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APPLICATION OF ARTIFICIAL INTELLIGENCE POWERED CHATBOTS FOR POST CABG PATIENTS

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ABSTRACT

Chatbots that use artificial intelligence (AI) can effectively deliver treatments and encourage a range of healthy behaviours. A chatbot powered by AI has the ability to swiftly examine and identify illness indicators and patterns that might otherwise go unnoticed by medical professionals. Helpers must create inquiries that are semantically connected to the one they are responding to in order to increase a chatbot's capacity for understanding natural language. The biggest cause of disability and mortality globally in 2019 was coronary artery disease (CAD), which resulted in 182 million disability-adjusted life years and more than 9.1 million fatalities. One of the key benefits of chatbots in cardiology is their ability to provide patients with individualised care. Patients who have undergone cardiac surgery can also benefit from this by helping them recover and get used to their new way of life.

KEYPOINTS

❖ Artificial intelligence-powered chatbots are very useful aids to cover the huge need of health care professionals in the health care delivery system.
❖ The development of healthcare chatbots needs careful assessment, reassessment, and supervision by skilled professionals, i.e., healthcare professionals and software development professionals.
❖ Chatbot development steps should be carefully followed to avoid spreading of false medical information to the public regarding cardiac health.
❖ The importance of developing chatbots is essential, as coronary artery disease (CAD) is a prominent cause of disability and mortality worldwide.
❖ The use of cardiac voice chatbots can make enormous changes in the rehabilitation process of post-CABG patients.
❖ Despite the potential of AI, it is unlikely that chatbots will ever totally replace medical specialists because the complexity of healthcare requires human interaction.

INTRODUCTION

According to the WHO, 18.25% of all fatalities result from coronary artery disease.[1] In consonance with 2019 report, coronary artery disease (CAD) accounted for 182 million disability-adjusted life years and over 9.1 million deaths, making it the prominent cause of disability and mortality worldwide.[2] Surgery, medication, and the adoption of good practices are the mainstays of treatment for cardiovascular diseases, one of the biggest killers in the world.[3] Medical therapy alone or revascularization techniques like coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI) are typically used to treat patients with CAD. The selection of treatment modalities is difficult and is influenced by the patient's characteristics, personal preferences, and invasive coronary angiographic findings.[2] Of all the therapies, surgery is the most complicated and has become more common nowadays, although its importance has a notable mortality rate and occurrence of various complications.

Clinical and administrative authorities have made reducing 30-day hospital readmissions a top aim with the main objectives of enhancing patient care and lowering hospital expenses. With the recent implementation of Medicare and Medicaid incentives and the growing use of hospital readmissions as a quality metric. Hence the significance of reducing readmissions is now more

important than ever.[4]

Bypass surgery patients are substantially more likely to experience additional cardiac events, such as persistent chest pain, heart attacks, heart failure, and an increased chance of death. Therefore, post-cardiac surgery patients' follow-up treatment is crucial. A thorough observation of the clinician's recommendations for treatment, follow-up appointments, and rehabilitation considerably lowers the likelihood of these issues.

About 70% of patients use search engines to find health information before talking to doctors. Chat generative pre-trained transformer (Chat GPT) is a dialogue-based artificial intelligence (AI), Launched in November 2022 that has garnered considerable interest from the scientific community. On February 8, 2023, Microsoft announced Bing-Chat, an AI-based chatbot that offers conversational assistance based on GPT-4 and access to real-time online searches (WSa-GPT). WSa-GPT responds to the form of natural conversations by combining deep learning algorithms with spoken language.[5]

By supplying evidence and enhancing healthcare delivery, artificial intelligence (AI) is reshaping the future of nursing. Routine chores can be automated by AI-powered systems, which can also collect patient data, support decision-making, spot potential dangers early on, and assist nurses in providing individualized care. Telehealth, which offers chances for remote monitoring and virtual consultations between patients and healthcare providers, is one way that AI is revolutionizing the future of nursing. AI-enabled gadgets can be used by nurses to identify falls at home, manage medicine intake, and remotely monitor vital signs. This enables them to act swiftly in the event of any warning indications.[11]

Artificial intelligence and chatbots in healthcare
i.   Artificial intelligence in health care
The use of Machine Learning (ML) and other cognitive disciplines to medical diagnostics is a important AI use case in healthcare. AI may assist healthcare professionals by using patient data and other information to provide more clear-cut diagnoses and treatment commendations. By benefitting big data analysis to provide more accurate resolutions for patients' preventative treatment, AI can also devote to improving health maintenance.[6]

The way we identify, treat, and monitor patients has changed as a result of artificial intelligence (AI), which has had a enormous effect on the healthcare sector. This technology has a significant positive impact on healthcare research and outcomes by enabling more tailored therapies and providing more accurate diagnoses. Healthcare AI's capacity to quickly assess vast amounts of clinical paperwork helps identify disease indications and trends that medical experts would otherwise miss. There are several practical implementations for artificial intelligence (AI) in

healthcare, ranging from projecting outcomes using electronic health records to assessing radiological images for early detection. By engaging artificial intelligence in hospital and clinic settings, healthcare systems can become smarter, quicker, and more efficient in providing treatment to millions of people around the world.[10]

Artificial intelligence (AI) refers to the utilization of machine learning (ML) algorithms and other cognitive technologies in healthcare. The capacity of computers and other technologies to imitate human cognition, learn, reason, and make decisions or perform actions is the most basic definition of artificial intelligence (AI). In light of this, artificial intelligence (AI) in healthcare refers to the use of machines to analyse and act on medical data, usually to forecast a certain outcome.[6]

Voice assistants (VAs), often referred to as "voice chatbots" or "conversational agents." They may speak to users using communication interfaces. Technically, when someone uses a wake word and a voice command to start a conversation. Conversational agents are cloud-based services that carry out speech-to-text and text-to-speech operations. The employment of virtual assistants (VAs) in healthcare has the potential to help the provision of treatment in a typical clinical environment when managed by a computerized clinical decision support system (CDSS). By training to think like a human health care expert, these robotic process automation (RPA) chatbots may carry out rule-based activities (such as digital patient triaging).[7]

A thorough medical plan must include personalized clinical instructions since they enable continuity and care coordination. Voice AI chatbots offer a prehospital triaging tool at the digital front door, helping to assess patients' clinical state prior to their direct interaction with a healthcare provider. Automatic clinical follow-up services provide you access to the most recent data on the patient's health state so you can make educated medical decisions. Infection and exposure risk are reduced as a result.[7]

Voice chatbots can enhance routine care by automatically monitoring patients at home, triaging cases, screening patients, giving medical advice and suggestions, and minimizing administrative tasks.[8] Chatbot solutions are practically off-the-shelf products that don't require a lot of server infrastructure or information technology when combined with a specialized dashboard for physicians. Conversational agents' relatively low cost and fast acceptance are important advantages for web-based care delivery.[9]

Role of AI-powered chatbots in Health care behavioral Changes
Artificial intelligence-impelled chatbots (AI chatbots) are conversational agents that simulate human contact with a user utilising text, voice, and visual means of communication.[13,14] Given the increased accessibility of

technological devices like smartphones, computers, and the internet, AI chatbots can provide receptivity, self-governing, and intriguing health-related information and services, which might be advantageous for technology-promoted therapies. Digital platforms like email and video chats may be used by healthcare providers to connect with patients, but existing telehealth and digital therapeutic treatments that include didactic components have encountered a number of challenges, including relatively poor adherence, unsustainability, and rigidity.[15,16]

Patients are already employing a new, much more potent tool for self-diagnosis in industrialized nations: artificial intelligence chatbots like Open AI's Chat GPT, the most recent version of Microsoft's Bing (which is built on Open AI's software), and Google's Med-PaLM. These large language models (LLMs), trained on content from the Internet, predict the subsequent word in a string of words to provide queries naturally. Researchers and medical professionals are hopeful that bots can fill the vital void left by the severe shortage of healthcare employees. These AI programs appear to be much more accurate than a Google search, according to preliminary tests by researchers. According to some researchers, a significant medical center may announce a partnership utilizing LLM chatbots within the next year.[12]

AI chatbots use data input from a variety of sources, followed by data analysis done using machine learning (ML) and natural language processing (NLP). The consumers' aims for their health behavior are then furthered by the data output. As a result, AI chatbots can successfully administer therapies and promote a variety of healthy behaviors. By incorporating embodied functions, this technology can also help improvements in health behavior. The majority of earlier research on AI chatbots focused on enhancing mental health outcomes. Comparatively, recent research is concentrating more

and more on the use of AI chatbots for motivating improvements in health behavior.[13]

AI-powered chatbot development steps - An information portal for healthcare
i.   Sourcing for Experts and Professionals
Using experts and professionals breaks down complex projects into manageable bits and contacts a large online community for help. These online groups can develop top-notch data sets for machine learning models, scale technological systems, and increase system functionality. Complex activities that call for domain-specific knowledge or skills are difficult for an internet-sourced workforce to finish. Finding specialists with sufficient topic knowledge is one remedy. A greater range of jobs, such as mock up design and software development are made possible by proficient supply. Because there aren't enough experts, a strong and flexible expert-sourcing system necessitates a thoroughly thought-out process and infrastructure.[14]

We can quickly and reliably construct the information gateway by sourcing experts from all over the world. Due to the uncertain and complicated structure of a public health emergency, extensive skillfull sourcing was necessary to filter content (such as Q-A pairs) and administer the site. Open pleas on social media and in scientific forums might be beneficial for locating volunteers who are medical professionals, scientists, engineers, technicians, or experts. A team with a variety of domain expertise may work quickly on the site thanks to the expert-sourcing framework.[15]

ii.   Operational structure of chatbot development
A method and well-defined roles enclosed in a practical structure that allows for the effective portrait of jobs and upholds scientific objectivity are necessary to assure attribute, reproducibility, and efficiency.

Box 1: Operational structure of chatbot development
1.   Administrators - Check question-answer pairs for scientific validity, linguistic proficiency, and informality
2.   Curators - Medical professionals
3.   Helpers – Technical Experts
4.   Testers - Make sure that updates were successfully applied

Administrators appoint new team members, organize every role, look up unresolved queries, and oversee open tasks. In that order, administrators check question-answer pairs for scientific validity, linguistic proficiency, and informality. To increase the caliber of the produced Q-A pairs, the same admin cannot do both the efficacy and eloquence checks for the same Q-A pair.

Curators operate QA pairing. They start with fresh, unresolved questions, seek solutions from reliable, trustworthy sources, and then write clear responses with supporting details. Curators also update previous responses. Finding reliable responses is a crucial task. A

select group of volunteers with demonstrated expertise—such as medical professionals and other professions—are awarded this position.

Helpers check responses, make notes if more research is necessary, and edit answers to make them more comprehensible. They also create numerous question formulations, such as alternate questions, using preexisting questions. This step gives data to train Machine Language models to better understand users' questions and improve chatbots' ability to provide the most relevant responses. We invite a wider range of volunteers with backgrounds in technology to apply for

this position.

Testers make sure that updates were successfully applied, and also test the entryway by posing the recently combined queries with different answers. They assess each response for readability, correctness, and freshness. They also keep an eye on the system for potential quality problems, such as format problems.[16]
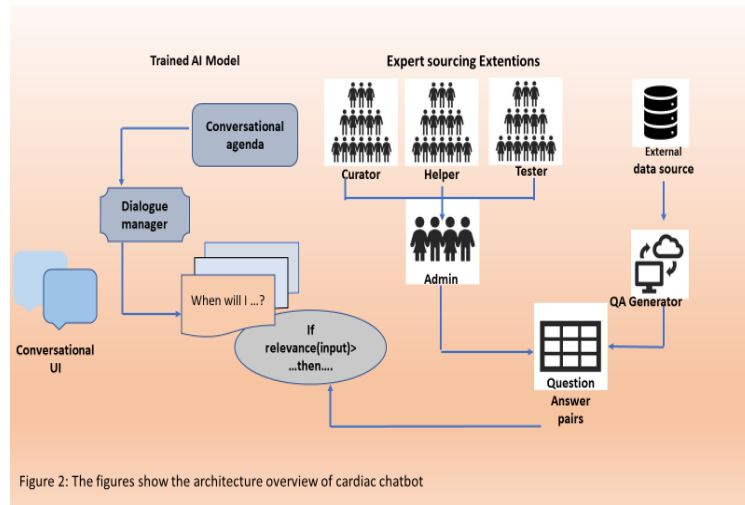

Figure 2: The figures show the architecture overview of cardiac chatbot

iii. Workflow of chatbot development

The system is initially seeded with its initial set of question answer pairs by Admins and Curators using reliable information sources. When the chatbot is activated, the supervisors regularly freight the unresolved questions from the system. When a fresh, unsolved question is submitted, admins generate a task for curators. Curators can register for a task and begin curating a response. After a query and its response have been thoroughly researched, Helpers are notified to verify the validity and quality of the Curators' answers. Workforce make a note, issue a flag, and alert Curators if a problem arises. To advance a chatbot's ability to grasp natural language, helpers also develop queries that are semantically related to the one they are answering.[17]

iv. Quality Assurance and Communication effectiveness of chatbot answers

A healthcare chatbot in the system should respond to user demands by meeting standards including clarity, accuracy, and openness as well as showing empathy. Accuracy and transparency required that the responses had to be supported by evidence from credible sources and approved by at least one respected medical professional. In addition, the language used in the responses should be friendly and caring, considering any stress or anxiety the users may be experiencing to improve trust.[18]
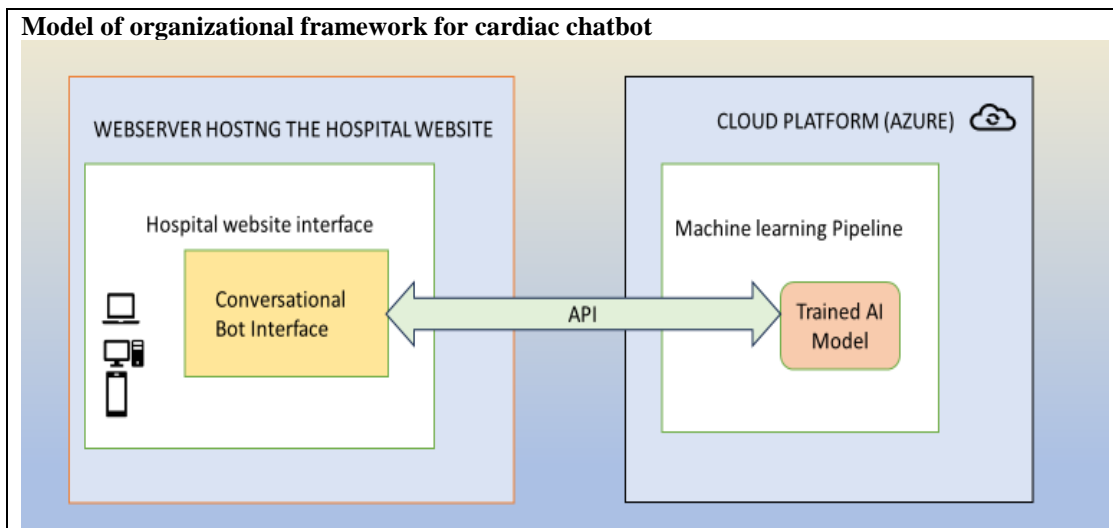

Figure 1: Access to the cardiac chatbot. The chatbot was made accessible to the patients through a custom, responsive website embedding the conversational AI web client user interface hosted on hospital infrastructure. The chatbot backend was hosted on the Conversational Bot Interface.
API: Application programming interface

Chat design
Supporting Two-way Adaptation- The two main challenges are 1) The chatbot users don't know how to start using it or don't know enough to ask further questions during the validity checking phase of a chatbot. 2) The chatbot won't function flawlessly; there's a risk certain inquiry won't be answered. If a chatbot is unclear on how to respond to a question, it will suggest questions that are similar so that users can learn more about the capabilities of the chatbot and get the proper replies.

Fostering mixed-initiative interaction – A chatbot's objective is to encourage mixed-initiative synergies. On the one hand, it actively encourages customers to ask questions. On the other side, it gives users the ability to start a chat at any time during the course of a conversation. Users can get information at their own pace thanks to these mixed-initiative synergies, which keep users interested.[19]

Chatbot creation process
1. **Update obsolete content** – provide access to the most recent information. The curators must continue to monitor the content they have produced to spot out-of-date knowledge.

2. **Communicate health information effectively**- It's challenging to inform the general people about health issues. Making the disease simple to consume not only directs the prevention of complications for a CAD patient after CABG surgery but also calms people's minds.

3. **Auditing and testing the chatbot** - Before making the chatbot available to the entire public, all testers intimate the issue of trialing it with new subject matter. A tool for testing and auditing will be expected by our participants to ensure quality. The simplest form of support is just keeping track of the test's progress. The tool may audit the chatbot by compiling a list of all available test cases following the release of an update. A different test scenario would be considered for each Question Answer pair.

4. **Validation with patients for scalability check of the chatbot (Software)** – The percentage of conversational turns in the chatbot channel will be used to gauge the chatbot's scalability.

5. **Real-world deployment** - The real-world distribution exibites the viability of the chatbot architecture in creating AI-powered chatbots that serve as wisdom portals and aid the public's effort to find enlightenment. Additionally, it offers a beneficial chance to further assess the framework from a comprehensive standpoint. By posting audition calls on our social networking webisites, newsletters, and e-publications, we can distribute chatbots through recruited individuals as well as the global scientific community.[19]

Importance of developing chatbots for cardiac patients
The capacity of chatbots in cardiology to offer patients individualized support is one of its main advantages. Chatbots can be configured to enquire about a patient's symptoms, prescriptions, and other medical details. Additionally, they can offer guidance and comfort to patients, assisting them in more effective management of their ailments. For instance, a chatbot can assist a person with high blood pressure to manage their food, exercise, and medication regimen and can send reminders for refilling prescriptions or scheduling doctor appointments.[20]

One of the important chatbot function in cardiac health care includes continuous monitoring of patients. Chatbots can be developed and organized in such a way that continuous patient monitoring devices are attached in to it and notifying about alarming changes to the health care professionals. If anything changes that might needed a call for medical care can be easily arranged in this method.[20]

In addition to that chatbots have a significant influence on patient fidelity to treatment regimens. Cardiology has a serious problem with treatment plan obedience because many patients don't take their medications as directed. Chatbots can educate and reassure patients to help them realize the value of adherence while also reminding them to take their medications. Chatbots can assist to decrease the probability of problems and rehospitalizations by enhancing loyalty to rehabilitation measures, which will eventually enhance patient outcomes.[20]

In addition to these important functions, chatbots can improve cardiology in several additional ways. For instance, they can aid patients in controlling their anxiety and stress levels, two things that might be crucial in the treatment of heart disease. Additionally, they can support patients who have had heart surgery by assisting them with healing and adjusting to their new way of life.[20]

Expected limitations for chatbots in healthcare
As we advance into the future, emphasizes the value of a collaborative paradigm where medical experts and AI chatbots collaborate to improve patient outcomes. Despite the potential of AI, it is unlikely that chatbots will ever totally replace medical specialists because the complexity of healthcare requires human interaction. The ultimate goal of using technology, such as AI chatbots, should not be to replace the indispensable human components of healthcare but to improve patient care and outcomes.

Al is now unable to exhibit the intuition, empathy, and years of training that medical experts bring to the table. These human qualities are crucial for providing patients with good care, particularly when complex linguistic interpretation and nonverbal clues are involved. The only pre-programmed data and algorithms that chatbots can

use; as a result, the quality of their recommendations is only as good as the data supplied to them, and any poor or biased inputs may provide unfavorable results.[21]

A doctor's responsibilities go far beyond merely making diagnoses and making treatment recommendations. When patients are stressed or vulnerable, doctors and nurses provide them with consolation, assurance, and empathy.[22] This doctor-patient relationship, which is based on rapport, trust, and understanding, cannot be mechanized or replaced by AI chatbots. Additionally, while chatbots may conduct everyday activities and offer general health information, their current skills do not include providing complicated medical answers. These questions frequently need in-depth medical knowledge, critical thinking, and years of clinical experience qualities that chatbots currently lack.[23] The complex medical queries and adaptable patient contacts so highlight the crucial part that medical experts play in healthcare.

In the past ten years, medical ethics has tried to lay forth guidelines and frameworks for the moral application of new technologies, particularly AI, in healthcare. Medical professionals are now expected to answer more rapidly questions about the legal and ethical implications of chatbots as conversational agents have become more popular during the COVID-19 pandemic. Patient safety, openness and trust between all parties, the sources of the chatbots' suggestions, cybersecurity risks, data use, privacy and integration, bias, and health inequalities are only a few of the ethical issues that chatbots in the healthcare industry have raised.[24]

The World Health Organization (WHO) urges caution while employing large language model tools (LLMs) produced by artificial intelligence (AI) to protect and enhance human welfare, safety, and autonomy as well as maintain public health.[25]

AI for Health Ethics and Governance Expert Group of the WHO. The committee was established this year in September. The need of adhering to ethical standards and effective governance as outlined in the WHO guidance on ethics and governance of AI for health is stressed by WHO when designing, developing, and implementing AI for health.[26]

Protecting autonomy is one of the six guiding principles listed by WHO. Other guiding principles include advancing human welfare, safety, and the public interest; establishing transparency, explicability, and comprehensibility; encouraging responsibility and accountability; ensuring inclusiveness and equity; and promoting AI that is responsive and sustainable.[26]

Recommendations to overcome health care chatbot limitations
1. **Consistently upgrading the chatbot's knowledge base:** For the chatbot to be able to give users correct and useful responses, its knowledge base needs to be frequently updated with pertinent and accurate data.

2. **Using machine Learning and Natural language processing:** By using cutting-edge technologies like machine learning (ML) and natural language processing (NLP), a chatbot may better understand user requests and give more precise answers.

3. **Implementing data Validation and Verification processes:** Data validation and verification procedures can be implemented to guarantee the accuracy of the data provided by the chatbot. Cross-referencing data with outside sources and having a person review certain responses before they are sent to users are two examples of how to do this.

4. **Ensuring data security:** Chatbots should be secure to protect sensitive user data.[27]

CONCLUSION
The technique to build, deploy, and validate chatbot services in cardiac surgical care is presented in this review. In addition, it draws attention to the necessity of enhancing follow-up care for heart surgery patients and the potential use of chatbot resources for more sophisticated care services. This helps to suggest approaches that digital health innovators may use, considering the requirement to fulfil physicians' and patients' demands, the resources available, and the proof of value in quick development cycles and actual context validation.

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