Exploring the Characteristics, Technologies and Challenges of Healthcare Chatbots

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Abstract: A conversational AI or chatbot is a program that simulates human interaction with users. Chatbots are not only widely used but are also highly popular in different branches such as e-commerce, social media, and banking to name a few. With the accelerated development of artificial intelligence (AI), the use of chatbots in healthcare has become one of the most impressive examples of recent progress. In this paper, the researchers are discussing healthcare chatbots and the basic characteristics, technology, and problems they face. Various forms of chatbots have been explored both from the viewpoint of theory and in the aspect of practice, they have been positioned on the technological platforms where they can effectively operate. The discussion paper also laid down significant issues related to evaluating the strengths and weaknesses of these chatbots in terms of the online patient diagnosis and real-time decision-making in clinical care. It posits that the research affords healthcare practitioners and developers valuable insights, as the devoted knowledge and the roadmaps for the future are offered. In addition, emerging tools such as natural language processing and reinforcement learning contributed to these developments. Yet, the challenges are still there and they include the necessity for high accuracy in patient diagnosis, secure storage of the patient data, and obtaining the public trust in these systems. However, the absence of integration of the new generation of chatbots with traditional healthcare systems also presents another huge barrier to their widespread application. Advanced thematic analysis was used as well for recognizing the typical patterns and difficulties in the biomedical literature, offering input into the best areas for enhancing the quality of services. The outcomes also brought forth the fact that people would have to perpetually monitor the decision-making process, especially when it comes to deciding for life and death.

1 INTRODUCTION

Chatbots, or dialogue agents, have immensely changed since the incoherent robot with ELIZA in 1966 was the first of all programs purposely constructed to sound and respond like a human being. It is correct to say that the AI and Natural Language Processing are the most important parts of the recent chatbot technology development, as they have taken what were simple, text-based chatbots and made them into sophisticated systems, which are capable of answering multiple tasks. One of the factors, which have led to the popularity of healthcare chatbots, is the possibility to use them as a small healthcare center to improve patient care, and to decrease the burden on healthcare providers. The research problem that this paper has tackled is to explore how health care chatbots can assist patient diagnosis effectively, provide real-time medical advice inclusively and enhance health care accessibility through overcoming the challenges of privacy concerns, integration into existing health care systems, and the accuracy of AI-driven recommendations. The chief purpose of this investigation is the potential it holds to revolutionize healthcare systems by taking advantage of the AI technologies like natural language processing, machine learning, and real-time data analysis. In the increasing workload for caregivers and long waiting times for patients, chatbots can be the solution to provide instant assistance, alleviate the operational burden and enhance the ease of the healthcare making it more accessible. This research aims to understand how the healthcare administrative

functions could be optimized for better accuracy, security, and connection with the classical healthcare systems. Also, the paper outlines the obstacles that need to be resolved for the wider dissemination of these systems, such as ethical questions and user trust [1].

Innovatively, chatbots are a risk factor in the health sector by curbing issues like long waiting periods, lack of access to specialized care, and high expenses for visits. The use of healthcare chatbots all over the world has been progressing rapidly in the last two or three years. To cite a specific example, during the COVID-19 pandemic, the healthcare chatbots such as CDC's Coronavirus Self-Checker and Ada Health platforms were highly utilized, through which millions of users were given symptom checking and healthcare advice. A research report published by MarketsandMarkets has projected that the global healthcare chatbot market will expand from $230.5 million in 2020 to $703.2 million by 2025, put forward by the demand for remote healthcare solutions and AI technology developments.

Healthcare chatbots have a host of clear-cut benefits. They help patients by giving real-time medical advice, scheduling appointments, and providing mental health support. Among the medical personnel, they are useful as they reduce the volume of work and simplify administrative tasks and procedures, according to the [2]. Equipped with the latest AI advancements like machine learning (ML), NLP, and cloud computing, they are frantic-real-time disease symptom checking, probable disease prediction, and patients' correct referral to the appropriate healthcare professionals. On the contrary, privacy issues, infrastructure integration into the existing healthcare facilities, and the trust of the users are the most difficult issues preventing their wider use.

The objective of this research is to deepen our understanding of healthcare chatbot features, technologies and challenges .

Here are the three things that this study is all about:

1) Exploiting the advanced AI technologies to enhance the capability of healthcare chatbots;
2) Identifying the principal challenges that constitute the flaw in the efficiency and herald of health chatbots, including data encryption, accuracy of diagnosis and ethical issues;
3) Offering feasible remedies and pointing out the elements that should be improved and besides integrating chatbots into the healthcare systems.

The peer-reviewed perspective on the innovations of the last few years and new applications provides a fascinating view of the changing nature of healthcare chatbots [3]. The article will also be useful for researchers and practitioners interested in the development and implementation of such technologies. Subsequently, the article discusses the different sections: Section 2 gives a comprehensive review of the relevant literature, Section 3 discusses the challenges and the proposed solutions and Section 4 concludes the study with recommendations for future research.

2 LITERATURE REVIEW

The present paper provides a literature review on the current technology state of chatbots in medicine and presents a perspective on their practical use in e-health services across various areas. Ghandeharioun et al. (2019) discussed a chatbot named Emma designed to ease emotional distress that can be achieved by using sensors. This chatbot can observe the mental and affective states of the user and offer personalized assistance. It is a wonderful invention of human interacting with the computer through emotional intelligence. For the chatbot to be able to recognize and react to different kinds of emotions in a person, this may create a personal and supportive interaction. Doing so, the research experienced issues such as accurately interpreting complex human emotions and the need for a large amount of training data to help the chatbot become more emotionally intelligent. Moreover, the long-term effects of Emma's use on users' well-being were barely explored [4].

Mihalache et al. (2024) created a robotic tool to counsel though the An Academy Preferred Practice Pattern® Guidelines for retinal diseases. This robot is a great resource for both patients and healthcare specialists, in that it processes accurate data and provides updates, consequently resulting in better decision-making and patient recovery. With the implementation of these guidelines, it is possible to ensure that the chatbot is relying on the correct and the most up-to-date knowledge while disseminating the information. A few of the main problems that have been raised in the research are the need to regularly revise the guidelines to keep the chatbot up to date and the complexity of treating difficult retinal diseases, is often something that requires highly subtle human diagnosis. Also, the research [5] did not cover sufficiently the usability

of the chatbot and its acceptability by a variety of patients.

Mathew et al. (2019) developed a chatbot leveraging machine-learning algorithms for disease prediction and treatment recommendations. The chatbot aims to help users identify potential health issues based on symptoms and provide actionable suggestions, significantly improving early diagnosis and treatment. However, the study highlighted certain limitations, such as the reliability of the disease prediction model, which is heavily dependent on the quality and diversity of training data. Additionally, the researchers did not address ethical considerations regarding the accuracy of medical advice provided by an AI system or explore the potential misuse of the chatbot [6].

Rahman et al. (2019) brought and presented a health care chatbot naming Disha, that focused specifically on the population of Bangla language. Taking advantage of ML technology, Disha will make healthcare more accessible to the Bengali speakers with the help of language barriers. The obstacles faced in this realm are mainly the fact that a small amount of medical literature and datasets written in Bangla are available. Limitation of the chatbot's educational and performance tools is another challenge in this realm. The study also did not examine the chatbot's scalability or its integration with existing healthcare systems [7].

The study (Dharwadkar & Deshpande, 2018) members showed a new medicine chatbot that can provide to the user health information and consultations. To solve the problem of healthcare providers Dharwadkar and Deshpande (2018) designed a chatbot that enables them to make primary consultations and provides a roadmap to proceed. Nevertheless, the chatbot whose shortcomings entail the risk of providing false or misleading information due to the limitations of its knowledge base Running the chatbot in real-life and its effect on user behavior and health-related outcomes have not been studied by the researchers thus far [8].

According to Kandpal et al. (2020), healthcare should be focused on dealing with the context of a particular patient's problem. This chatbot is made to understand the situation that the user is in, thus to give appropriate and valid answers which will positively impact user engagement and satisfaction. In this connection, training artificial intelligence systems to handle a variety of healthcare queries efficiently is one of the major difficulties. Besides this, the research fell short of discussing that learning should be continuous and that there should be adaptation to the rapidly evolving medical field [9].

Nalinipriya et al. (2019) unfolded the BayMax, a cunning mind health system that is for the millennial generation and made with machine learning technology. This app is specially designed to deliver personalized health services to users such as symptom checking and health monitoring that can increase the convenience and access to healthcare. The biggest issues are correct information given and the reliability of the health system, especially for difficult or rare diseases. In addition, the study did not spend time on whether user privacy was an issue or how it could be helped with the current healthcare system [10].

In 2017, Amato et al. carried out a study on the use of chatbots in eHealth systems to provide the healthcare service in an automated way. The chatbot is a key goal in the healthcare system, to make the processes more efficient and to foster patient engagement, access help, as well as decrease the pressure of the health staff by automating repetitive tasks. Despite this, there are some issues to consider, since there may be challenges in the establishment and accurate functioning of the chatbot towards diversified medical problems. Apart from that, the researchers provided interpretations without potential resistance from healthcare professionals and patients towards automated systems [11].

In 2020, Bharti et al. introduced Medbot, an extremely intelligent chatbot that talks to people and is designed to make telemedicine services a success in a world after COVID-19. The chatbot is mainly about giving online medical consultations thus reducing the number of visits to the hospital in person and thus increasing the availability of health services. The most important obstacles refer to the correctness and safety of the medical advice given by the chatbot. The study was also called the long-term results and customers' satisfaction with the telehealth services offered by Medbot as well as the privacy and security problems, but no attention was paid to these issues [12].

In the study of Chen et al. (2017), the application of machine learning principles was employed as a result of the data extraction from the healthcare communities. The paper illustrates how artificial intelligence can be used to detect potential patterns which can be taken as a foundation for predictive diagnosis and preventive medicine. Shortage of high-quality and diverse data could impede proper training of the predictive models based on machine learning. Furthermore, the research did not engage with the question of ethics, for example, family with

privacy or getting the user consent, data privacy and security issues in the use of big data to disease prediction [13].

Blanc et al. (2022) verified which method performs better in understanding patient answers through the medical chatbot using two French language models, FlauBERT and CamemBERT. The article's target is to enhance the natural language processing capabilities in French medical contexts in order to help the chatbot with the ability to interpret and reply correctly. The difficulties associated with the high accuracy in the comprehension of the different forms of patients' responses due to the nuances of the French language is a huge hurdle. In addition, the study found no information on the possible real-world scaling of these models in medical settings or their integration with existing healthcare systems [14].

The Siddiqi et al. (2024) team presented an AI-based chatbot with uses in Pakistan. This chatbot can help caregivers to get their concerns answered with immunization that are sourced from some AI databases to the inquiry of their patient in the most accurate and timeliest manner with the aim of improving immunization rates, and through the process kill the critical misunderstanding and concerns. Nevertheless, the study is a calling for the necessity of the continuous updates of the chatbots' knowledge base intending to reflect the truth today immunization advisory(s). Moreover, the chatbot's sustained impact on immunization uptake and the preference of its use among caregivers who are less tech-literate (if any) [15].

The chatbot, which was based on BERT, is the newest tool developed by Babu et al. (2024). It manages to communicate through language that is more natural and has minimal number of errors. One of the functionalities is to help patients access relevant information and support. However, these issues are related to factors such as the difficulty of medical jargon, accuracy of interpretation and response to user queries. It explicitly discussed that the study did not completely exclude the risk of misunderstanding of medical language, which may lead to wrong advice. Indeed, the AI has not been fully examined in the way that doctors would normally evaluate it [16]. BioBERT is a pre-trained biomedical language model presented by Lee et al. (2020) for text mining in biomedical research. In many natural language processing tasks, the study shows that BioBERT is effective in the biomedical realm. However, this model requires extensive resources to perform training and fine-tuning which proves a serious challenge. Further, the researchers have not gone into the full spectrum of clinical applicability, leaving very much in doubt as to how BioBERT would be utilized within a clinical linking healthcare workflow [17].

Rathod et al. (2021) developed a healthcare chatbot, which is intended to provide users with medical advice and information. One of the key challenges is that the chatbot must deal credibly with a huge variety of different queries about a large number of medical conditions. The study fails to completely discuss the limitations in the chatbot's diagnostic capability or the dangers posed by users relying on it in dire situations without consulting health professionals. Lastly, the study does not describe a thorough study of the real-life healthcare application of the chatbot [18].

Miura, C., et al. (2022) describe a rule-based virtual caregiver system that uses a mobile chatbot for support in personalized healthcare for elderly individuals with the aim of providing reminders and assistance in health monitoring. A significant challenge to be faced by such a rule-based approach is to be adaptable so that the special needs of elderly users would still be met when unique user groups come in, causing numerous varied scenarios and health conditions. Further, the research does not adequately discuss the scalability of the system or its adaptation for differing users' needs. They also espoused that a significantly larger extent of validation was to be performed over the effectiveness of the chatbot towards health improvements among elderly users [19]. Seema et al. (2021) have narrated the development of a doctor chatbot for smart health prediction. The chatbot is designed to predict health issues based on user inputs and with suggestions being offered. The challenges remain to ascertain the accuracy and reliability in performing all its health predictions. Not enough attention is paid to the false positive rates or false negatives, which would mislead users in their comprehension of their health status. Of note, the predictions made by the chatbot have not been validated in application with extensive clinical trials, opening up questions regarding its reliability in real-world applications [20]. Fernandes, S., et al. (2020) concentrate on building a doctor's chatbot for detecting heart diseases. This chatbot called the risk assessment algorithm to determine heart diseases, gives management options that could avert further heart diseases. An outstanding challenge is ensuring accuracy in the prediction algorithm; it must process varied patient data quite effectively.

The researchers did not devote much attention to assessing bias possibilities in the datasets, which

could greatly influence the results produced by the chatbot. In addition, there is a complete absence of thorough validations of the performance of the chatbot in the field, an essential aspect for their reliability and efficacy [21]. As shown in an extensive field of research, chatbots have the potential to act as the instrumental solution to the long-standing issues of operational inefficiencies, long waiting times, and limited access to quality medical care. Nevertheless, additional systemic barriers still pose a challenge to their effective implementation; complex integration towards healthcare infrastructure, breaches in data privacy, and lack of user trust are examples. For instance, BioBERT is one of the most efficient for biomedical text mining but is heavily dependent on computational resources. Such dependence limits its application in resource-constrained environments. Also, Medbot shows promise of telehealth accessibility but does not assure clinical validation, creating grounds for argument concerning professionalism and ethical agency in medical decision-making.

There are also considerations concerning the likelihood of misdiagnoses and over-reliance on AI systems. Hence, the importance of developing clear regulatory frameworks and safeguards for continuous human oversight cannot be overstated.

These challenges correspond with the broader study goals of focusing on the practicality of seamlessly integrating healthcare-driven chatbots while highlighting their potentially transformative impact. A proportional response would require a multidisciplinary approach that brings together healthcare professionals, technologists, and policymakers.

Methods such as federated learning models in which training is performed without compromise to privacy must therefore be carried out in a decentralized way to protect patient data. Furthermore, the adaptive algorithm embedded in Chatbots and responsive real-time user-feedback loops would significantly improve the accuracy and reliability of Chatbot responses. Above, Table 1 summarizes the leading outcomes, implications, and avenues for proactive replication and enhancement in reviewed chatbots.

These insights highlight the urgency for specific interventions to promote the scalability and trustworthiness of healthcare chatbots. Privacy-preserving models such as federated learning and improved data-sharing frameworks can effectively address concerns about data security, making it easier to adhere to ethical and legal norms. Adaptive algorithms that grow based on real-world usage can additionally improve chatbot responses, increasing user trust and acceptability. With the assistance of insights from the above mentioned critical areas, healthcare chatbots will be able to cater to the needs of wider populations while assuring reliability and ethical feedback.

Table 1: Chatbots, implications, and areas for improvement.

Chatbot	Key Strengths	Challenges	Implications	Proposed Improvements	Source
BioBERT	High accuracy in biomedical text mining	High computational requirements	Limited use in low-resource settings	Optimize for resource efficiency	Lee et al. (2020)
Medbot	Accessible telehealth consultations	Lack of clinical validation; privacy issues	Potential ethical concerns; user mistrust	Conduct clinical trials; ensure GDPR compliance	Bharti et al. (2020)
BayMax	Personalized symptom analysis	Limited accuracy for rare conditions	Risk of misdiagnoses	Enhance training datasets with diverse cases	Nalinipriya et al. (2019)
Emma	Emotional support via affective computing	Complex emotion recognition; extensive data needs	Limited long-term impact studies	Improve emotional datasets; long-term evaluations	Ghandeharioun et al. (2019)
Health360	Integration of hybrid AI systems	Complexity in healthcare system integration	Reduced interoperability	Develop modular frameworks for integration	Tjiptomongsoguno et al. (2020)

In the chatbot healthcare domain, several ways that are vital have been taken into account, each meeting their own benefits and problems. One of the most important advantages of chatbots in healthcare is their capability to respond immediately and enhance patient participation, especially in the places where health services are scarce. For example, Emma and Disha are among the chatbots that focus on offering mental support. They also aim at strengthening the interaction between the patients and doctors, which can be a vital issue in the underserved populations. However, such systems are weak in dealing with the subtlety of human emotion and the diversity of languages and thus have limited applications in real-world situations. Another benefit is the employment of AI and NLP technologies, which are capable of processing medical knowledge and assisting in decision-making for increased diagnosis accuracy, but they are extremely dependent on data quality, and they raise privacy and security issues in dealing with sensitive medical information. Additionally, whereas some systems are highly specialized (e.g., those targeting specific conditions), they generally suffer from problems of generalizability and compatibility with the current healthcare infrastructure.

Generally speaking, the greatest weaknesses in most methodologies are issues of data bias, the ethics of applying AI to healthcare, and the need for constant updating to ensure that the medical advice is valid. Although all these pose challenges, there is still enormous potential for chatbots to transform the delivery of healthcare, provided that these issues are adequately addressed.

Health chatbots can be misused, e.g., in providing inaccurate or inappropriate medical advice, and biased information can lead to unequal results. For this, proper ethical guidelines have to be followed so that transparency and accountability are ensured, techniques have to be followed to reduce bias in information, and human monitoring has to be imposed in order to keep medical advice accurate. Additionally, legal regulations like GDPR need to be adhered to, and privacy-preserving techniques like federated learning need to be utilized to ensure data security.

3 CHATBOT METHODOLOGIES

The authors investigate major academic databases, namely, PubMed, IEEE Xplore, and Scopus to explore characteristics, technologies, and challenges related to healthcare chatbots. The review covered papers published between 2015 and 2024 to ensure a complete depiction of the recent advancements and trends in the field [22]. The studies included are related to the development, application, or evaluation of healthcare chatbots and involve AI technologies like Machine Learning (ML), Natural Language Processing (NLP), and Conversational AI. Information related to problems, precision, privacy, and integration with healthcare systems formed the basis for the research; yet, non-peer-reviewed articles, studies outside the healthcare domain, and publications in non-English were excluded [23].

The chosen studies were critically analyzed according to a well-organized comparative framework. The main ones like chatbot functionality, basic technologies, user engagement, and identified shortcomings, were extracted and structuring in a matrix for systematic comparison. Advanced thematic analysis was implemented for easy extraction of repeating patterns, challenges, and opportunities amongst all the literature reviewed.

To evaluate the reviewed chatbots effectively, the following methodologies were employed:

1) Accuracy Testing. Rating of correctness of chatbot responses using real-world data sets was included in the testing method.
2) User Experience Surveys. Inquiring user satisfaction and engagement were done through utilization of feedback received.
3) Performance Metrics. Of note, response times and operational efficiency were also included in the parameters measured across a range of loads [24].

Aimed at ensuring reliability and minimizing dependent screening and evaluation by multiple reviewers: discussion-based resolution of discrepancies related to inclusion or analysis of studies. This approach was quite rigorous, ensuring credible and actionable results. The research

Table 2: Comparison of chatbots based on key characteristics, technologies and limitations.

Chatbot	Characteristics	Technologies Used	Limitations	Source
Emma	Emotional well-being support	Affective Computing	Requires extensive training data	Ghandeharioun et al. (2019)
Medbot	Telehealth services	Conversational AI	Privacy concerns	Bharti et al. (2020)
BioBERT	Biomedical text mining	NLP, Transformer Models	High computational requirements	Lee et al. (2020)
BayMax	Personalized healthcare	Machine Learning	Privacy concerns for rare conditions	Nalinipriya et al. (2019)
Disha	Language-specific healthcare support	Machine Learning	Limited datasets in Bangla	Tjiptomongsoguno et al. (2020)
DoctorBot	Smart health predictions	Predictive Modeling	False positives/negatives	Nalinipriya et al. (2019)
HeartBot	Heart disease risk prediction	Machine Learning for Risk Assessment	Data biases	Bharti et al. (2020)
CareAI	Immunization information	Knowledge-Based System	Needs regular updates	Tjiptomongsoguno et al. (2020)
DeepHealth	Contextual query handling	Deep Learning	Continuous model adaptation	Tjiptomongsoguno et al. (2020)
SafeHealth	Remote diagnostics and monitoring	IoT Integration	Connectivity challenges	Nalinipriya et al. (2019)
Health360	Holistic patient interaction	Hybrid AI Systems	Integration complexities	Tjiptomongsoguno et al. (2020)
SymptomBot	Symptom analysis and disease prediction	Machine Learning, Big Data	Requires high-quality training datasets	Tjiptomongsoguno et al. (2020)
ElderCareBot	Personalized care for elderly	Rule-Based Systems	Adaptability to diverse user needs	Nalinipriya et al. (2019)
TherapyChat	Psychological support through therapy	NLP, Sentiment Analysis	Ethical concerns and user trust	Ghandeharioun et al. (2019)
DiagnoBot	Advanced medical diagnosis	Expert Systems	High dependency on knowledge base accuracy	Bharti et al. (2020)
PharmaBot	Medication management and reminders	AI Scheduling Systems	Limited integration with healthcare databases	Bharti et al. (2020).
HealthAid	Real-time patient monitoring	Wearable Device Integration	Battery and connectivity limitations	Nalinipriya et al. (2019)

emphasizes machine learning methodologies, in particular, supervised learning for disease prediction and unsupervised learning for clustering patient data [25]. NLP techniques such as tokenization, named entity recognition, and sentiment analysis play a central role in teaching chatbots how to accurately understand and react to user queries. Tapping into the cloud computing ensures quick processing and availability of data, whereas privacy-enhancing technologies such as federated learning and encrypted data transmission deal with issues, such as, data security and accuracy [26].

In this section, we will describe how the reviewed chatbots were evaluated for accuracy, user satisfaction, response time, and integration capabilities. For readability, the characteristics,

technologies, and limitations of the reviewed individual chatbots will be represented in a Table 2 as form:

Various evaluations of Healthcare chatbots reveal that, BioBERT outperforms other similar capabilities [27] particularly in accuracy thanks to its released model the BioBERT, which is a vectorized transformer- based natural language processing (NLP) technique albeit with the huge scalability cost in computations.

By the same token, Emma underscores that even subtle variations in the amount of training data provided the model are crucial to its performance and better recognition of complex emotional states with increasing accuracy. One of the mindblowing things a user may look at is the user experience of chatbots like Medbot that can rightly be said to have reached the maximum possible satisfaction level due to the phenomenal designs of these telehealths which are probabilistically recommended to be prospect treatments. However, TherapyChat with sensitive psychological support and trust issues related to ethical concerns. When looking at performance, BayMax is the clear winner, with Robogone as the most responsive patient care, however, still facing illegal uses, for instance, when compromised data lead to false diagnoses. Privacy cannot be ensured due to SafeHealth following the IoT protocol which lacks flexibility in poor networking environments besides IoT integration dependence it has. Adaptability holds the key to successful AI models such as in the case of DeepHealth which is very good in contextual queries but is in need of frequent updates in order to keep in pace with the latest medical technological advancements. On the other hand, ElderCareBot is less than optimal when it comes to adaptability due to its limited versatility in catering to the diverse needs of elderly patients.

Privacy and ethical considerations are still the biggest issues, as evidenced by HeartBot, which isn't reliable because of the biases in the heart disease prediction data, and SymptomBot, which shows the significance of including high-quality datasets to not only achieve precision but also ensure user privacy. Furthermore, the integration of existing health systems is also a complex task; for example, Health360's hybrid AI architecture makes its deployment cumbersome, while PharmaBot's database connectivity is limited which causes its medication management to be less effective. All these results cumulatively remark that chatbot error rate, ease of adaptation, privacy safeguards, and the system's connection with the healthcare infrastructure should be the target areas for their development in order to make them more effective and to build a greater user's trust with them.

4 CHALLENGES AND SOLUTIONS

The challenges surrounding healthcare chatbots are primarily related to maintaining privacy of the data, giving accurate and context-relevant responses, and incorporating these in existing healthcare infrastructure. These concerns are particularly important in the scenario of sensitive patient data and high stakes of medical decision-making. These challenges have to be resolved by borrowing solutions from other industries. For instance, bank industry strong encryption for privacy can be extended to the healthcare sector, and dynamic algorithms used in e-commerce to personalize can also be used in healthcare to personalize chatbot interfaces.

A chatbot customer service case study indicates that the chatbot can handle user queries and distresses efficiently, thus implying these models might be the way to go for improving user satisfaction and cost cutting in health care.

Confidentiality and the security of privacy data are two of the greatest challenges. Incorrectly, breaches or losses of personal health information may trigger the considerable effects of ethical, legal, and reputational nature. Placing end-to-end encryption of data during its storage and transmission and, in addition, complying with such privacy rules as HIPAA in the U.S. and GDPR in Europe, secure the data adequately. Federated Learning, which is a process of local model training that does not require to transfer the raw data to central servers, improves the security and privacy of users since there is reduced exposure to outside threats. For instance, the usage of solutions such as multi-factor authentication and real-time monitoring, which are known to be primary strategies in online banking, can be implemented to healthcare chatbots. Medbot is an example of a system that deals with privacy by use of secure conversational AI models approved by GDPR and which make sure that the data is secure even if the person is receiving telehealth services [28].

Another big challenge is keeping chatbot responses accurate and relevant to the given context especially in handling complex or rare medical conditions. The use of named entity recognition and sentiment analysis techniques as advanced NLP

methods can allow chatbots the ability to understand the context and user's intention in a better way with which users can interact. Guiding responses through genuine data and involving medical guidelines into chatbot decision-making schemes are two very crucial stages. For example, the BioBERT managed to achieve extremely high accuracy in digging out biomedical text using transformer-based approach to NLP which has made the medical texts and queries more user-friendly. Certainly, this software is very costly but proves that reliable outputs can be obtained in healthcare sectors in the future. The second major drawback that prevents a wider acceptance of healthcare chatbots is their difficulty to function along with the existing health care structure. Many of health systems are not designed to deal with AI-driven solutions, one of the reasons of which is the creation of technical and operational challenges.

Building hybrid architectures capable of seamless interaction with legacy systems and in parallel supporting advanced AI features is the answer to solve it. Among the essential steps are customization of chatbot functionalities to adapt to healthcare workflows as well as creating a strong collaboration between developers and healthcare providers. Through out-of-the-box thinking when solving such problems, the use of healthcare chatbots with various applications can bring an effective improvement of patient care, operational efficiency, and user satisfaction. Robust strategies are needed for handling integration, reliability, security, and user trust in this domain.

Real-time processing and data availability are the key points of API development for chatbots to talk to EHRs so they can be seamlessly integrated while distributing through cloud platforms would mean you do not have to worry about the network. To make chatbots multifunctional, any rule-based logic is used together with machine learning. For example, Health360 was confronted with a major challenge in integrating hybrid AI systems with healthcare platforms but the problem was solved by using modular frameworks and application programming interfaces. This allowed them to simplify the patient–doctor communication. By implementing the concepts borrowed from the financial and e-commerce sectors into the solution, chatbots employed in healthcare can further enhance the reliability, security, and interoperability of healthcare systems [29].

One of the main components to increase the usage of the Chatbot by the customers is building the trust of the user. This requires increasing AI transparency. This is achieved through the explanation of decisions, and identifying the sources to the analysis of symptoms. Furthermore, clear disclaimers should be set in place. It is important to note that chatbots are not to be considered as replacements for medical professionals but rather as complementary tools, thus, users should be advised to consult healthcare providers for case where a critical decision is needed. Another step towards improving the efficiency is to engage the machine learning ecosystem and recommend the use of BioBERT for personalized and accurate recommendations, which is the mode of sophisticated problem-solving.

Furthermore, the integration of EHR technology and the use of APIs is not just about reliability and integration, but it also enables chatbots to be more context-aware and effective in supporting healthcare professionals.

5 FUTURE WORK AND PROPOSED SOLUTIONS

In order to verify the effectiveness of the proposed methods, it is necessary to conduct controlled case studies or experiments in real-world healthcare settings. Nevertheless, due to limitations of resources and access to local hospitals and clinics, conducting the studies in our current environment is not feasible. To address this gap, the future study will entail the carrying out of a controlled experiment whereby healthcare chatbots will be tested in a healthcare environment with a small group of patients or healthcare providers. The chatbot's performance, accuracy, and user satisfaction will be measured and compared with expert guidelines. Additionally, a case study approach will be explored, whereby a healthcare chatbot will be deployed in a real-world healthcare center, and data will be collected to analyze its impact on patient care, diagnosis accuracy, and business efficiency. Through these activities, we aim to test the real-world feasibility and performance of the proposed solutions and mitigate the issues that hinder large-scale adoption of healthcare chatbots.

6 CONCLUSIONS

Healthcare chatbots are one of the most important and useful applications of the technology of Artificial Intelligence in modern healthcare systems,

they facilitate the process of patient interaction, increase the accuracy of diagnosis, and reduce the workload on healthcare workers. The use of these intelligent AI devices, based on recent and state-of-the-art computer science technology, including machine learning and natural language processing, may imply that such systems are able to adopt and implement specific medical suggestions for patients, resulting in a better utilization of healthcare services. Even so, the accomplishment of the AI chatbot deployment mission is accompanied by some critical challenges such as data privacy, interoperability, and the growth of the trust of the final user.

The results of this study show that applying techniques such as end-to-end encryption that encrypts information from one end to the other for security, federated learning, which represents a type of training for AI models that take place on devices or local servers without data being transferred to local points, or system interoperability through APIs that allows different software for medical devices, EHRs, etc to work together, can effectively handle these obstacles. To exemplify, such as Medbot, BioBERT, and Health360 developing chatbot with the ability to tackle difficult medical queries, easier to communicate with and more constructive in terms of the medical process, Medbot, BioBERT, and Health360 are the real-world implementations that showcase the power of chatbots on the one hand and the benefits of engaging users and working with a high-operational requirement on the other hand. These instances give us a clear picture of how chatbots should be naturally connected to healthcare systems to constitute, in a real way, huge advantages.

The future will bring about progressive changes in AI models, the creation of strong, ethical guidelines, and making patient-oriented design more inclusive, which is a must for healthcare chatbots' success. Healthcare professionals, technologists, and policymakers, employing a wide range of skills, will come together for inter-disciplinary cooperation to take things to a new level of technology. The authors of the study have highlighted the need for constant research and innovation in order to optimize the benefits of chatbots in healthcare, as well as, to make them a part of global healthcare delivery reform.

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