Introducing an AI Chatbot to Assist in Patient Admission to MRI Examinations

Mohamad Jawad Sharafeddine
Department of Physics and Electornics,
Faculty of Science, Lebanese University,
Baalbeck, Lebanon
mohamad.sharafeddine.11@gmail.com

Jamal Charara
Department of Physics and Electronics,
Faculty of Science, Lebanese University,
Beirut, Lebanon
jcharara@ul.edu.lb

Maroun Geryes
Saint George University of Beirut,
Beirut, Lebanon
mgeryes@sgub.edu.lb

***Abstract*—**AI chatbots are emerging as a very helpful tool in the medical field, specifically in radiologic imaging. AI chatbots can be used to assist radiologists in reading CT, help prioritize cases based on urgency, collect patient information, improve patient communication and education and help patients understand the exam and prepare for the procedure, etc. This study introduces a newly designed AI chatbot that can greatly assist with patient admissions for MRI examinations. The chatbot improves patient-technician/physician communication and helps in reducing communication/human errors which can lead to diagnostic mistakes. The MRI chatbot was tested on around 98 patients who had took MRI examinations. Results showed that over 75% of patients who interacted with the chatbot found it to be effective, clear and accurate. This also correlated with the latter patients' satisfaction with the chatbot and intention to reuse it in case they had an MRI examination. These results have significant future implications where the chatbot can be intuitively used to help in MRI examination admissions.

Keywords—AI, chatbots, MRI, effectiveness, clarity, accuracy, satisfaction, intention to reuse.

I. INTRODUCTION

The rapid development in Artificial Intelligence (AI) has revolutionized various industries and is now considered a game-changer for many companies and service providers. AI is helping to improve and diversify their services and boost their performance [1]. It is a quickly evolving field that encompasses various techniques and algorithms designed to mimic human cognitive abilities. According to a recent review, AI refers to the ability of machines to perform tasks that would normally require human intelligence, such as learning, reasoning, perception, and decision-making [2]. AI is rapidly gaining traction in the medical domain, with promising applications in radiology, medical imaging, quality control, and personalized medicine. One of the earliest studies on the use of AI in radiology developed an algorithm that could automatically detect and classify liver lesions in CT scans, which demonstrated the potential of AI in improving diagnostic accuracy and reducing the workload of radiologists [3]. Another notable study on AI in medical imaging used deep learning techniques to identify tuberculosis (TB) in chest X-rays. The algorithm achieved a high level of accuracy in detecting TB, which could have significant implications for TB screening in resource-limited settings [4]. Quality control is another area where AI has shown promise in the medical field. In a study, an AI system was developed to detect and classify breast lesions in mammograms, with the goal of reducing the number of false positives and false negatives. In addition to improving diagnostic accuracy and quality control, AI has also been explored for its potential in advancing medical research. In a study, deep learning was used to diagnose skin cancer with a level of accuracy comparable to that of board-certified dermatologists [5].

Spurred by AI's latest development in areas such as machine learning and deep learning, chatbots have been developed for tasks with high complexity. AI chatbots are much superior to rule-based chatbots that operate based on pre-set rules and triggers. Rule-based chatbots are not flexible in nature and can only manage simple, basic interactions [6]. AI chatbot is a software application designed to mimic human conversation through text or voice interactions. According to a study, chatbots can be programmed for various tasks, such as customer service, language learning, and financial advice. Another research defines chatbots as virtual assistants capable of engaging in human-like conversations and performing a wide range of tasks. Chatbots can seamlessly integrate into messaging platforms, websites, and mobile apps, providing users with a smooth experience [7]. The size of the chatbot market was 17.7 billion U.S. dollars in 2020 and is expected to reach 102 billion U.S. dollars in 2026 [8]. As more and more chatbots are being designed and becoming more intelligent, they are being incorporated in different sectors such as healthcare [9], education [10], hospitality [11], tourism [12], e-commerce [13], and foodservice. Chatbots have been explored as a tool to improve the efficiency and accuracy of medical imaging routines. In a study, a chatbot was developed to assist radiologists in reading CT scans. The chatbot provided relevant clinical information and helped prioritize cases based on urgency, improving the efficiency of the radiologists' workflow [14]. A study developed a chatbot-based educational tool for mammography, which helped patients understand the exam and prepare for the procedure [15]. In another study, a chatbot was developed to assist with breast cancer screening, providing personalized. Finally, a study, a chatbot was developed to assist with the diagnosis of COVID-19 using chest CT scans, achieving high accuracy in identifying cases with COVID-19 pneumonia [16].

However, communication plays a crucial role, involving the exchange of information through various means like verbal, written, or nonverbal cues. Effective physician-patient communication is particularly significant, as it correlates with positive health outcomes such as improved patient satisfaction, adherence to treatment, and overall health status. Research conducted by Bartlett et al. in 2008 highlighted that communication issues with patients can contribute to preventable adverse effects, often related to medications. Furthermore, communication failures have been estimated to account for 27% of medical malpractice cases, emphasizing the

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importance of enhanced communication to reduce medical errors and patient harm. In contrast, inadequate communication can lead to negative consequences like decreased treatment compliance, patient dissatisfaction, and inefficient resource utilization [17]. In radiologic imaging, specifically, communication errors have been extensively documented and recognized as a significant issue [18]. The rising demand for radiographers has caused technologists to work more shifts, creating fatigue and a challenging work environment. This shortage extends beyond radiology departments, affecting multiple healthcare facilities in the United States and increasing the chances of errors due to overworked staff [19]. "At least 5% of adults seeking outpatient care experience diagnostic errors, which contribute to nearly 10% of deaths annually and up to 17% of adverse hospital events" [20]. While the majority of research on communication failures in radiology target on the communication of results, it is noteworthy that 52.4% of communication errors actually take place during the process of ordering, scheduling, and conducting imaging examinations [21].

In an attempt to reduce physician/technician-patient communication error, this paper introduces an MRI chatbot built to improve the latter communication. The MRI chatbot intends to assist patients in their MRI examinations, help technicians ask the patients all possible MRI-related questions and record their concerns in relation to their examination. The objective of the study is to assess the chatbot performance in terms of its effectiveness accuracy and clarity as well as the patient's experience using the chatbot in specific their satisfaction and intention to reuse the chatbot. In the field of MRI chatbots, numerous proposals have been put forward, but their implementation in practical settings remains limited. To address this research gap, we believe it is essential to examine the patient experience with MRIBOT23.

II. METHODOLOGY

A. Study Design

The study adopted a quantitative approach with a quasi-experimental design. Effectiveness, accuracy, clarity, satisfaction and intention to reuse outcomes constitute the three major sets of dependent variables measured in the study. The MRIBOT23-human interaction manipulates human-chatbot interaction (HCI). HCI is achieved by using the MRI chatbot to answer and pose questions regarding MRI examination. The aim of using HCI is to study patient experience while dealing with the MRI chatbot. For the purpose of the present study, an AI chatbot was developed on Poe platform (poe.com) able to assist patients in their MRI examinations. A link was first shared with the participants. Due to the newness of chatbots, specifically in the medical imaging field, most participants likely have not had any experience with chatbots, and many may not even know what chatbots [22]. Thus, introducing and explaining chatbot application to the users was a must in this study. Then a link was shared with the patients. The patient was then requested to communicate with the chatbot. The chatbot will first greet the patient and start asking him MRI examination-related questions. The chatbot will also provide suggestions to all questions it poses. Main questions include do you have any medical implants or devices, such as a pacemaker, artificial heart valve, or cochlear implant? Are you allergic to any medications or substances, including contrast agents? etc.

From chatbot interaction, we intend to examine the four dependent categories of variables: chatbot level of effectiveness, accuracy and clarity in conducting MRI related examination entry questions, along with the level of patient satisfaction and intention to reuse the MRI chatbot.

B. Measurement

A survey is dispatched for the aim of understanding patient experience with MRI chatbot. The subsequent survey consists of the following sections. The first section measures effectiveness, accuracy and clarity of the MRI chatbot. The latter three variables were measured on a 5-point Likert scale anchored from strongly disagree (1) to strongly agree (5). The second section measures patient a satisfaction using the chatbot and intention to reuse the chatbot. Both variables were measured on a 5-point Likert scale anchored from strongly disagree (1) to strongly agree (5).

The last section includes the demographic questions including gender, age, education level, computer literacy, and the number of previous times the participant used any kind of chatbots [23].

C. Data Collection

The data in this study is collected from patients who have already undergone MRI examination.

The quasi-experiment includes 150 participants aged 18 and above. Data was collected between June 2023 and July 2023. Patients were first identified as they had an MRI, then the questionnaire link was sent as a WhatsApp message to their phones with a detailed explanation of the questionnaire objectives and sections. The next day, each participant received a phone to make sure they understood how to fill out the questionnaire. The participants' sample covered both male and female gender with a mean age (30 to 39 years). The study did not focus on a particular age group. Participants were recruited from different age groups to gain a broader understanding on the MRI chatbot experience and to explore the acceptance of chatbots.

150 questionnaires are dispatched for every one of the 150 participants; however, the collected replies were as follows: out of 150, only 98 responded on the questionnaire. Thus, a total of 98 completed questionnaires are collected from the 150 participants and retained for hypothesis testing, resulting in response rate of 60%. Thus, the study sample size meets the requirement of the minimum sample size [24].

D. Control Variables

According to previous studies particularly in the technological environment [25], variables such as age and level of education are included as common control variables. We included these control variables in our model to confirm that the results from the empirical studies are not because of variance with these demographic variables.

Moreover, to ensure the internal validity of our research results, we accounted for two confounding variables in the questionnaire. First, before answering the construct-related

questions, participants reported how familiar they are with the MRI examination that they had already undergone which could potentially influence their responses to certain MRI related questions and thus their answers. Second, computer literacy question was also included to take into account how familiar the participants are with using computer technology and how skillful they are with computers.

E. Data Analysis

All collected data where first cleaned and then analyzed using Statistical Package for the Social Sciences (SPSS, Version 26.0). Univariate analyses allowed to eliminate outliers and to describe the sample. Factor analyses and reliability analyses were conducted to check the dimensionality and the internal consistency of each scale. Then correlations and multiple regressions were carried to test our hypotheses.

III. Results And Discussion

A. Preliminary Results

First, factor analysis with Varimax rotations was performed to examine construct validity. A KMO and Bartlett's test was first conducted to examine the strength of the partial correlation between the variables. From all constructs, KMO values are greater than 0.5. Values above 0.5 are considered acceptable and values close to 1 are considered ideal [26]. This indicates that the degree of information among the variables overlap greatly and thus the presence of a strong partial correlation.

In addition, the Bartlett test of Sphericity indicated statistical significance; i.e. the items of the correlation matrix are correlated (sig=0.000 < 0.05).

The factor analysis shown in the results revealed that all items indicate high factor loadings above the recommended threshold of 0.6. Second, the internal consistency of the scales was calculated using Cronbach's alpha values for each construct. The reliability coefficients for the constructs are shown in Figure 1. All reliability coefficients were above 0.7, which is considered acceptable [27].

B. Descriptive Statistics

The Figure 1 shows that the highest percentages related to Chatbot Effectiveness, Chatbot Accuracy, Chatbot Clarity, Patient Satisfaction and Patient Intention to Re-Use variables are those of the agree and strongly agree answer, indicating high effectiveness, accuracy and clarity of the MRI Chatbot along with a high patient satisfaction and intention to re-use the Chatbot.

The majority of respondents (82.6%) either agreed (29.25%) or strongly agreed (53.35%) that the MRI Chatbot is effective. Only 5.1% disagreed (3.05% disagreed and 2.05% strongly disagreed). This suggests a high level of perceived effectiveness. While there is a notable percentage (32.85%) of respondents who were neutral about the chatbot's accuracy, a combined 58.675% agreed (28.2%) or strongly agreed (30.475%) that the chatbot is accurate. This indicates that a substantial portion of users found it accurate. A significant majority (60.075%) of respondents agreed (28.875%) or strongly agreed (32.2%) that the chatbot is clear in its communication. While there's a portion of neutral responses (31.95%), indicating room for improvement, the overall perception of clarity is positive A combined percentage of 62.05% (31.45% agreed, 30.6% strongly agreed) of respondents reported satisfaction with the chatbot. This is a positive sign for its impact on patient experience. The highest percentage of respondents (66.875%) expressed a strong intention to re-use the chatbot. This suggests that users are not only satisfied but also motivated to continue using the chatbot.

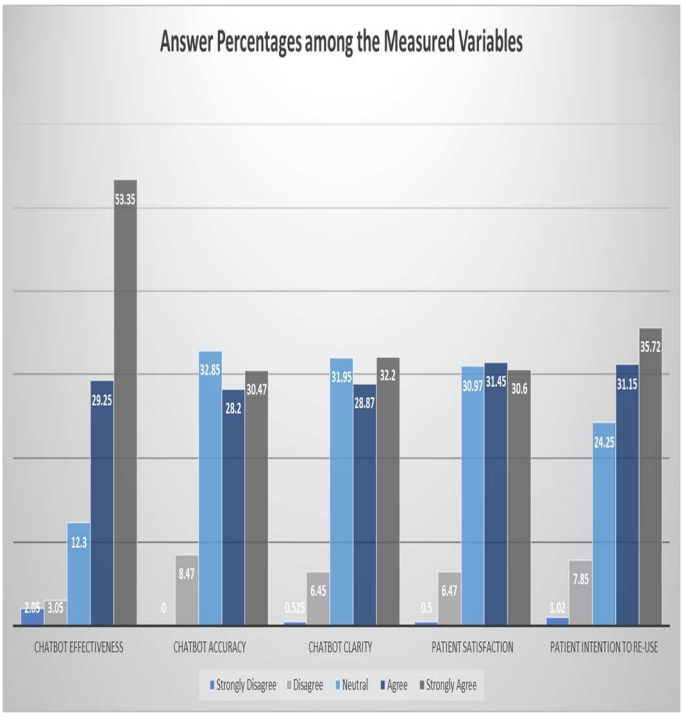

Figure 1: Answer Percentages among the Measured Variables

C. Correlation Test

Correlation test was conducted to test the impact of chatbot effectiveness, accuracy and clarity on patient satisfaction and intention to re-use.

The Null and alternative Hypothesis are:

H1.1: Chatbot Effectiveness/Accuracy/Clarity has no impact on Patient Satisfaction/Patient Intention to Re-Use
H1.2: Chatbot Effectiveness/Accuracy/Clarity has an impact on Patient Satisfaction/Patient Intention to Re-Use

Table 1: Correlation between Effectiveness, Clarity and Accuracy with Satisfaction and Intension to reuse.

		Satisfaction	Intention to Re-use
Effectiveness	**Pearson Correlation**	**.453****	**.449****
	Sig. (2-tailed)	**.000**	**.000**
	N//Missing Answers	**92//6**	**96//2**
Accuracy	**Pearson Correlation**	**.923****	**.777****
	Sig. (2-tailed)	**.000**	**.000**
	N//Missing Answers	**94//4**	**96//2**
Clarity	**Pearson Correlation**	**.934****	**.809****
	Sig. (2-tailed)	**.000**	**.000**
	N//Missing Answers	**94//4**	**96//2**

The results in Table 1 show that, Chatbot Effectiveness is positively correlated with Satisfaction (R=0.453 and sig=0.000<0.01) and Intention (R=0.449 and sig=0.000<0.01). H1.2 is confirmed for Chatbot Effectiveness. The results also show that Chatbot Accuracy is strongly positively correlated with Satisfaction (R=0.923 and sig=0.000<0.01) and Intention (R=0.777 and sig=0.000<0.01). H1.2 is confirmed for Chatbot Clarity. Finally, Chatbot Accuracy is strongly positively correlated with Satisfaction (R=0.934 and sig=0.000<0.01) and Intention (R=0.809 and sig=0.000<0.01). H1.2 is confirmed for Chatbot Accuracy.

IV. CONCLUSIONS

Technician or Physician errors during admissions to MRI examinations, is considered a concerning issue. AI Chatbots have been recently used as a helpful tool in many fields including radiologic imaging. In this study, a chatbot is developed to assist technicians and physicians specifically in MRI patient admission. The chatbot takes all patient-related data and processes the communication with the patient asking all MRI examination required questions. The chatbot is tested on 98 patients who already has undergone MRI examination. Chatbot effectiveness, accuracy and clarity is measured and patient satisfaction and intention to reuse is also measured. Descriptive statistics results show that over 80 % of the participants agree to the effectiveness, accuracy, clarity of the chatbot, satisfaction with the chatbot and intention to reuse it. Correlation results show that chatbot effectiveness, accuracy and clarity are all positively correlated to patient satisfaction with the chatbot and their intention to reuse it. The results of this study will have many theoretical and practical implications in the near future where the MRI chatbot could help reduce MRI-related examination errors and lower the workload on the technicians and radiologists. In addition, the findings pave the way for the broader adoption of AI chatbots in healthcare settings, emphasizing the need for continued research and development in this promising field

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VI. ABBREVIATIONS

MRI: Magnetic Resonance Imaging
SPSS: Statistical Package for the Social Sciences
AI: Artificial Intelligence
CT: Computed Tomography
MRIBOT23: The chatbot’s name
TB: tuberculosis
HCI: Human-Chatbot Interaction