



Designing conversational agents for facilitating patient-physician communication and clinical consultation

Brenna Li

brli@cs.toronto.edu

University of Toronto, Department of Computer Science
Toronto, Canada

ABSTRACT

Pre-consultation chatbots present a unique opportunity to benefit both patients and physicians by facilitating essential information exchange prior to appointments, streamlining the consultation process. However, existing literature on how to design, implement, and evaluate such applications is limited. My thesis addresses this gap through design and evaluation studies with patients and physicians. I use my understanding of physicians' perspectives on synchronous consultations over text messaging to guide the development of a large-language model based pre-consultation chatbot, which I then test with patients in a real-world clinic. My next steps involve developing an interface that physicians can use to review the patient information from the chatbot before the appointment. My thesis contributes to the growing literature on medical large-language model applications in which physician and patient relationships are enhanced, not replaced. It supports a collaboration model where physicians remain responsible for making clinical decisions.

CCS CONCEPTS

• **Human-centered computing** → Empirical studies in HCI; • **Applied computing** → Health informatics.

KEYWORDS

LLMs, chatbots, primary care, information gathering, patient intake

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1 INTRODUCTION

Healthcare systems across the globe are struggling with resource constraints. In the United States, nearly 30% of Americans do not have access to a primary care physician [17]. For those lucky enough, the average wait time to see their physician is 26 days, and the average wait time for a specialist appointment is 11 weeks [4, 14, 20]. On the other hand, 73% of physicians across all disciplines are experiencing burnout [38], leading many to consider

leaving the profession and, further exacerbating the dire situation [10, 31].

A major source of physician burnout is the documentation burden. Nearly half of a physician's working time is allocated to clinical documentation or data entry tasks related to the electronic health record (EHR) systems [6, 13, 32]. To compensate for efficiency loss, many physicians try to multi-task by working on EHR documents while speaking with patients during the consultation [31]. This forces physicians to divide their attention between the computer screen and their patients [13], which consequently leaves patients feeling neglected during the consultation and unsatisfied because their concerns were not fully addressed [2, 13, 42]. Ultimately, this can lead to miscommunication, causing a rift in the patient-physician relationship and negatively impacting patients' health outcomes [5, 8].

One way clinics have attempted to ease the burden on physicians and improve communication with patients is through pre-consultation questionnaires [33]. The process involves asking patients about the reasons for their visit, expectations of the visit, and relevant medical history before the actual encounter [11, 35, 36]. Several studies have shown that pre-consultation information exchange helps patients feel more prepared for their appointment and better at articulating their concerns [24, 34, 40]. Physicians also benefit by having to do less documentation since patients' preliminary health concerns would already be captured through the pre-consultation process, allowing them to focus their attention on the patient themselves [33]. Despite these benefits, pre-consultation questionnaires can lead to "survey fatigue", a phenomenon in which patients become disengaged or bored with the process, resulting in incomplete or inaccurate responses [26] and negatively affecting the quality of information gathered.

Recent research suggests that chatbots can be a superior alternative to static web-based surveys [15]. Xiao et al. [39] found that chatbots can simulate personable and engaging natural conversations, effectively eliciting more detailed and expressive responses from users. However, existing healthcare chatbots primarily focus on risk assessment and symptom diagnosis [1, 9, 21, 27, 28]; their potential in pre-consultation questioning and patient information gathering remains unexplored. Additionally, these chatbots are often designed for a single stakeholder — the patient — and have little to offer for reducing physicians' burdens. By shifting the focus to pre-consultation questioning, chatbots can offer a more engaging experience for patients, provide more comprehensive information for physicians, and ultimately improve patient-physician communication and the overall clinical experience for both stakeholders.

In my thesis, I aim to explore the use of chatbots for pre-consultation patient-physician communication. The chatbot I design would function as a physician assistant serving both patients and physicians.

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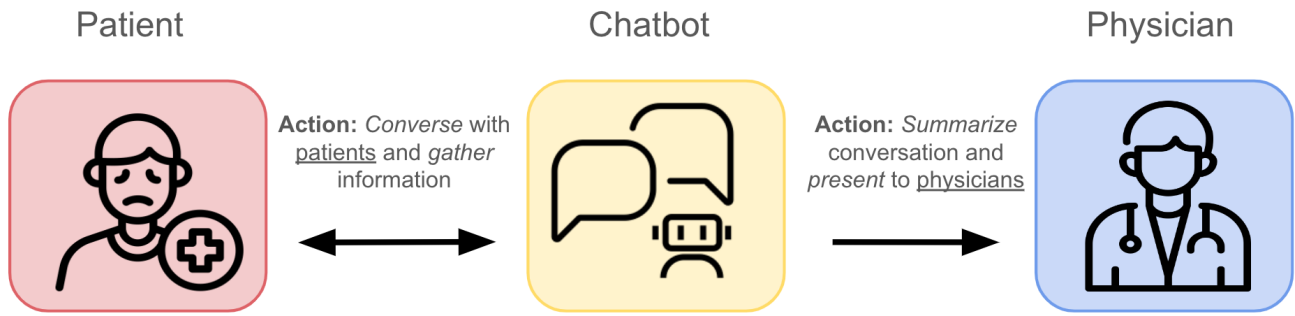


Figure 1: My research aims to design a pre-consultation chatbot that can converse with patients to gather information and summarize the conversation for physicians to quickly review.

As shown in [Figure 1](#), it first converses with patients to gather information about their concerns and medical history. It then summarizes the conversation and present the information to physicians as a starter note that can be quickly reviewed before the consultation. This design leverages the strengths of chatbots in communication and user engagement while circumventing the consequences of having them make medical recommendations. As a result, the required sophistication and medical knowledge for the chatbot is reduced, supporting AI-human collaboration where physicians remain responsible for making clinical decisions.

2 RESULTS AND CONTRIBUTIONS TO DATE

2.1 Understanding Patient-Physician Consultations During Synchronous Text-based Chat

To understand how to design a pre-consultation chatbot, I first examined how consultations are conducted by physicians in a text-based chat context [19]. This work was further motivated by the surge in virtual care driven by the pandemic, which popularized synchronous text messaging as a mode of medical consultation [3, 12, 16]. However, the impact of this new modality on physicians' ability to conduct consultations, how physicians perceive these interactions, and the dynamics of these conversations have remained under-explored. To address this gap, I conducted a qualitative study with 8 primary care physicians. I employed standardized patients (SPs) — professional actors trained to portray patients — to act out scenarios with our physician participants through a text-based chat platform. These two scenarios, which were developed with the help of our clinical collaborator, included (1) an individual with a urinary tract infection and (2) an individual experiencing work-based anxiety. Each physician participant engaged with both medical scenarios and was subsequently interviewed for 30 minutes to gain insights into their experiences. From open coding the interview transcripts, I found that text-based consultations were perceived to be equally effective for conducting consultations when the medical concern does not require a physical examination. I identified some text-specific constraints, such as the lack of verbal cues and typing inefficiencies, but physicians were able to quickly

adapt to these constraints with workarounds. For example, they used more empathetic acknowledgment terms in their responses to demonstrate active listening and employed double-barrel questions to facilitate conversation flow. However, the latter approach was not always well-received by the SPs, who sometimes found the double-barrel overwhelming. [Figure 2](#) shows an example of when double-barrel questions were used [Figure 2a](#) and contrasts the conversation to when the questions were separately asked [Figure 2b](#). I also learned about the structure of the conversation, including how physicians interwove questions, empathy, and explanations, all of which were instrumental in guiding my approach to designing a pre-consultation chatbot that I used in the next study.

2.2 Developing a Pre-consultation Chatbot and Evaluating with Real Patients

Even with an understanding of how physicians conduct their consultations through text messaging platforms, developing a pre-consultation chatbot that can be used directly by patients requires an iterative process. However, the existing literature in this space is particularly limited, and most relevant research (e.g., Ni et al. [23]) are conceptual rather than pragmatic and validated. The goal of this work, which is currently under review, was to understand how pre-consultation chatbots built on large-language models should be designed and to determine the most effective prompts for these chatbots in conducting pre-consultation interactions.

I first generated a list of questions that could be asked to patients. This list of questions was sourced from existing pre-consultation questionnaires [22, 30, 37, 40], but I iterated upon them so that they would be generic enough to apply to most patients regardless of their health concern while also being comprehensive enough that the information gathered would be somewhat useful for physicians to know before meeting the patient. Then, I worked on prompt engineering GPT-4 [25] to engage and ask questions in a manner that resembled how physicians would want to conduct their consultations. The chatbot was designed to inquire about patients' concerns, past medical history, and any information that needed follow-up. Initially, I found that the chatbot was unclear about its role and provided medical recommendations as if it were a physician. After tweaking the instructions to emphasize the chatbot's role as

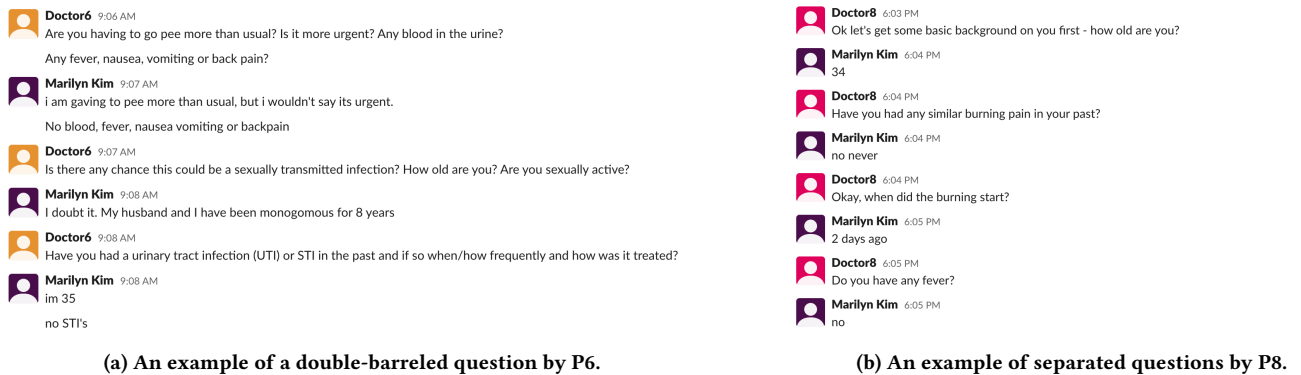


Figure 2: Conversation excerpts illustrating double-barreled and separated questions.

a physician assistant and to explicitly prevent it from providing medical recommendations, I was able to test the conversation with several human-computer interaction experts as patient pilots.

To assess how real-world patients would perceive the chatbot, I conducted a study at a local walk-in clinic with 33 patients. Approximately half of the patients were randomly assigned to interact with the GPT-based chatbot (AI-agent), while the other half were assigned to interact with a medical resident acting as if they were a chatbot (Wizard-agent). Having the latter condition allowed us to observe how conversing with the chatbot compared with conversing with a medical professional, which would ultimately help us identify potential improvements for our existing design.

We found that both conditions were equally well received by patients in their post-interaction survey. However, the extent of the follow-up questions and the amount of empathy impacted the chatbot’s perceived thoroughness and sincerity. From this study, I was able to develop a set of design guidelines for future pre-consultation chatbots as shown in Table 1.

3 CURRENT AND NEXT STEPS

3.1 Summarizing the Pre-consultation Conversation for Review

Currently, I am working on developing a system that generates summaries of pre-consultation conversations with a chatbot. To generate such summaries, I have been exploring the use of several different large-language models. There are several factors to consider: the accuracy of the summary, which depends on the conversation that the chatbot had with the patient; and the summary format, which may need to be personalized for each physician since everyone could have their own note-taking style [18]. I plan to engage with my medical collaborators to understand the various attributes and styles for writing a brief medical note.

Once the summarization engine has been sufficiently developed, I will develop an interface that allows physicians to quickly review summaries as a starting point for their medical notes. This interface will need to present information visually in an efficient and intuitive way to support physicians’ existing workflow. I will present this interface to physicians with various summary options for review and hypothetical use. I will then have each physician

rate the summary they received and describe how they may want to include the summary in their medical note. By having a better understanding of the summarization piece, I hope to gain a better perspective on how to improve the overall design of the pre-consultation chatbot-summary system.

3.2 Comparing a Pre-consultation Chatbot System Against Existing Pre-consultation Questionnaires

In the final part of my thesis, I will evaluate the pre-consultation chatbot-summarization system in comparison to existing pre-consultation questionnaire solutions. Pre-consultation questionnaires have become a staple in many clinics and have undergone iterative improvements to become highly efficient tools [1, 41]. However, as mentioned earlier, they come with intrinsic limitations that can lead to survey fatigue [7, 29]. In a medical context, this could result in incomplete or inaccurate information, potentially impacting patient health outcomes [26]. In this final phase of my thesis, I aim to gain a deeper understanding of the benefits and limitations of these two different information sourcing methods: chatbot versus questionnaire. This is where I plan to address some of the hypotheses outlined earlier, particularly the notion that chatbots can be more engaging and can gather richer patient information. I am also interested in exploring how patients perceive the different interactions and whether the inefficiencies of typing out responses can be offset by the more flexible and conversational nature of chatbots.

4 CONCLUSION

In this thesis, I plan to design and implement a pre-consultation chatbot-summarization system using large language models to facilitate patient-physician communication and streamline clinical workflows. The system will gather preliminary patient information so that patients and physicians can have more focused consultations while ultimately keeping physicians responsible for the final decision making. My research will include a series of qualitative evaluation studies, each highlighting a different step of the design process. Beyond healthcare, my research on chatbots can provide design insights for many sectors that require effective communication among multiple stakeholders, where information gathering

Table 1: Prompt design goals and recommendations for pre-consultation chatbots.

Category	Prompt Goal	Recommendations
Content	Improve thoroughness of questions	Ask more follow-up questions, especially ones that relate to the symptoms the patient has mentioned.
	Improve structure of questions	Focus on one issue at a time unless it seems like the symptoms may be related.
Language	Convey more sincerity	Encourage appreciative language, but not at every conversation turn. Consider appreciation when it seems like the patient is sharing information they may otherwise not be comfortable providing.
	Improve clarity	Encourage acknowledgements, but not at every conversation turn. Provide a summary only when the chatbot needs to confirm information that they may have misunderstood.
Situating in the Clinical Experience	Set expectations for the pre-consultation	Either before the conversation or shortly after the initial greeting, describe the chatbot's conversation capabilities.
	Set expectations for the chatbot	Either before the conversation or shortly after the initial greeting, describe how pre-consultation will help inform the patient's consultation with the doctor.

and summarization tasks can better prepare both parties, fostering mutual understanding and facilitating better communication.

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