

E-Healthcare and Chatbots in Preliminary Diagnosis: A Survey

Gokul Dudani, Tanu Shree, Kajal Singh, Anushka Singh Chauhan

*Department of Computer Science & Engineering,
Galgotias College of Engineering & Technology, Greater Noida, India*

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Abstract: E-healthcare, also known as Mobile Health is a healthcare practice that incorporates electronics & other technologies in public health domain and is proposed to overcome geographical, temporal and organizational barriers of the traditional healthcare architecture. A Health Chatbot is essentially an integral part of E-Health. It is an Artificial Intelligence (AI) program capable of establishing a smart communication with the user via auditory or textual methods regarding healthcare issues. These chatbots can be utilized for providing preliminary diagnosis, as a consequence of which the current human workforce crisis in the medical field may also be significantly reduced. This paper presents a survey of various characteristics of chatbots and their existing applications in healthcare. It also includes a systematic review of existing research on related domains and attempts to outline the essential research findings that are crucial to be addressed. It provides insight into the desirable features of a chatbot for acceptance by both the doctor and the patient. A sincere attempt has also been made to study the existing challenges and E-Health and Chatbots future scope in providing a preliminary diagnosis.

1 INTRODUCTION

According to the World Health Organization (1948) Health is defined as – "A state of complete physical, mental and social well-being and not merely the presence of disease or infirmity".

Since the dawn of human civilization, accessibility to healthcare facilities has been a fundamental right of a human being. In a world of almost 7.5 billion people comprising vast diversity, it poses an enormous challenge to the healthcare delivery system. Moreover, due to the workforce's uneven distribution globally, many people residing in remote locations have minimal or no accessibility to the healthcare infrastructure. The traditional healthcare facilities are expensive and are usually high-priced by the socially and economically underprivileged and marginalized families.

E-Healthcare is a relatively recent healthcare practice that incorporates electronics & other public health technologies to overcome geographical, temporal and organizational barriers of the traditional healthcare architecture. Mobile Health (m-Health) also aims to introduce smartphones and other technological gadgets in the healthcare system. It supports two-way communication; it engages user

interactively through a mechanism of proper feedback and assists the doctors in suggesting medical advice to the patients.

Health Chatbot is essentially the pillar on which E-Healthcare system depends. Formally, a health chatbot can be defined as- "An artificial intelligent (AI) program that is capable of establishing a smart communication with the user via auditory or textual methods regarding healthcare issues". There are a variety of chatbots used in the healthcare domain. For example, Ada (Ada Health GmbH 2018) enables its users to respond to several diagnostic suggestions and identify over 1500 clinical pictures and 200 rare diseases (Flick 2018). Ever since the concept of health chatbots has come into the limelight, its capabilities and applications have increased. Its applications include: -

- Reducing healthcare spending (increasing affordability).
- Allow early detection of disease (preliminary disease diagnosis).
- Improve clinical outcomes validated in a real clinical-context.

Shortly, health chatbots will become the primary contact for disease diagnosis and clinical treatment.

Table 1.

S.No.	Reference	Keywords	Research Outcomes
1	Chin-Yan-Huang, Ming-Chan Yang, Chin-Yu Huang, Yu- Jui Chen, Meng-Lin Wu, Kai-Wen Chen	Overweight, obese, smartphone, mobile app, public health, artificial intelligence, chatbot	The paper proposes a chatbot supported Smart Wireless Interactive Health Care System (SWITCH-es) with an objective of weight control and spreading health awareness. The system can establish smart communication and has a wide-reaching approach for users who require medical consultation.
2	Keng Siau, Weiyu Wang, 2018	Health Chatbots, healthcare, trust, artificial intelligence	The paper discusses the factors that affect the trust-building process and develops a trust model that depicts the building process between the user and the health chatbots.
3	Arvind Kasthuri, 2018	Awareness, Accessibility, Workforce Crisis, Affordability, Accountability	The paper presents an overview of the existing challenges to the healthcare system in India. The limitations are expressed in five A's: Awareness, Accessibility, Absence of Workforce or Human Power Crisis, Affordability and Accountability.
4	Sven Laumer, Christian Maier, Fabian Tobias Gubler, 2019	Conversational agents, disease diagnosis, adoption, chatbot, mHealth, UTAUT	The research focuses on developing a research model that can be used as a basis for the acceptance of health chatbots or conversational agents (CA) for disease diagnosis in the medical domain. The model comprises the UTAUT2 (Unified Theory of Acceptance and Use of Technology) factors, newly identified factors, and re-defining other factors to better fit a consumer context.
5	Ahmed Fadhil, Gianluca Schiavo	Design Patterns, Bots, Conversational UIs, Dialogue Systems, Health and Wellbeing	The paper introduces CA-CUI (Conversational User Interface) for healthcare. It also describes several design principles and other complex elements for building emotionally intelligent health chatbots for interaction with humans. The design principles are presented after a careful literature review of relevant research works.
6	Flora Amato, Stefano Marrone, Vincenzo Moscato, Gabriele Piantadosi, Antonio Picariello, and Carlo Sansone	eHealth, Big Data, Deep Learning, Watson Decision Support System, Prevention Pathways	The objective of the research was to study the effectiveness of the classic human-machine interaction for eHealth applications. Proposes an approach of a chatbot that can interact with patients as a medical professional validated in a real clinical context to overcome the cons of restricted and biased interaction between the human and the computer software. It also proposes HOLMES (Health Online Medical Suggestion), which is an eHealth recommendation system.
7	Nivedita Bhirud, Subhash Tatalle, Sayali Randive, Shubham Nayar, 2019	Chatbot, Healthcare Domain, ML (Machine Learning), NLG (Natural Language Generation), NLU (Natural Language Understanding), Smart Communication, Virtual Communicating Friend	The paper presents a discussion about the various NLU, NLG and ML techniques which must be incorporated in health chatbots to overcome the monotonous interaction between the user and the chatbot and make the m-Health system more smart and communicative.
8	Krishnendu Rarhi, Abhishek Bhattacharya, Abhishek Mishra, Krishna Mandal, 2017	Chatbot, Health	The research objective is to provide a design for health chatbot that can provide disease diagnosis and treatment through the user's symptoms to the system. It replaces many existing chatbots and gives a realistic experience to the user during the interaction with the chatbot.
9	Divya S, Indumathi V, Ishwarya S, Priyasankari M, kalpana Devi S, 2018	Artificial Intelligence, Prediction, Pattern matching, Disease, Query processing	The paper emphasizes developing a chatbot with improved symptom recognition and disease diagnosis features with AI's help (Artificial Intelligence).

Table 1 (Cont.).

S.No.	Reference	Keywords	Research Outcomes
10	Rashmi Dharwadkar, Neeta A. Deshpande, 2018	Medical Chatbot Natural LanguageProcessing, PorterStemmer Algorithm, Word Order SimilarityBetween Sentences	The paper proposes a system through which users can consult about the dosage of drugs through voice. The system can effectively process the query and can generate and display all medicine names. The paper recommends incorporating various data analytic techniques for building the system.
11	Rohan Jagtap, Kshitij Phulare , Mrunal Kurhade, Kiran Shrikant Gawande	Teacher Forcing,DL(Deep Learning), Inference Model, Tensor Flow,Feed-Forward NeuralNetwork, SoftMax, Word-Embedding, Conversation Context, GRU, Diagnosis, Categorical Cross-Entropy	The idea presented in the study is to develop an AI-powered chatbot which can extract the keywords from the symptoms provided by the user and try to diagnose the disease accordingly. It takes into consideration the user's conversational and replies accordingly to better fit the consumer context.

2 LITERATURE SURVEY

This section presents a literature survey of existing researches. For each paper, a sincere attempt has been made to summarize its main characteristics, salient features and contributions. An effort has also been made to prepare a draft of common jargons and recurrent patterns. Moreover, it includes crucial research observations and inferences that should be addressed.

3 CHARACTERISTICS OF A DESIRABLE HEALTH CHATBOT

This section focuses on the desirable characteristics of health chatbots for eHealth applications. This investigation aims to develop a human-machine interaction mechanism with an approach that leverages a human being validated in a real clinical context.

There are certain factors which affect the adoption of health chatbots in a real environment:

- **Performance Expectations:** the degree to which chatbot can benefit the customer in providing intended health and other related services.
- **Effort Expectations:** the extent of simplicity associated while interacting with a chatbot.
- **Social Influences:** the willingness of an individual to seek medical assistance from a health chatbot.
- **Facilitating Conditions:** the availability of resources or support mechanisms to effectively interact with a conversational agent (CA) for health-

related FAQs.

- **Hedonic Motivations:** refers to the degree of customer satisfaction after interaction with health chatbot.

- **Price Values:** the cognitive trade-off between the applications' perceived benefits and the monetary cost of using them.

There are several other characteristics which should be present in a desirable health chatbot. An ideal health chatbot should be user compatible; it should be practical and accurate in giving health suggestions and providing disease diagnosis. Interactivity with the user must be high. It should also maintain integrity, privacy and ensure the security of user's data. The trust-building process with the user is also one of the critical features of a desirable health chatbot. Health chatbots must also be reliable, transparent, and accountable for any recommendations and diagnosis provided by it. Few other traits must be kept in mind while designing a chatbot for medical applications. A health chatbot designed for specific applications that suit the needs of the customer should consider:

- User Demographics
- Chatbot Application Domain
- Data Interaction
- Dialogue Structure and so forth

Unfortunately, there has not been much discussion of the critical design elements related to health chatbots. Moreover, recent studies lack highlighting crucial issues and challenges faced during the development of realistic conversational agents. When taken into consideration, these characteristics can make the system more capable of establishing smart communication with the user and can prove fruitful for counselling and providing other health

recommendations. These chatbots can be carefully deployed in the medical industry to predict diseases and provide a preliminary diagnosis to the patients who can play a crucial role in saving human lives.

4 CHALLENGES TO HEALTHCARE SYSTEM

There has been a glorious tradition of public healthcare since the beginning of human civilization. It can be seen in references to the study of the Indus Valley Civilisation (5500-1300 BC) where the concept of "Arogya" or holistic well-being has been illustrated.

In the current scenario, the population of the world has been multiplying. The population spectrum presents enormous diversity and poses an enormous challenge to the existing healthcare system. Moreover, since the population distribution is uneven, it becomes challenging for people living in remote locations to have accessibility to the healthcare facilities. There have also been challenges in delivering healthcare to the so-called "everyone" which includes the socially marginalized, disadvantaged and the economically deprived people of the society.

While there are many challenges, this section briefly presents some (five A's) for the consideration: -

- **Awareness:** can be described as a general understanding of an individual regarding health issues. Lack of awareness is one of the critical reasons for challenges in the healthcare domain. Low educational status, poor literacy rate and low priority for health in the people are the key reasons for lack of awareness.
- **Accessibility:** can be defined as the opportunity for availing any facility or service. Physical access is one of the determining factors of accessibility is defined as "the ability to enter a healthcare facility within 5km from the place of residence or work". Periodic surveys have revealed that people living in remote locations have minimal or no healthcare infrastructure access due to temporal & geographical limitations.
- **Absence or Workforce Crisis:** a 2011 study estimated that approximately 20 healthcare workers are over a population of 10,000 people in India. Moreover, there is a non-uniform distribution of healthcare workers over the region. It has been observed that the concentration of healthcare resources in bare areas is dense as compared to mountainous or other remote regions.

- **Affordability or Cost of Healthcare:** can be thought of as the ability to avail healthcare resources. The public sector usually offers healthcare services at very cheap or no cost but is often unreliable and inefficient. On the other hand, the private sector offers services at a very high cost and is generally the seeker's first choice unless he/she cannot afford it. Thus, the economically deprived section of the society is forced to make unreliable and inefficient public healthcare services. Thus, customer choice and satisfaction are often neglected, which is a big challenge to the healthcare system.

- **Accountability or Risk of it:** it is the set of procedures by which one takes responsibility for actions and its consequences. Generally, the private sector is often held more accountable as compared to the public health domain. The lack of trust and communication gap between the seeker and the public health sector poses a challenge to the existing system.

There are numerous other factors than the five mentioned above that present a challenge to traditional healthcare architecture. As we move into the future, there is an urgent need of looking out for healthcare alternatives that should rule out the present limitations and ensure universal health and well-being.

An emphasis has to be made on the significance of "Preliminary Diagnosis" in the medical field that can be crucial in saving patients' lives and accurate health delivery, which is currently missing from the existing framework. E-health and health chatbots can be utilized to fulfil the purpose and provide medical professionals with accurate results.

5 FUTURE SCOPE OF E-HEALTH AND CHATBOTS

E-Health is a term used to describe the introduction of electronics & other technologies in the traditional healthcare infrastructure. Also, known as Mobile Health (mHealth), it aims at overcoming the geographical, temporal and organizational barriers of the existing healthcare system. Health chatbots are an integral part of mHealth. They are an Artificial Intelligence (AI) program that provides users with accurate disease diagnosis and their cure based on the system's symptoms. It supports two-way communication; it engages user interactively through a mechanism of proper feedback and assists the doctors in suggesting medical advice to the patients.

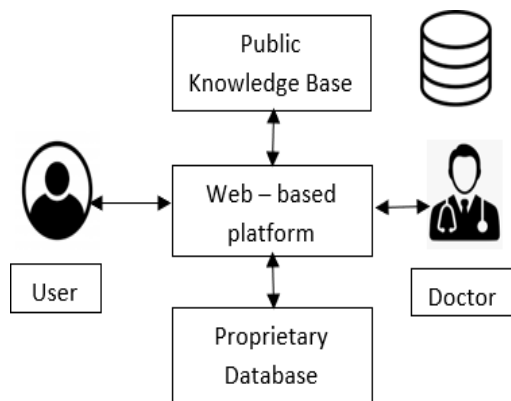


Figure 1: The Operational Concept of Health Chatbots

There are many chatbots which are currently providing their services in the healthcare domain. For example, Endurance is a chatbot which helps users suffering from a disease known as Dementia. The current limitations in the existing healthcare delivery system can be overcome by deploying health chatbots in the medical industry and transitioning from health to e-health. The future scope of e-health and health chatbots is discussed below:

- E-health and related conversational agents (CA) can provide general healthcare FAQs that can spread awareness among the public. For example, MedWhat is a question-answer chatbot that answers basic healthcare FAQs and provides information related to various diseases and their symptoms.
- Specific mobile applications can be used in public health to keep track of nutrition, diet planning, physical, mental & social activities deemed more accurate than relying on one's analysis.
- Recent advancements in technology have led health chatbots to overcome the disadvantages of classic interaction between doctors and patients, thus removing bias and allowing the patient to a freer and comfortable interaction paradigm.
- Moreover, there are plans to create advanced versions of chatbots that will emulate medical professionals on one side of the communication in a real clinical context and focus on improving the health chatbots' human-like behavior. Various data processing and analytics algorithms are being used to transform healthcare, aiming to provide modern digital healthcare solutions to the patients. The whole e-healthcare delivery process is more accurate and efficient, less expensive and of high quality.
- Health chatbots are highly reliable and are also capable of establishing smart communication with the user. Moreover, the recommendation

building procedure is entirely transparent and explainable, contributing to the mHealth infrastructure's accountability. It also helps in the development of the trust-building process between the health chatbots and the users.

- Medical consultation involves user's data and thus data protection, privacy and security become a matter of prime importance which is effectively maintained by e-health and health chatbots. With the ever-growing advancements in technology, health chatbots' capabilities have been growing significantly and are likely to become the primary point of contact for medical consultation and diagnosis. Medical professionals would be using health chatbots as a supporting tool for preliminary disease diagnosis and medical consultation. On the other hand, patients would use chatbots and mHealth facilities for healthcare-related FAQs and other recommendations.

6 SCOPE OF HEALTH CHATBOTS IN PRELIMINARY DIAGNOSIS

Diagnosis is the process of identifying a disease, condition or injury from its sign and symptoms. Preliminary diagnosis is an initial stage of medical diagnosis that occurs before any or little symptoms. Preliminary diagnosis is essential as it allows timely detection of diseases and can play a crucial role in saving the patient's life. Health chatbots can play an essential role in providing a preliminary diagnosis to the patients. It would enable accurate diagnosis as well as treatment of diseases which will eventually improve clinical outcomes.

According to research, approximately 60% of the visits made to a medical practitioner are for small-scale and straightforward diseases. These include common cold, infections, headache, abdominal pains and allergies etc. These diseases can be easily cured at home using traditional home remedies. If ignored, these diseases can act as base for several deadly diseases like tuberculosis, cardiac arrest, brain strokes, etc. Here preliminary diagnosis comes into practical application.

There are a variety of chatbots which provide services in the medical domain. But the majority of these chatbots provide answers to general healthcare FAQs only.

The future scope of these chatbots would be to accurately predict the disease from the patient's early symptoms so that timely treatment could be

provided, which would be crucial in saving lives. Moreover, treatment of many small-scale diseases could be directly provided by the chatbots, which would reduce the current crisis of medical professionals in the health sector.

7 CONCLUSION

The paper attempts to present a discussion on eHealth and Health Chatbots in providing a preliminary diagnosis to the patients. It also describes various flaws existing in the current architecture of the healthcare system and provides an insight into the future scope of eHealth and utilizing health chatbots to ensure universal health. The research study then discusses the characteristics present in an ideal health chatbot for acceptance by both the doctor and the patient. The paper then concludes with a systematic literature review of the existing researches related to the field and sincere efforts were put to outline the vital research findings which were considered essential to be addressed.

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