A pilot of artificial intelligence telephone triage of patients with suspected head and neck cancer

Katrina Mason[1], Karen Young[1], Kanishka Rao[1], Mairead Kelly[1], Ernest Lim[2], Aishling Higham[2], Nick de Pennington[2], Sarah Little[1], and Enyi Ofo[1]

[1]St George's University Hospitals NHS Foundation Trust
[2]Ufonia Limited

March 27, 2024

Abstract

1. The overwhelming majority of patients referred into secondary care with suspected head and neck cancer (HNC) do not have cancer (˜95%). **2.** During the COVID-19 pandemic telephone triage of patients with suspected HNC was necessary. During this time, a validated HNC risk-calculator, HaNC-RC-v2 (a set of symptomatology-based questions) was recommended by ENT UK to stratify patients into high or low risk of having HNC via telephone triage [(1)](#ref-0001) 3. Ufonia, a digital health company which uses an Artificial Intelligence (AI) voice assistant to automate clinical conversations via telephone, and *INSTITUTION*, were awarded an SBRI Healthcare grant to help develop an AI-delivered HNC triage telephone call. This was based on the HaNC-RC-v2 and co-created with HNC patients from the Heads2Gether charity via round-table discussions and one-to-one sessions. 4. Twenty-nine patients underwent a clinician-supervised AI-delivered HNC triage conversation as part of their standard telephone consultation. 100% of calls were completed with an average agreement of 89% between the clinician and the AI system for all symptoms asked. The technology was highly acceptable to patients with a median net promoter score (NPS) score of 8 out of 10. 5. Novel technologies involving AI automated telephone calls can be generated to remotely triage suspected HNC patients. This technology may offer an exciting opportunity to help departments triage suspected HNC referrals in an ever increasingly resource pressurised NHS.

1. The overwhelming majority of patients referred into secondary care with suspected head and neck cancer (HNC) do not have cancer (˜95%).
2. During the COVID-19 pandemic telephone triage of patients with suspected HNC was necessary. During this time, a validated HNC risk-calculator, HaNC-RC-v2 (a set of symptomatology-based questions) was recommended by ENT UK to stratify patients into high or low risk of having HNC via telephone triage (1)
3. Ufonia, a digital health company which uses an Artificial Intelligence (AI) voice assistant to automate clinical conversations via telephone, and *INSTITUTION*, were awarded an SBRI Healthcare grant to help develop an AI-delivered HNC triage telephone call. This was based on the HaNC-RC-v2 and co-created with HNC patients from the Heads2Gether charity via round-table discussions and one-to-one sessions.
4. Twenty-nine patients underwent a clinician-supervised AI-delivered HNC triage conversation as part of their standard telephone consultation. 100% of calls were completed with an average agreement of 89% between the clinician and the AI system for all symptoms asked. The technology was highly acceptable to patients with a median net promoter score (NPS) score of 8 out of 10.
5. Novel technologies involving AI automated telephone calls can be generated to remotely triage suspected HNC patients. This technology may offer an exciting opportunity to help departments triage suspected HNC referrals in an ever increasingly resource pressurised NHS.

Introduction

Head and neck cancer (HNC) is a collective term used to describe a group of cancers that arise from tissue in the head and neck region. HNC patients are diagnosed via emergency presentation, routine referral, or via the nationally approved 'urgent suspected cancer (USC)' (formerly "'two-week wait'), pathways having presented with one or more of a set of 'red flag' signs or symptoms to their General Practitioner (GP). A validated HNC risk-calculator, the HaNC-RC-v2, which combines patient demographics, risk factors, and a set of 12 'red-flag' symptoms has been developed to differentiate patients into having a high ([?]7%) or low (<7%) probability of having cancer (2).

In 2019/2020 227,665 patients were referred in England with suspected HNC of which 6,466 were subsequently diagnosed with cancer (3).This represents a conversion rate of 2.8%, meaning the overwhelming majority (97%) of patients referred on an urgent suspected head and neck cancer (USHNC) pathway do not have cancer. Once referred on an USHNC pathway, review in secondary care is traditionally done face-to-face by a HNC surgeon who undertakes a history and a physical examination which may include direct examination of the mucosal surfaces of the head and neck region with flexible nasendoscopy (FNE).

In 2020 the global coronavirus disease pandemic (COVID-19) saw a dramatic re-rationalisation of healthcare resources, with a shift to non-contact interactions necessitated to reduce disease spread, protect population health and to prevent overwhelming hospital systems. Ear Nose and Throat (ENT) and HNC specialists were particularly vulnerable due to their interactions with the reservoirs of the virus (nasopharynx), which saw these doctors worldwide unduly affected by nosocomial infection (4). As a result, the national governing bodies of UK HNC surgeons, advised that patients with USHNC should be assessed by telephone using the (HaN-RC-v.2) to help risk-stratify who should be seen face-to-face (1). Despite the recent abatement of the COVID-19 pandemic, telephone consultations have remained across a wide range of healthcare settings, seen as a solution helping to address the ongoing challenge of increasing referrals to secondary care, with limited resources to meet this referral demand. External solutions, such as automation, are increasingly being reviewed as a means to help address this ongoing capacity-demand mismatch.

Ufonia, a digital health company, has created 'Dora', an AI-driven clinical assistant which can conduct a natural-language telephone conversation with patients (5). Dora is a UKCA Class 1 approved medical device. In 2022 Ufonia and *INSTITUTION* were awarded a UK Research and Innovation Small Business Research Initiative (SBRI) healthcare grant to develop and pilot this technology to the clinical application of HNC triage. The HNC triage conversation was based on the HaNC-RCv.2 and was co-created with patients from the 'Heads2Gether' HNC charity.

Methods

Context & Intervention

The HNC automated conversation was based on the HaNC-RCv2. PPI activities involved two round-table discussions and individual technology trials with HNC patients from the 'Heads2Gether' HNC Charity and Ufonia conversation engineers. An external PPI expert was commissioned to oversee all PPI activities. All patients involved self-volunteered, were informed of the scope of the project via telephone and then in written briefing documents, they were then verbally consented by the external PPI expert prior to participation. All patients were remunerated for their time according to NHS England expenses and time rates for patient-participation. The final conversation was approved by the Trust's HNC department and regional HNC multi-disciplinary team Lead.

Setting and Participants

Patients referred into *INSTITUTION* with suspected HNC in June 2022 who were having an initial telephone consultation had a clinician-supervised Dora call as part of their routine telephone consultation. A clinician listening to the live autonomous conversation independently labelled answers for each component of the HaNC-RC-v2.

Main outcome measures

The main outcome measures included number of completed calls, AI-automated system (Dora) and clinician data capture rate and agreement for each component of the HaNC-RC-v2, and final cancer diagnosis at 1 year. Patients were also asked a net-promoter score (NPS), how likely out of 10 they were to recommend the technology to a friend or family member (6).

Ethical considerations

The Oxford University Clinical Trials and Research Governance /Joint Research Office classified the preliminary patient public involvement (PPI) activities as 'pre-research' not requiring formal regulatory approvals or research governance (decision on 25.06.2021).

For the clinical pilot, the Medical Research Council and the NHS Health and Research Authority research decision support tool (7) was used to determine that this project was not a formal research project as the HaNC-RC-v2 was a standard tool used in telephone triage of USHNC at the trust. This was confirmed with the trust's Associate Medical Director for Research in March 2022. Trust information governance and data sharing processes were approved in April 2022 (IG 2021-214).

All patients at the beginning of their telephone consultation were verbally consented by their clinician to undertake an automated conversation as part of their consultation.

Reporting Guidelines

The Equator Network SQUIRE 2.0 reporting guidelines, the framework for reporting new knowledge about how to improve healthcare, were used for the drafting of this manuscript.

Results

Twenty-nine patients had a supervised, automated Dora call as part of their care following informed consent. Age ranged from 22 - 83 years, (mean 47 years), with 19 female and 10 male patients. 100% (n=29) of the calls were successfully completed, and 100% (n=29) of the symptoms were satisfactorily labelled by the supervising clinician from Dora's automated conversation. Dora was able to independently capture and label 95% of all the symptoms (Range 83%-100%). Of the 406 symptom labels, agreement levels between Dora and the clinical supervisor were on average 89% (range 79-100%) (Figure 1). 66% (n=19) were classified as 'high' risk of having HNC (>7.1%), with 34% (n=10) classified as low risk of having HNC (<7.0%). None of the patients were ultimately diagnosed with HNC (confirmed at 1 year).

Patient acceptability was high, net promoter scores ranged from 4 to 10, with a median NPS of 8 out of 10, and a calculated NPS of 56% (Figure 2).

Discussion

Summary

This feasibility study has shown that the novel technology of AI-led telephone calls using automated voice assistants can be delivered to patients with USHNC with a high level of data capture (95%) and accuracy (89%) when compared to clinicians. Patients on this pathway were highly likely to recommend this novel technology to a friend or family member (NPS average 8 out of 10).

Interpretation

Zhu et al who reviewed patient satisfaction of HNC telephone triage during the COVID-19 pandemic found patients rating telephone triage between 'satisfied' and 'very satisfied', with an overall score of 4.29 out of 5 (8). Our study showed similar robust patient acceptability with an average NPS of 8 out of 10. This likely reflects the fact that the technology was cognisantly co-created with HNC patients helping to ensure that the conversation was appropriate and sensitive for this population. This co-creation with patients and professions is imperative to ensure AI technologies are robustly validated, safe and appropriate for patients.

Hardman et al have published the 2020 national prospective INTEGRATE study reviewing 4568 USHNC cases that were remotely triaged via telephone consultation using the HaNC-RCv2 as recommended by ENT UK during the COVID019 pandemic (9). The authors conclude that remote triage which incorporates risk stratification, as offered through the HaNC-RC-v2, may both reduce unnecessary attendances of low-risk patients and facilitate targeted investigations for higher risk patients. In addition, in the context of a progressively lower HNC conversion rate (number of cancers picked up from those referred in) over time, and in the absence of a national screening programme, innovative solutions such as remote triage need to be considered.

Limitations

A significant limitation is the small size of the study (29 patients) which reduces the power of conclusions drawn and the generalizability of our findings. This was due to the strict timings of the SBRI grant funding, with a longer time than anticipated needed to obtain necessary information governance approvals at the trust. It was however intended as a small feasibility study to show proof of concept and form the groundwork for more formal technology trials in the future. A significant strength therefore is that, to our knowledge, this is the first real-world use of an AI-led autonomous HNC triage conversation via the telephone.

Conclusions

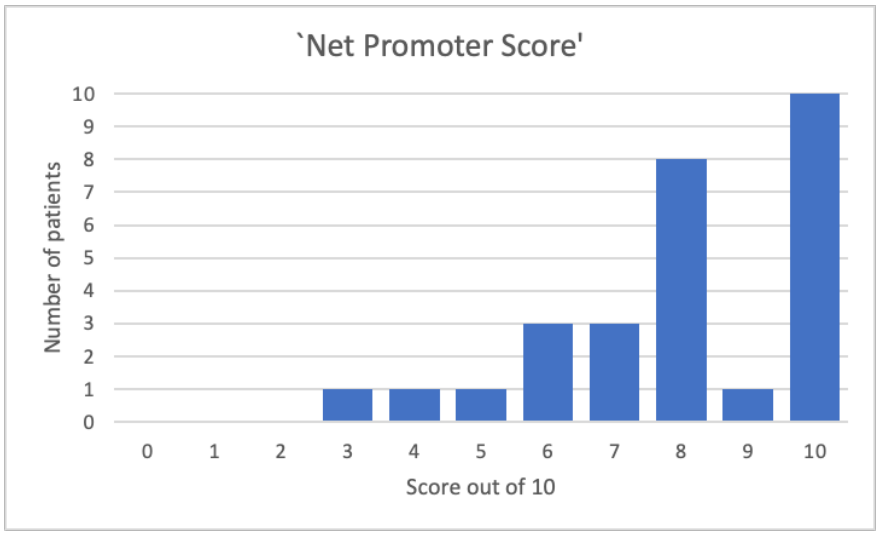
This work aligns with current priorities in the HNC community, as seen in the EVEREST-HN research programme currently underway at the Royal Marsden (10). The project has an overarching aim of improving the USHNC pathway, speeding up HNC diagnosis whilst utilising healthcare resources more efficiently.

AI promises to remove human-clinician capacity limitations and provide exponentially scalable care. In a human resource dependent healthcare system that is ever increasingly feeling the pressures of such limitations, innovative technologies including AI facilitated triage may offer a means of helping address these challenges.

Figure 1. Rate (%) of answers capture by Dora and agreement rate (%) between Dora captured answer and clinician

Symptom	*Answer captured by Dora*	*Agreement between Dora and Clinician*
Voice (Hoarseness)	100%	100%
Airway (Stridor)	97%	93%
Feeling of something in the throat (FOSIT)	100%	100%
Sore Throat	93%	79%
Odynophagia	97%	90%
Dysphagia	97%	90%
Oral swelling	93%	93%
Oral Ulcer	93%	90%
Unilat otalgia	93%	90%
Neck Lump	97%	90%
Skin lesion	93%	90%
Smoker	97%	83%
Alcohol consumption	93%	79%
Weight loss	83%	83%
Average	95%	89%

Figure 2. Net Promoter Score given by patients



References

1. Paleri V, Hardman J, Tikka T, Bradley P, Pracy P, Kerawala C. Rapid implementation of an evidence-based remote triaging system for assessment of suspected referrals and patients with head and neck cancer on follow-up after treatment during the COVID-19 pandemic: Model for international collaboration. Head Neck. 2020;42(7):1674-80.

2. Tikka T, Kavanagh K, Lowit A, Jiafeng P, Burns H, Nixon IJ, et al. Head and neck cancer risk calculator (HaNC-RC)-V.2. Adjustments and addition of symptoms and social history factors. Clin Otolaryngol. 2020;45(3):380-8.

3. CancerData. Cancer Waiting Times (CWT) urgent suspected cancer referrals: referral, conversion and detection rates 2023 [Available from: https://www.cancerdata.nhs.uk/cwt_conversion_and_detection.

4. Vukkadala N, Qian ZJ, Holsinger FC, Patel ZM, Rosenthal E. COVID-19 and the Otolaryngologist: Preliminary Evidence-Based Review. Laryngoscope. 2020;130(11):2537-43.

5. Ufonia. Ufonia: Autonomous clinial conversations 2023 [Available from: www.ufonia.com.

6. Lewis C, Mehmet M. Does the NPS® reflect consumer sentiment? A qualitative examination of the NPS using a sentiment analysis approach. International Journal of Market Research. 2020;62(1):9-17.

7. Council MR. HRA-Decision tool: Defining Research Support Tool 2022 [Available from: https://www.hra-decisiontools.org.uk/research/about.html.

8. Zhu Y, Chen Z, Ding A, Walter H, Easto R, Wilde A. Patient Satisfaction With the Head and Neck Cancer Telephone Triage Service During the COVID-19 Pandemic. Cureus. 2021;13(9):e18375.

9. Hardman JC, Tikka T, Paleri V, Ent Uk B, Integrate. Remote triage incorporating symptom-based risk stratification for suspected head and neck cancer referrals: A prospective population-based study. Cancer. 2021;127(22):4177-89.

10. Marsden R. EVEREST-HN Evolution of a patient-reported symptom-based risk stratification system to redesign the suspected head and neck cancer referral pathway 2022 [Available from: https://www.royalmarsden.nhs.uk/everest-hn.