

Project Title

AskNDCS: A round-the-clock dental triaging and appointment booking chatbot

Project Lead and Members

Project Lead: Mr Ricky Hi Cheong Leong, Director, Operations

Project Members:

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- Dr Qian Li
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- Dr Yang Jing Rong

Organisation(s) Involved

National Dental Centre Singapore

Healthcare Family Group(s) Involved in this Project

Medical (Dental)

Applicable Specialty or Discipline

Department of Dentistry, Patient Experience Office

Project Period

Completed date: 21 September 2021

Aim(s)

To develop and implement a sustainable solution that can provide round-the-clock triage for the public with dental issue

Background

See poster appended/ below

Methods

See poster appended/ below

Results

See poster appended/ below

Lessons Learnt

Talk, Talk, Talk

Each time we speak to someone during the development phase of **AskNDCS**, there would be a perspective that we had not considered.

Test, Test, Test

We underestimated the time needed to test **AskNDCS**. During our initial testing, the trial chatbot went into an infinite loop of asking the same question over and over. At times, different answers were given to the same dental condition, depending on sequence which the symptom was presented. It took the team substantial amount of time to review and correct these “loops”. Reflecting on this, perhaps planning and framing could have avoided the redundant testing. Given that a chatbot is an interactive instrument, it would be difficult to predict how a user would present his symptoms and hence quite complicated to construct a comprehensive decision tree. Testing, testing and testing after the launch of a prototype will still be a useful approach.

Train, Train, Train

The initial chatlog reviewed that many chats did not proceed smoothly. A systematic approach to “train” **AskNDCS** had to be put in place. The team met weekly to review the chatlog based on a confidence level index that measures the association of an utterance to an intent. The frequency of the review sessions reduce when we were more confident with the performance of **AskNDCS**.

Conclusion

See poster appended/ below

Additional Information

While the current capabilities of chatbot technology is still far from replacing a complex diagnosis by medical professionals, chatbot is an excellent tool that is able to provide consistent and accurate answers pertaining to administrative matters and simple rule-based triaging, which are also integral to a patient's journey. Its round-the-clock availability allows care to continue beyond working hours and is accessible anytime anywhere with a touch of the phone.

Project Category

Technology, Digital Health, Chat Bots

Keywords

AskNDCS Chatbot Dental Triaging

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AskNDCS: A Round-the-clock Dental Triage and Appointment Booking Chatbot

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Introduction

The team developed and implemented AskNDCS, an AI-powered chatbot, which provides round-the-clock dental triaging, and right-site the cases to appropriate level of care. If a specialist dental treatment is required, AskNDCS will seamlessly book a dental appointment at NDCS. Coupled with machine learning and natural language processing, AskNDCS is able to predict the user's intent and converse with human-like responses that are most appropriate to the user's queries.

With an added digital chat channel, members of public can have a wider range of options to access to dental enquiries beyond the traditional means like telephone call or email, providing patients with a convenient way to obtain information as compared to web search.



Issues



Lack of 24/7 access to dental triaging and appointment booking services

- Patient with dental disorder after operating hours may experience **frustration or anxiety** when their pain is not addressed.
- Extending call center operating hours is unfeasible and costly
- Patient who called call center during peak hours are subjected to **waiting time depending on availability of a call agent**



Wrong triage outcome

- 4% of the initial dental assessments were found to be wrong referrals
- Resulting in **additional load** incurred at specialist clinics, **delay in treatment and poor patient experience**



Off-the-shelves medical chatbots do not provide customisable solutions that fits NDCS use-case

Results

1. AskNDCS is faster than humans in case resolution

21,827 chat session were held which provided assistance to **20,260** unique member of public.



596 (30%) of the chats occurred after operating hours

Avg handling time of AskNDCS is **2.28 mins**

2. AskNDCS is more consistent than human in classifying patients into dental speciality.

97% triage accuracy among 35 actualised appointments.

815 users right-sited to primary care.

3. Patients prefer AskNDCS than call center agents

73.4% of users who rate gave 3 stars and above



Methodology

1. Gathering of user's queries and formulating responses

A list of common dental complaints was compiled and categorised into dental specialities by a team of doctors. For broader symptoms, the doctors have designed a series of follow-up questions that the chatbot would prompt the user to answer before arriving at a suitable triage outcome.

2. Designing triage framework

- **Safe to use**- Besides dental advisory that the chatbot is not a substitute for professional dental advice and diagnosis, chatbot is able to detect emergent or urgent conditions throughout the conversation. If the chatbot is unable to discern the user's condition, it will direct the patient to seek care from primary care providers. Taking into consideration of data security, we finalised the hand-off process from chatbot for appointment booking to be done via email.
- **Accurate triage outcome**- 7 rounds of triage flow brainstorming sessions were conducted where the team conducted several rounds of Plan-Do-Check-Act cycles to ensure that the chatbot provides consistent and accurate answers before Go-live.

3. Testing

3 rounds of closed trials were conducted among NDCS clinicians, administrative staff, and members from SingHealth Patient Advocacy Network (SPAN). Feedback provided includes missing intents, wrong answers to the queries, and suggestions to improve user's interface or chat experience.

4. Go-live and Post implementation

The chatbot was launched on the NDCS website on 21 September 2021. We convened quarterly to refine chatbot content.

Milestones	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22
Launch of AskNDCS Project																
Development Phase- Intent Classification and Triage Flow Design																
UAT																
Training: Rule engine management, Chatlog review, Dashboard management																
Closed Trial																
Go-Live																
Post Implementation review																

Conclusion

While the current chatbot technology is unable to replace medical professionals, chatbot is an excellent tool to provide **consistent and accurate answers** pertaining to administrative matters and rule-based triaging. Its **round-the-clock availability** allows care to continue beyond working hours.

Next Step

1. Improve the appointment booking process by linking chatbot to HealthBuddy, such that users may book an appointment directly after arriving at triage outcome.
2. Expand the functionality of the chatbot to include services such as electronic financial counselling.