is their ability to provide accessible and convenient healthcare services to patients (1, 8). Chatbots can be accessed anytime and anywhere, making them particularly useful for patients with difficulty accessing traditional healthcare services due to geographical, financial, or mobility constraints (9, 10). In addition, chatbots can improve patient adherence to medication therapy by providing regular medication reminders and education (11, 12). Studies have shown that chatbots can significantly improve patient adherence rates for various medical conditions, including diabetes, hypertension, and tuberculosis (13-15). Furthermore, chatbots can provide patients with personalized and tailored information and advice based on their symptoms, medical history, and lifestyle factors (16).

Despite the potential benefits of chatbots in pharmacies, there are concerns about their safety, accuracy, and effectiveness (17, 18). Using chatbots in healthcare raises ethical and legal issues concerning patient privacy and data security (19, 20). Furthermore, the reliability of chatbots in accurately assessing patient symptoms and providing appropriate recommendations is a concern. Additionally, there is a need to assess the impact of chatbots on patient satisfaction, engagement, and health outcomes (21). These concerns must be addressed through rigorous testing, evaluation, and regulation to ensure the safe and effective use of chatbots in pharmacies. Therefore, this review aims to evaluate the current evidence on using chatbots in pharmacies and assess their potential benefits and limitations. We conducted a systematic review of the literature to identify studies that have examined the use of chatbots in pharmacy, including their impact on medication adherence, patient education, medication management, and other outcomes. We also discussed the ethical and legal considerations associated with using chatbots in pharmacies and identified areas for future research.

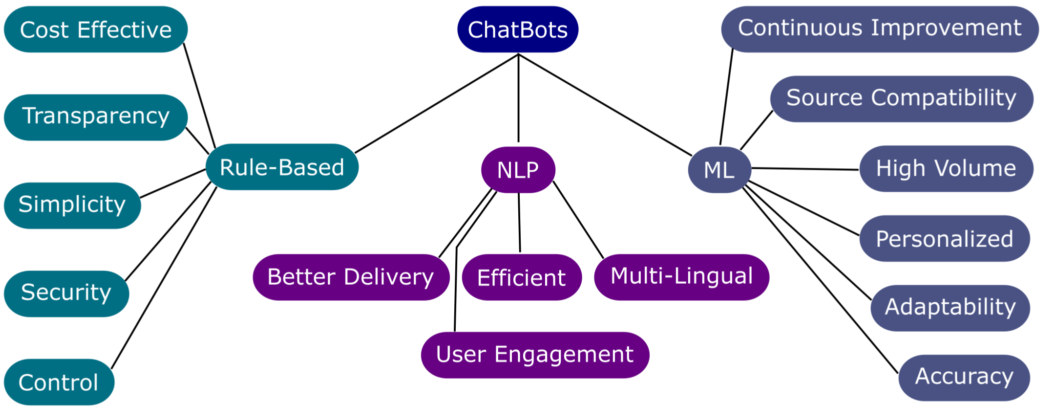

Figure 1. Pros comparison of chatbot models.

Overview of Chatbots in Pharmacy

A chatbot, short for "chat robot," is a computer program that uses artificial intelligence (AI) and natural language processing (NLP) to simulate human conversation with users. Chatbots can be programmed to provide information, answer questions, complete tasks, or even engage in small talk with users (22). Chatbots have gained popularity recently due to their ability to offer 24/7 support and immediate responses to patients (23). In pharmacy, chatbots are designed to assist patients with their medication-related queries and concerns. To understand and respond to patient queries, these chatbots use predefined rules, natural language processing, and machine learning algorithms (24). Chatbots in pharmacies can be deployed via several different channels, such as mobile apps, messaging platforms, or web-based interfaces (25). Pros comparison of chatbot models can be seen in Figure 1.

There are three primary types of chatbots in pharmacy: rule-based, natural language processing (NLP), and machine learning (26). Rule-based chatbots rely on predefined rules and decision trees to guide user interactions. They are relatively simple to develop and require less training data than other chatbots, but their ability to understand and respond to complex queries is limited (23).

On the other hand, NLP chatbots use machine learning algorithms to analyze and interpret natural language queries from users. They can learn and adapt as they receive more input but require extensive training data to develop accurate and effective responses (27). Machine learning chatbots are the most advanced type of chatbot and can make predictions and decisions based on large amounts of data. However, they are also the most complex to develop and require significant training data and computational power (28).

Chatbot Models

Rule-based Chatbot

Rule-based chatbots are a type of chatbot that operates by following a set of predefined rules and decision trees to guide their interactions with users. The developers establish these rules based on a set of if-then statements (29). For example, suppose a user asks a chatbot about the side effects of a specific medication. In that case, the chatbot will retrieve the appropriate information from its database and provide it to the user. Rule-based chatbots are relatively simple to develop and require less training data than other chatbots (23). However, they have limited capabilities in understanding and responding to complex queries (30). They also have a limited ability to learn and adapt over time. As such, they are best suited for use cases where user interactions are relatively simple and predictable (31).

Rule-Based chatbots offer several advantages that make them useful in certain healthcare scenarios. These chatbots are easy to program, with a clear set of rules to follow, and can be quickly set up and implemented, making them a good choice for simple use cases. Rule-Based chatbots are highly controlled and can only provide pre-determined responses based on specific rules. This makes them a good choice for use cases where accuracy is critical (30). Regarding cost-effectiveness, rule-based chatbots can be less expensive to develop and maintain than other chatbots, as they rely on pre-determined rules and do not require complex machine learning algorithms or natural language processing (32). Moreover, the decision-making process for these chatbots is transparent since the rules that guide their responses are explicitly defined. Finally, Rule-Based chatbots can be more secure than other chatbots, as they are not subject to the same level of machine learning bias or attack vulnerability (22). Overall, Rule-Based chatbots offer a controlled and cost-effective solution for providing pre-determined responses to users, making them a good choice for certain use cases in the healthcare industry.

An example of a rule-based chatbot in pharmacy is the Ask A Pharmacist chatbot from Walgreens, a US-based pharmacy chain. The chatbot is designed to answer frequently asked medication-related questions, such as drug interactions and side effects. The chatbot follows predefined rules and decision trees to guide its interactions with users, providing them with accurate and reliable medication-related information. However, the chatbot is limited in its ability to understand and respond to complex queries, as it is based on a fixed set of rules and cannot learn and adapt over time (33).

Natural Language Processing Chatbot

Natural Language Processing (NLP)-based chatbots are a type of chatbot that uses machine learning algorithms to understand and respond to natural language queries from users (34). NLP-based chatbots are designed to mimic human conversations and can understand and interpret the meaning of words and phrases the user uses. This allows for more natural and intuitive interaction between the user and the chatbot (35). NLP-based chatbots use a variety of techniques to analyze and interpret user queries. These include natural language understanding, sentiment analysis, and intent recognition (36). Natural language understanding allows the chatbot to analyze the structure of user queries and extract relevant information. In contrast, sentiment analysis enables the chatbot to understand the emotional tone of the user's queries. Intent recognition allows the chatbot to identify the user's intent and respond accordingly.

Natural Language Processing (NLP)-based chatbots offer several advantages that make them a promising technology for improving patient care and healthcare delivery. NLP-based chatbots can understand natural language inputs from users, making it easier for patients to interact with them and obtain the information they need. They can also be programmed to understand and respond to multiple languages, making them a valuable tool in multilingual healthcare environments. NLP-based chatbots can quickly parse large volumes of text data to provide relevant responses to users, making them a helpful tool for healthcare providers looking to improve efficiency and reduce costs. They can be trained to recognize and respond to specific phrases or terms, improving the accuracy of their responses to user queries (37). Furthermore, NLP-based chatbots can analyze unstructured text data, such as patient feedback or medical records, to identify patterns and trends that may not be immediately apparent to human analysts (38). Finally, NLP-based chatbots can provide patients with personalized health advice and recommendations, helping them to make better healthcare decisions and improve their overall health outcomes (39).

Machine Learning Based Chatbot

Machine learning (ML)-based chatbots are a type of chatbot that uses complex algorithms to analyze and interpret user queries (40). Unlike rule-based chatbots that rely on predefined rules and decision trees and NLP-based chatbots that use machine learning algorithms to interpret natural language queries, ML-based chatbots can learn from past interactions to improve their accuracy and effectiveness over time (41). ML-based chatbots use various techniques to understand and respond to user queries. These include supervised and unsupervised learning, deep learning, and reinforcement learning (42). Supervised learning involves training the chatbot on a labeled dataset of user queries and responses, while unsupervised learning involves training the chatbot on an unlabeled dataset of user queries (43). Deep learning involves training the chatbot on a neural network, allowing it to learn complex patterns and relationships in the data. Reinforcement learning involves training the chatbot to learn from feedback based on previous actions (44).

Machine Learning (ML)-based chatbots offer several advantages over other chatbots. They can learn from past interactions to improve their accuracy and effectiveness, which makes them well-suited for complex and unpredictable use cases. They can also provide personalized responses to users based on their past interactions, making them a powerful tool for patients looking for personalized health information and advice (45, 46). Additionally, ML-based chatbots can adapt to changes in user behavior or data patterns, making them more effective in handling complex and evolving use cases (47). They can handle a high volume of user interactions without requiring significant human resources, making them cost-effective and scalable (48). Unlike rule-based or NLP-based chatbots, ML-based chatbots can analyze and interpret multiple data types, including images and audio, giving them multimodal capabilities (49). Finally, ML-based chatbots can continuously learn and improve based on user feedback, making them an excellent tool for improving patient outcomes and healthcare delivery (50).

An example of an ML-based chatbot in pharmacy is the Ada Health chatbot. Ada Health is an AI-powered platform that provides users with personalized health information and advice. The Ada Health chatbot uses ML algorithms to analyze user queries related to medication, such as dosages, side effects, and interactions with other medicines. The chatbot can also provide users with information on healthcare providers and assist with scheduling appointments. The chatbot uses ML algorithms to improve its accuracy and effectiveness over time, making it a powerful tool for patients seeking personalized health information and advice (51).

Research on Chatbot Developments in Pharmacy

Chatbots have become an increasingly popular tool in the healthcare industry. Recently, chatbots have been applied to the pharmacy field to assist patients and healthcare professionals in medication management, disease education, and drug information retrieval. With the emergence of the COVID-19 pandemic, chatbots have also played an essential role in providing health information and education, symptom assessment, and teleconsultation services. Table 1 lists various chatbots used for medical and pharmaceutical purposes. The table summarizes the chatbots' names, models, and functions that describe their development and evaluation. The table includes a variety of chatbots with different functions, ranging from medication recommendation, symptom assessment, disease education, medical information retrieval, and drug management to healthcare education.

Table 1. Chatbots for medical and pharmaceutical purposes.

No	Chatbot Name	Model	Function	Ref(s)
1.	CUDoctor	NLP and Fuzzy Logic	The service's primary aim is to assess the symptoms of tropical illnesses in Nigeria, and it has received an average SUS score of 80.4, suggesting an overall favorable evaluation.	(52)
2.	Sharifah Nur Pharmacy	Rule-based	The chatbot can provide recommendations on medication types by utilizing the information provided by the user.	(53)
3.	Intelligent Health Advice Bot (IHAB)	NLP	The chatbot provides relevant health information.	(54)
4.	-	NLP and Fuzzy Logic	The chatbot aids hospital caregivers in obtaining reliable information on drugs and pharmacy management.	(55)
5.	Pharmabot	Rule-based and NLP	The chatbot is created to recommend and provide information about generic medicines for children.	(56)
6.	-	Rule-based and NLP	The chatbot is designed to assess symptoms and provide prompt recommendations for patients who may have been exposed to nCOV-19.	(57)
7.	Warfarin Talk	Rule-based	A chatbot on Messenger is intended for individuals who are prescribed warfarin.	(58)
8.	-	NLP	The chatbot is used for learning pharmacology.	(59)
9.	-	Rule-based	A chatbot tool to support medical education.	(60)
10.	Ana	NLP	A chatbot tool to support medical education.	(61)
11.	Pharmabroad	Rule-based and OCR	A chatbot tool to identify a pharmaceutical product.	(62)
12.	-	NLP	The chatbot offers free basic healthcare education, information, and guidance to patients with chronic conditions.	(63)
13.	PharmaGo	NLP	A chatbot designed for an e-commerce platform for ordering pharmaceutical products online.	(64)
14.	Chatbot	NLP and Deep Neural Networks	This chatbot can help users find any information about drug	(65)
15.	Vik	NLP and ML	Vik provides verified medical information on this condition's epidemiology, treatment, side effects, and quality-of-life improvement strategies.	(66)
16.	GREAT4Diabetes	Rule-based	A WhatsApp chatbot for educating people with type 2 diabetes during the COVID-19 pandemic.	(13)

Chatbots in pharmacies can provide many benefits for patients and healthcare providers, such as improved medication adherence, increased patient engagement, and reduced workload on pharmacy staff (67). Chatbots have been shown to improve patient adherence to medication therapy by providing regular medication reminders (68). In addition to reminding patients to take their medications on schedule, chatbots can also provide information on potential side effects and proper usage to promote safe and effective medication use. This can be particularly helpful for patients with complex medication regimens or those who may struggle with remembering to take their medications as prescribed (69). By improving medication adherence, chatbots can help to reduce the risk of adverse events and improve patient outcomes.

In a study conducted on patients with type 2 diabetes, researchers found that using a chatbot as a regular medication reminder increased patient adherence by up to 80% (70). Another study on patients undergoing tuberculosis treatment found that using a chatbot as a medication reminder and providing treatment information increased patient adherence (71). Other studies have shown that using chatbots can help increase patients' adherence to medication therapy for coronary heart disease by improving their understanding of their medications and setting appropriate medication schedules (72). A recent study has shown that chatbots can help increase adherence to medication therapy in breast cancer patients by providing emotional support and information about medication side effects (12). A meta-analysis study found that chatbots can significantly improve patient adherence to medication therapy for various medical conditions, including diabetes, hypertension, and tuberculosis (73).

Chatbots in pharmacies have been found to help reduce the workload on pharmacy staff by providing basic information about medications and answering common patient questions, thus allowing pharmacy staff to focus on more complex tasks (74, 75). As an automated system, chatbots can provide instant and accurate responses to patients, which can help to reduce the time and effort required by pharmacy staff to provide the same information. A study on the use of chatbots in a hospital pharmacy found that chatbots were effective in reducing the workload of the pharmacy staff by providing basic medication information to patients and answering common questions about medication use and side effects during the Covid-19 pandemic (76). Another study found that chatbots could reduce the workload of community pharmacy staff by providing information about mask availability to patients during the Covid-19 pandemic (77). This can reduce the number of phone calls and office visits made by patients, allowing healthcare providers to focus on more complex patient care tasks and pharmacy staff to focus on more complex tasks, such as medication reviews and clinical services, which could improve patient outcomes and satisfaction (78).

Chatbots can improve patient engagement and satisfaction by providing quick and easy access to medication information and reducing waiting time for answers to patient questions. Patients can interact with the chatbot anytime and anywhere, which increases their convenience. A study conducted in a community pharmacy in the United States found that patients were delighted with the chatbot service and that it helped to improve their medication knowledge and adherence (79). Another study in a hospital setting showed that patients who used a chatbot to access medication information reported higher levels of engagement and satisfaction compared to those who received information from other sources (8). In addition, chatbots can also personalize the information and support provided to patients, making them feel more valued and involved in their care (68).

However, it is essential to note that chatbots should not replace human interaction altogether. Some patients may still prefer to talk to a human pharmacist or healthcare provider, especially for more complex issues or personal advice (80). Therefore, chatbots should be designed as complementary tools to enhance patient education and communication rather than replacing human interaction. To ensure that chatbots are effective in improving patient engagement and satisfaction, it is crucial to consider the design and functionality of the chatbot. The chatbot should be user-friendly, with a simple interface that is easy to navigate (81). The chatbot should also be able to provide accurate and reliable information and recognize and respond to various language styles and dialects (82).

Using chatbots in healthcare can help reduce costs associated with patient care and improve overall care processes. By providing patients with access to a virtual assistant that can answer their questions and provide assistance with medication management, healthcare providers can reduce the need for additional staff and resources (83). This can help to minimize the risk of errors and other issues that can be costly to address. Research has shown that using chatbots can lead to significant cost savings for healthcare providers (84). A study conducted by Accenture found that the implementation of a virtual assistant in healthcare could increase profit levels by up to 55% in 2035 (85). The Digital Health: Vendor Analysis, Emerging Technologies & Market Forecasts 2017-2022 report, published by Juniper Research on Wednesday, indicated that adopting chatbots in healthcare resulted in a cost savings of $3.6 billion globally by 2022 (86). In addition, using chatbots can help reduce the cost of medication management and prescription refills by providing patients with reminders and information about their medications (87). Another way that chatbots can help to save costs is by reducing the need for unnecessary medical visits (78). Patients can use chatbots to ask basic questions and get information about their condition without needing an in-person visit. This can help to reduce the strain on healthcare resources and improve access to care for patients who may have difficulty visiting their healthcare provider in person.

Chatbot has the potential to improve the security and privacy of patient information (88). By reducing the amount of human data access, a chatbot can minimize the risk of data breaches and ensure that patient data is kept secure (89). Furthermore, chatbots can maintain strict privacy and security standards using encryption and authentication methods to protect sensitive information (90). In summary, integrating chatbots into healthcare is a promising trend that offers new opportunities for improving healthcare delivery and patient outcomes. The chatbots listed in this article demonstrate the diverse range of applications and functions that can be achieved using these tools. As the field continues to evolve, there is a need for further research to optimize the design, implementation, and evaluation of chatbots in healthcare settings.

Challenges of Chatbots in Pharmacy

Technical Limitations

Limited Understanding of a Context

Chatbots are designed to understand and respond to user input based on programmed rules or machine learning algorithms. However, one of the technical limitations of chatbots is their limited understanding of context, which can result in misinterpretation or lack of understanding of user queries in certain situations (91). For instance, chatbots may struggle to recognize sarcasm or humor, leading to inappropriate or ineffective responses (92). Another factor that contributes to a limited understanding of context is the inability of chatbots to understand the broader context of a conversation (88). Chatbots often focus on individual user queries rather than interpreting the overall context of the conversation, which can lead to fragmented responses or an inability to provide adequate support to users (93). This limitation can be especially problematic in healthcare, where conversations between patients and healthcare providers can be complex and multifaceted. In addition, chatbots may struggle to recognize and respond to user queries outside their programmed scope. For example, a chatbot designed to provide medication reminders may not be able to respond to a user's question about the side effects of a particular medication, which can limit its usefulness to users (94). This limitation can be mitigated by designing chatbots with a broader scope of knowledge and by providing access to resources such as FAQs or links to relevant information.

Inability to Handle Complex Queries

Chatbots are designed to provide quick and easy access to information and assistance. However, they may struggle to handle complex queries or requests beyond their programmed capabilities, which can frustrate users (95). This limitation arises because chatbots rely on predefined rules or machine learning algorithms that have a limited scope of knowledge and understanding (96). As a result, they may not be able to handle requests that require a high degree of complexity or nuance, such as medical diagnoses or legal advice. Furthermore, chatbots may struggle to recognize user requests' intent, particularly when users make spelling or grammatical errors or use informal language (97). This limitation can further complicate the ability of chatbots to handle complex queries or requests, particularly in instances with a high degree of ambiguity or uncertainty.

To overcome these limitations, developers can incorporate natural language processing (NLP) technologies into chatbots, which can help them understand the context and intent of user requests more accurately. NLP can enable chatbots to recognize the nuances of language, including idioms, slang, and colloquialisms, which can improve their ability to handle complex queries and requests (98). Additionally, developers can incorporate machine learning techniques into chatbots to learn from previous interactions and improve their capabilities.

Dependence on Data Quality

Chatbots depend on data quality for their effective functioning, making data quality a crucial factor for their performance (99). The quality of data affects the accuracy of the responses generated by chatbots. Data quality refers to the completeness, consistency, and accuracy of data. If data is incomplete or inaccurate, it can result in poor responses generated by the chatbot (100). For instance, if a chatbot is designed to provide medical advice based on symptoms provided by patients, insufficient quality data can lead to inaccurate diagnosis, bad advice, or irrelevant information. Furthermore, the chatbot's ability to learn from user interactions and provide appropriate responses depends on the data quality. Chatbots rely on machine learning algorithms that learn from user interactions, and if the data is of low quality, it can lead to the learning of inaccurate or irrelevant patterns (101). This can lead to a decrease in the chatbot's effectiveness and the users' satisfaction.

In addition, the quality of data can also affect the ability of chatbots to adapt to changing circumstances or new scenarios. If the data is not updated or maintained regularly, the chatbot may not provide accurate or relevant responses to the users (102). Therefore, ensuring data quality is critical for chatbot performance and user satisfaction.

Integration Challenges

Integration of chatbots with other systems or platforms can pose technical challenges. The integration process may require modifications to the existing systems or the development of new interfaces to ensure seamless communication between different systems (103). One of the primary challenges of integration is dealing with legacy systems that may not be designed to work with modern chatbot technologies (104). Such systems may lack the necessary APIs or may have incompatible data formats, requiring additional efforts to ensure compatibility. Furthermore, complex IT environments, such as those in large enterprises, can pose significant integration challenges (105). These environments may consist of numerous interconnected systems with data structures and interfaces. Integration with such environments requires a comprehensive understanding of the underlying systems and careful planning and execution of the integration process. Failure to integrate chatbots properly with existing systems can result in data inconsistencies, security vulnerabilities, and reduced performance (106).

Organizations can leverage middleware technologies and APIs to address these challenges and streamline integration (107). Middleware technologies can act as a bridge between different systems, allowing chatbots to access and interact with data from various sources. APIs can also simplify integration by providing a standardized interface for data exchange between systems. Additionally, organizations can work with chatbot vendors or integration specialists to ensure a smooth integration process.

Maintenance and Updates

Chatbots require ongoing maintenance and updates to ensure they function effectively and accurately (108, 109). This includes updating the chatbot's database with new information and ensuring its algorithms are up-to-date with the latest technological advancements. However, performing these updates can be time-consuming and resource-intensive, particularly for organizations with limited technical expertise.

Additionally, as chatbots become more sophisticated, they may require more advanced maintenance and updates, increasing their complexity and cost. This can include upgrading the chatbot's hardware or software and re-training the chatbot's algorithms to handle new queries or requests. Furthermore, ensuring the chatbot's security is essential to maintenance (110). As chatbots become more widely used, they become a target for hackers who may try to exploit vulnerabilities in the chatbot's code or database (22). Regular security updates and patches are essential to prevent these types of attacks and ensure the safety of users' information.

When handling sensitive personal information, organizations must ensure that chatbots adhere to data protection regulations, such as the General Data Protection Regulation (GDPR) and Health Insurance Portability and Accountability Act (HIPAA) (111, 112). Failure to comply with these regulations can result in legal and financial repercussions. Furthermore, using chatbots may raise ethical concerns around data privacy and autonomy. Patients may be uncomfortable sharing personal health information with a machine rather than a human (113). Organizations must ensure patients are appropriately informed about using chatbots and collecting personal data. Patients can opt out of chatbot interactions if they choose to do so.

Limited Emotional Intelligence

Chatbots have limited emotional intelligence, which means they cannot recognize or respond to emotional cues that are a significant aspect of human communication (114). As a result, they may struggle to understand or respond appropriately to emotionally charged situations or requests. This limitation can lead to frustration or dissatisfaction among users, mainly when dealing with sensitive issues (115). Furthermore, chatbots may also struggle to distinguish between different forms of language, such as sarcasm or humor, which can further complicate their ability to understand and respond to user input (92). As such, developers must continue to explore ways to improve chatbots' emotional intelligence to enhance their effectiveness and user experience.

Inability to Handle ambiguity

One of the technical limitations of chatbots is their inability to handle ambiguity (115). This is because chatbots rely on programmed rules or machine learning algorithms to understand and respond to user input, which may not always account for the nuances of language. As a result, they may struggle to interpret ambiguous or vague requests or statements, leading to confusion or incorrect responses (116). Moreover, the lack of understanding of context can also contribute to chatbots' difficulty in handling ambiguity. Chatbots may misinterpret or lack knowledge of the context in certain situations, making it difficult to respond appropriately. Additionally, chatbots may have difficulty identifying and addressing issues that require more detailed information or clarification, further exacerbating their inability to handle ambiguity (117).

To overcome this limitation, some chatbots are designed to seek clarification or provide suggestions for rephrasing when they encounter ambiguous input

(118). However, this approach can still be challenging as it requires chatbots to understand language and context, which can be difficult to achieve with current technology.

Ethical Considerations

Privacy Concerns

Chatbots in the pharmaceutical industry raise privacy concerns due to the potential collection of personal information from users. This information may include sensitive details such as medical history or prescription information, which must be handled carefully (1). Chatbots also raise questions about how this data is collected, stored, and used, as well as whether users have given informed consent for their information to be used in this way. The collection and use of personal data by chatbots in the pharmaceutical industry must comply with regulations and ethical standards. This includes obtaining explicit consent from users for collecting and using their personal information and ensuring that data is stored securely and used only for the purposes for which it was collected (119).

Another ethical consideration is the potential for bias in chatbot algorithms. If algorithms are trained on biased data, they may perpetuate or amplify existing biases (120). This could seriously affect health outcomes and healthcare access for certain populations. Additionally, there is the question of whether chatbots in the pharmaceutical industry are accessible and equitable for all users, regardless of age, language proficiency, or technological literacy. If chatbots are not designed with these considerations in mind, they may exacerbate existing health disparities and widen the gap in healthcare access between different groups (121, 122).

Bias and Discrimination

Chatbots in the pharmaceutical industry may perpetuate bias and discrimination in healthcare due to their reliance on datasets for training their algorithms (123). Chatbots may inadvertently propagate these biases when interacting with patients if these datasets are biased or incomplete (124). This could result in inaccurate diagnoses or treatments and unequal access to healthcare services for specific populations. Additionally, chatbots may be programmed with biases or discriminatory language, which could lead to harm or discomfort for certain users (125). Therefore, it is essential to ensure that chatbots are trained on diverse and unbiased datasets and programmed with inclusive and respectful language for all users.

Responsibility and Liability

Chatbots are programmed to provide advice and information to users, but the accuracy and completeness of this information are not always guaranteed (126). In cases where a user suffers harm due to incorrect or incomplete information provided by a chatbot, it is unclear who should be held responsible. One potential solution to this issue is clearly defining the roles and responsibilities of all parties involved in developing and deploying chatbots in the pharmaceutical industry (127). This could include the chatbot developer, the pharmaceutical company, and any regulatory bodies involved. Establishing clear guidelines and standards for chatbot development, including testing and validation procedures, may also be necessary to ensure that chatbots provide accurate and reliable information (128). Another potential solution is incorporating disclaimers and warnings into chatbot interactions, which could help mitigate the risk of harm caused by incorrect information (129). This could include informing users that the chatbot is not a substitute for medical advice from a qualified healthcare professional and advising users to seek professional medical advice in certain situations.

Autonomy and Decision-making

Using chatbots in the pharmaceutical industry may lead to ethical concerns regarding autonomy and decision-making (130). Chatbots may influence or decide about a user's health without understanding or consent. Chatbots may provide advice or suggest treatments that users may not fully understand or agree with, leading to questions about the user's autonomy in making health-related decisions (131). Furthermore, chatbots may not provide users with a complete understanding of their health condition or the potential consequences of their choices. This raises concerns about whether users can make fully informed decisions about their health and whether they are provided adequate information to do so (132). Moreover, there may be instances where the chatbot's suggestions or advice conflict with the user's values or beliefs (133). This raises questions about the chatbot's role in decision-making and whether it is appropriate for a machine to make decisions that may conflict with a user's values or beliefs.

Transparency and Accountability

Chatbots in the pharmaceutical industry must prioritize transparency and accountability to ensure users can make informed decisions about their health (134). This includes being transparent about their programming, data sources, and the algorithms and methods they use to arrive at their recommendations. Without this transparency, users may be left with unanswered questions or concerns about the chatbot's advice or information, leading to mistrust and disengagement (135). Furthermore, transparency is vital for ensuring accountability for the chatbot's advice or information. If users have adverse health outcomes following the chatbot's recommendations, they need to know who is responsible and who they can turn to for support or compensation. By being transparent about their programming and data sources, chatbots can help to ensure accountability and build trust with users (136).

Fairness and Justice

Ensuring fairness and justice in the design and implementation of chatbots in the pharmaceutical industry is crucial to avoid exacerbating disparities in healthcare access and outcomes (137). Language and cultural barriers, socioeconomic status, and geographical location must be considered (138). For example, if a chatbot is only available in English, it may exclude non-native speakers who require medical advice. Similarly, if a chatbot is trained on data from a specific demographic group, it may not effectively provide accurate information to users from other demographic groups. This highlights the importance of ensuring diversity and representativeness in the data used to train chatbots.

Moreover, fairness and justice considerations also extend to the potential impact of chatbots on healthcare systems and providers. Chatbots should not be seen as a replacement for healthcare providers, particularly in areas with a shortage of providers (139). Instead, they should be viewed as complementary tools that enhance healthcare access and outcomes. This requires careful consideration of the potential impact of chatbots on healthcare systems, providers, and users and ensuring that any possible negative consequences are mitigated. In addition, transparency and accountability are also important in ensuring fairness and justice in using chatbots. Users should have access to information about how chatbots are programmed, what data sources they use, and how they arrive at their recommendations. This allows users to make informed decisions and ensures accountability for the advice or information provided. Furthermore, efforts should be made to ensure that the use of chatbots in the pharmaceutical industry does not further widen existing disparities in healthcare access and outcomes but instead promotes fairness and justice for all (140).

Impact on Pharmacist

Chatbot is a type of software that is programmed to simulate human conversation through text or voice-based interactions. Chatbots are becoming increasingly popular in the healthcare industry because they can provide round-the-clock customer service and support and enhance healthcare services' efficiency. However, the question remains whether chatbots will replace the role of pharmacists. While chatbots can provide basic healthcare advice and support, they cannot replace the expertise and knowledge of pharmacists (88, 141). Pharmacists play a crucial role in the healthcare system by ensuring patients receive the correct medication and dosages, monitoring patients' health outcomes, and providing counseling and education about their medications (142-144). This requires a deep understanding of pharmacology, patient care, and drug interactions, which a chatbot cannot replicate.

Additionally, pharmacists are trained to provide personalized care to each patient, considering their medical history, lifestyle, and individual needs (144-146). This level of personalization and individualized care cannot be achieved by a chatbot, which is programmed to respond to predefined queries and may be unable to address each patient's unique concerns or needs. However, chatbots can still play a valuable role in supporting the work of pharmacists. Chatbots can help pharmacists manage routine tasks, such as answering basic queries, scheduling appointments, and providing medication reminders, freeing pharmacists' time to focus on more complex tasks. They can also help improve medication adherence and patient outcomes by reminding patients to take their medication, monitoring their health status, and educating them about their medications.

Figure 2 shows pharmacists play a crucial role in implementing digital health, including chatbots. Pharmacists can act as observers and decision-makers in learning and training data for artificial intelligence. Additionally, certain limitations in patient-chatbot conversations can be applied to prevent medication errors, particularly regarding autonomy decision-making. Pharmacists can take over conversations in specific cases or when patients need and request it. Furthermore, medication purchases and orders, especially those that require a prescription, should be handled and controlled by pharmacists. Decisions regarding the use, changes, switches, and discontinuation of treatment should be carried out by pharmacists in collaboration with other healthcare providers.

In conclusion, while chatbots can enhance the efficiency of healthcare services and provide basic support to patients, they cannot replace the role of pharmacists. Pharmacists ensure patient safety and personalized care, requiring expertise and knowledge that a chatbot cannot replicate. However, chatbots can still play a valuable role in supporting pharmacists' work and improving patient outcomes.

Future Directions of Chatbots in Pharmacy

Chatbots in pharmacies have several potential future directions to improve patient care and accessibility. Integrating electronic health records (EHRs) can provide more personalized and accurate patient recommendations (147). Additionally, expanding language capabilities can accommodate non-English speaking patients and increase accessibility (148). Chatbots can also be utilized for medication adherence monitoring and patient education, potentially reducing hospital readmissions and improving outcomes. Integration with wearable technology and other monitoring devices can provide real-time health data and recommendations (149). At the same time, more advanced natural language processing (NLP) and machine learning algorithms can improve the accuracy and effectiveness of chatbot interactions with patients. Collaboration with other healthcare providers, such as physicians and nurses, can provide a more comprehensive approach to patient care. Moreover, expansion into telemedicine and virtual consultations can allow patients to receive care from the comfort of their own homes. Furthermore, an increased focus on privacy and security measures can protect patient data and prevent breaches. Finally, chatbots can also be used for clinical trials and research, potentially improving patient participation and data collection (150).

The integration of voice-text-voice features in chatbot technology presents a significant opportunity for the future of pharmacy (151). This advancement would allow patients to communicate with chatbots using voice commands and receive responses in audio format, removing the need for typing and potentially improving accessibility for patients with disabilities or limited dexterity. With this technology, patients could easily order prescriptions, receive medication reminders, and obtain guidance on medication use through simple voice commands. This could increase medication adherence and improve patient outcomes, as patients would have easier access to critical information. Furthermore, integrating voice-text-voice features could allow chatbots to conduct basic health assessments through voice-based symptom analysis. Chatbots could identify specific symptoms through voice recognition technology and provide personalized recommendations and guidance for the patient's condition. However, there are some challenges to overcome in implementing this technology in the pharmacy setting. One potential limitation is the accuracy of voice recognition technology, which may result in errors and misunderstandings in communication. In addition, there may be concerns about patient privacy and data security when using voice-based interactions. Despite these challenges, integrating voice-text-voice features in chatbot technology presents a promising future direction for the pharmacy field. This technology allows patients to access personalized, convenient, and accurate healthcare guidance without manual input, potentially improving medication adherence and overall patient outcomes.

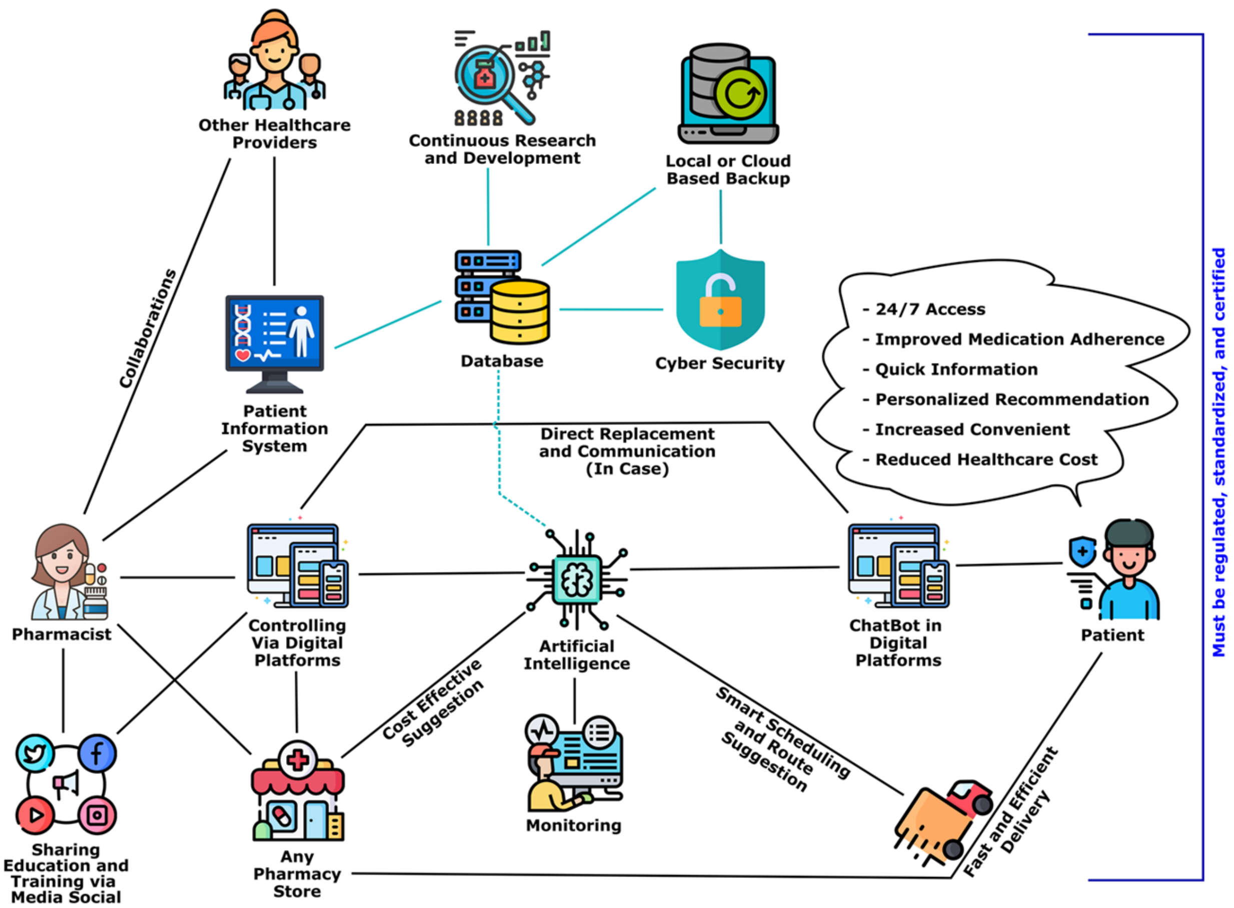

Figure 2. The dynamic interplay of a pharmacist, healthcare collaboration, and AI.

Conclusion

In summary, chatbots have the potential to revolutionize pharmacy practice by providing patients with personalized and accessible healthcare recommendations, promoting medication adherence, and improving patient outcomes. However, several concerns must be addressed, such as privacy and security, bias and discrimination, responsibility and liability, and autonomy and decision-making. To ensure that chatbots are implemented ethically and effectively, future research should focus on developing more advanced natural language processing and machine learning algorithms, integration with wearable technology and electronic health records, collaboration with other healthcare providers, and increased focus on privacy and security measures. The implications for the future of pharmacy practice are significant. Chatbots can improve access to care, reduce healthcare costs, and increase patient satisfaction. However, their implementation must be carefully managed to avoid unintended consequences such as perpetuating bias and discrimination or compromising patient autonomy.

Declarations

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