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Accuracy of the Head and Neck Cancer Risk Calculator in identifying maxillofacial malignancies

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Abstract

The OMFS urgent suspicion of cancer (USOC) referral pathway for head and neck cancer is costly in terms of time and resources, and despite NICE referral guidance, it has a low conversion rate with many inappropriate referrals. The Head and Neck Cancer Risk Calculator version 2 (HaNC-RC-v2) gives recommendations to primary care referrers on appropriate referral priority. To our knowledge, this is the first study to investigate the accuracy of the HaNC-RC-v2 in a cohort of maxillofacial referrals. Electronic patient records were reviewed for all malignancies diagnosed by OMFS in 2019 (n = 54), and a sample of USOC referrals to OMFS (n = 204). The HaNC-RC-v2 was applied to each patient, using information from the referral letter and the clinical notes from the new patient consultation. The mean and median HaNC-RC-v2 scores for patients with malignancy were 42.22% and 32.23%, respectively. For patients without malignancy, mean and median scores were 9.27% and 5.68%, respectively. There was a statistically significant relation between the presence/absence of malignancy and the recommendation made by the risk calculator (p = 0.0012). The calculator recommended USOC referral for 76% (41/54) of patients with malignancy, and only 41% (83/204) of patients without malignancy. The negative predictive value of the HaNC-RC-v2 was 99.2%. The calculator has the potential to reduce the number of inappropriate referrals to OMFS via the USOC pathway.

Keywords: Oral cancer; Cancer risk; Suspected cancer; Cancer referral; Head and neck cancer

Introduction

The diagnosis and management of head and neck cancer (HNC) forms a significant proportion of the workload of oral and maxillofacial surgery (OMFS) units in the UK. In 2000, the UK Department of Health proposed that all patients in England who are urgently referred to a specialist due to a suspicion of cancer should receive a consultation within two weeks,[1,2] a target often termed the 'two-week rule'. In England, Scotland, and Northern Ireland patients should commence treatment for a confirmed cancer within 62 days of a suspected cancer referral from primary care.[2,3]

As a result of these targets, the urgent suspicion of cancer (USOC) pathway is time and resource-intensive for OMFS units.[4] The pathway has a conversion rate of only 8.8%,[5] and many referrals are considered inappropriate,[6–8] so methods to improve its efficiency and efficacy would be valuable.

NICE guidance exists to aid primary care doctors and dentists to identify patients who should be referred on the USOC pathway.[9] However, use of the guidance is variable: Mettias et al[10] found that only 52% of referrals were compliant with NICE criteria, whereas Hong et al[8] showed that 93.6% of referrals were compliant. The 2015 guidance has also been criticised for removing persistent unilateral sore throat and unexplained otalgia from its referral criteria,[11–13] and for recommending that some lesions are reviewed by a dentist prior to referral, which may introduce delays in obtaining a diagnosis.[14,15]

A novel tool to aid referrers is the Head and Neck Cancer Risk Calculator Version 2 (HaNC-RC-v2), developed by Tikka et al.[12,16] Available online at http://www.orl-health.com/risk-calculator-2.html, it allows clinicians to input patient demographics, social history risk factors,

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symptoms, and examination findings, and it algorithmically determines the percentage chance of a patient having a malignancy. The tool recommends USOC referral when the risk of HNC is at least 7.1%, an urgent referral for a risk of 2.2% or more, and a routine referral for a risk of less than 2.2%.[16] It was used by multiple ear, nose and throat (ENT) units as an adjunct to remote/telephone triage of USOC referrals during the COVID-19 pandemic, allowing for the deferred assessment of patients considered low risk, and thus relieving some service pressures.[13,17–19] However, to the authors' knowledge, it has not yet been independently validated for a cohort of OMFS patients, so there is a desire to assess its accuracy with respect to the recognition of sinister intraoral lesions in high-risk patients. The aim of this study therefore was to determine the suitability of the HaNC-RC-v2 to aid USOC referral triage in a regional OMFS unit.

Methods

Approval for this project was granted locally by the departmental quality improvement team.

Inclusion criteria

- The patient was referred to OMFS on the USOC pathway in 2019 or was diagnosed with a malignancy by OMFS in 2019.
- The patient was seen following a new referral and was not under regular review/surveillance with OMFS.
- Diagnosis was confirmed histologically, or the clinician was confident of a benign diagnosis from the history and clinical examination alone (for example, torus palatinus, resolved ulceration, or dental infection).

Exclusion criteria

- The patient failed to attend their assessment appointment.
- The diagnosis was uncertain and the patient declined further investigation.

Lists of relevant patients were obtained from the Information Analysts for Scheduled Care and the Southeast Scotland Cancer Network Audit Facilitator. Patients were grouped for data collection and analysis as follows:

Group A patients: confirmed malignancies

This group included all patients with a confirmed malignant diagnosis referred to OMFS in 2019, irrespective of referral priority. A total of 54 patients were identified.

Group B patients: benign/potentially malignant lesions

In total, 665 patients referred to OMFS via the USOC pathway in 2019 received a non-malignant diagnosis. As this group was much larger than Group A, a representative sample of these referrals was sufficient for analysis, and given the ease with which a generous sample could be obtained, the sample size was not based on an a priori power calculation. Data were collected on all referrals from 1 January to 30 April 2019, a large sample of 204 patients.

Data collection

Electronic patient records were retrospectively reviewed for all patients. Data were collected on referral source, referral and triage priority, diagnosis, and HaNC-RC-v2 percentage (along with the demographic data, and clinical signs and symptoms required to calculate this).

When a particular symptom was not mentioned in the clinical notes it was assumed to be absent. When detailed information on a symptom or clinical sign was not available (for example, laterality of a sore throat was not recorded), a mean average of the possible risk calculator percentages was taken using all the possible variations of that symptom. This occurred in only four cases, all of which were in Group B.

Data were collated on a Microsoft Excel spreadsheet and used in compliance with our local information governance policy. Data on patient demographics and referrals were summarised in tables. The spread of risk calculator percentages (RC%), and how the risk calculator recommendations compared with the referrals received, were demonstrated graphically.

Standard measures of accuracy (positive predictive value (PPV), negative predictive value (NPV), sensitivity and specificity) were obtained for the HaNC-RC-v2 when applied to all USOC referrals from 1 January to 30 April 2019, including both Group A and B patients. Risk calculator recommendations for benign and malignant lesions were collated on a contingency table and a relation between the recommendation and the eventual diagnosis was tested for using Fisher's exact test of independence.

Results

Demographic data are shown in Table 1. Group A comprised 54 patients with confirmed malignancy. The 204 patients in Group B had a range of diagnoses including benign conditions such as amalgam tattoo, fibroepithelial polyp, and frictional hyperkeratosis, as well as lesions with malignant potential such as lichen planus, oral epithelial dysplasia, and pleomorphic salivary adenoma.

Table 1
Demographic data.

	Group A (n = 54)	Group B (n = 204)
Mean (range) age (years)	62.81 (24–89)	61.46 (27–95)
Male	32	86
Female	22	118

The mean age of Group A (62.81 years) was slightly higher than that of Group B (61.46 years). Group A showed a male majority (32/54) whereas most patients in Group B were female (118/204, 57.8%).

Referrals

Table 2 shows the source of the referrals. For both groups, most came from general medical practitioners or general dental practitioners, with small numbers coming from other sources, including the hospital emergency department, public dental service, and other OMFS units.

The referral and triage priority for Group A patients is shown in Table 3. Twelve patients were not referred via the USOC pathway, but nine of them did see their referral priority upgraded at the triage stage, seven of these to the USOC pathway.

One patient was seen as an emergency following self-presentation to the emergency department.

All patients in Group B were referred on the USOC pathway. At consultant triage, 100% (204/204) of these referrals were allocated as urgent (suspicion of cancer). No USOC referrals were downgraded at triage in either group.

Risk calculator percentages

The range of HaNC-RC-v2 percentages for Groups A and B are shown in Fig. 1. The mean risk calculator percentages for Groups A and B were 42.22% and 9.27%, respectively. A total of 21/54 Group A patients scored more than 60%, which was higher than the maximum RC% seen in Group B (57.95%).

Recommendations of the HaNC-RC-v2

As shown in Fig. 2, around three quarters (41/54) of Group A patients exceeded the required threshold for the HaNC-RC-v2 to recommend a USOC referral. The calculator would have recommended referral of all but one of the remaining Group A patients on an urgent basis.

For the patients in Group B, 59% would have been referred via a non-USOC pathway based on their RC% (32% urgent and 27% routine), with the remaining 41% referred as suspected cancers.

Overall accuracy of the HaNC-RC-v2

An analysis of every USOC referral (regardless of diagnosis) received between 1st January - 30th April 2019 was carried out to assess the overall accuracy of the risk calculator. This included 11 patients from Group A and 204 patients from Group B (Table 4). Fisher's exact test of independence confirmed a statistically significant relation between the presence/absence of malignancy and the recommendations made by the risk calculator ($p = 0.0012$), with non-malignancy patients much more likely to be recommended for routine or urgent referral. A post-hoc power calculation based on this contingency table, with an alpha value of 0.05, revealed a power of 98.4%.

The accuracy of the risk calculator was 60.9%, with a sensitivity of 90.9% and specificity of 59.3%. PPV was 10.8%, and NPV was 99.2%.

Table 2
Referral source.

	Group A (n = 54)	Group B (n = 204)
General dental practitioner	23	115
General medical practitioner	25	87
Other	6	2

Table 3
Referral and triage priority for Group A patients (n = 54). Cells marked with an asterisk (*) show referrals that had their priority upgraded at triage.

Referral priority	Triage priority			
	Emergency	USOC	Urgent	Routine
Emergency	1	0	0	0
USOC	0	42	0	0
Urgent	0	5 *	2	0
Routine/NR	0	2 *	2 *	0

USOC: urgent suspicion of cancer

Discussion

Although this, to our knowledge, is the first study to use the HaNC-RC-v2 in a maxillofacial surgery cohort, the age and sex distribution of our patient group was comparable to that of previous studies in ENT units.[13,17,20]

The proportion of referrals from general dental practitioners was greater in the non-malignancy group (Group B) than the malignancy group (Group A). This is in keeping with other published research, which suggests that the majority of HNC referrals come from medical practitioners,[8] possibly as a result of poorer rates of dental registration and attendance amongst at-risk patient groups.[21]

The most notable strength of the HaNC-RC-v2 is its NPV, with Tikka et al quoting a NPV of 98.6%,[16] and other studies finding similar values.[17,18] Our findings support this conclusion with a NPV of 99.2%. Only one Group A patient, who had a haematological malignancy, was categorised as low risk when the calculator was applied.

Fig. 2 shows that if the HaNC-RC-v2 had been used by referrers for this patient cohort, 59% of Group B patients would not have been referred on the USOC pathway, mitigating the issue of it becoming 'over-burdened by low-risk patients'.[7] A valid concern about implementing a risk calculator is the potential for delayed cancer diagnoses, but it is well documented that a significant number of HNCs are already referred through slower, non-USOC pathways.[5,22] Our findings (Fig. 2) show that the proportion of Group A patients referred via non-USOC routes would not have changed substantially had the calculator been utilised.

The HaNC-RC-v2 assigns levels of risk to oral ulceration and oral swellings, but not to any other intraoral lesions, notably erythroleukoplakia. This has a high malignant poten-

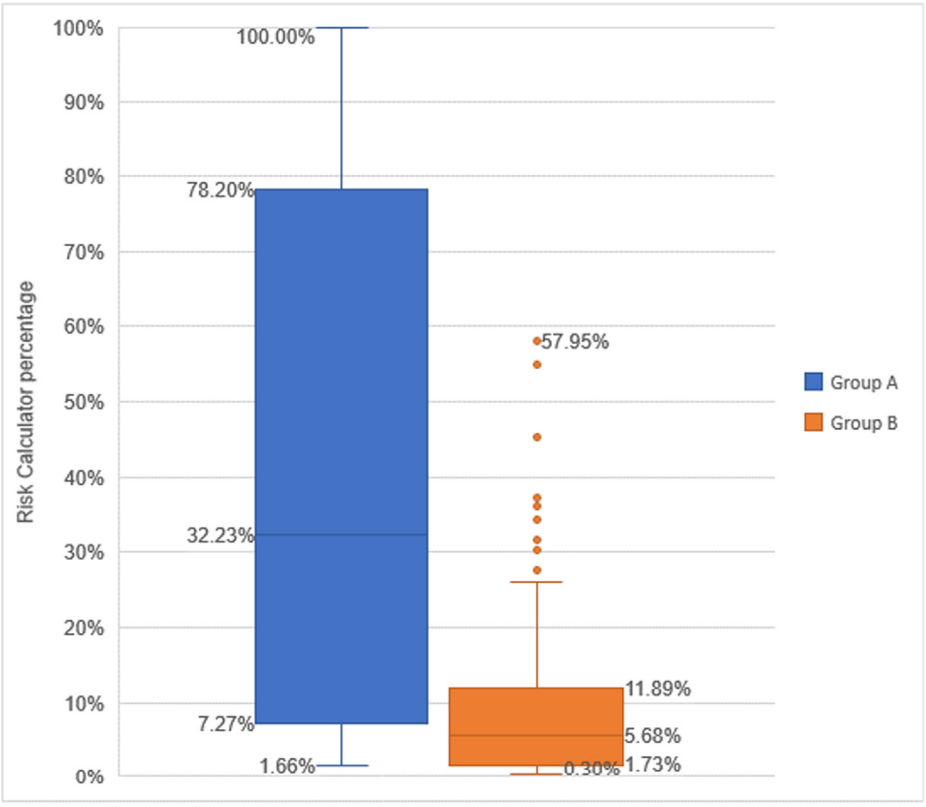

Fig. 1. Modified box plot demonstrating the spread of risk calculator percentages. The minimum, median, and maximum values are shown along with the upper and lower quartiles.

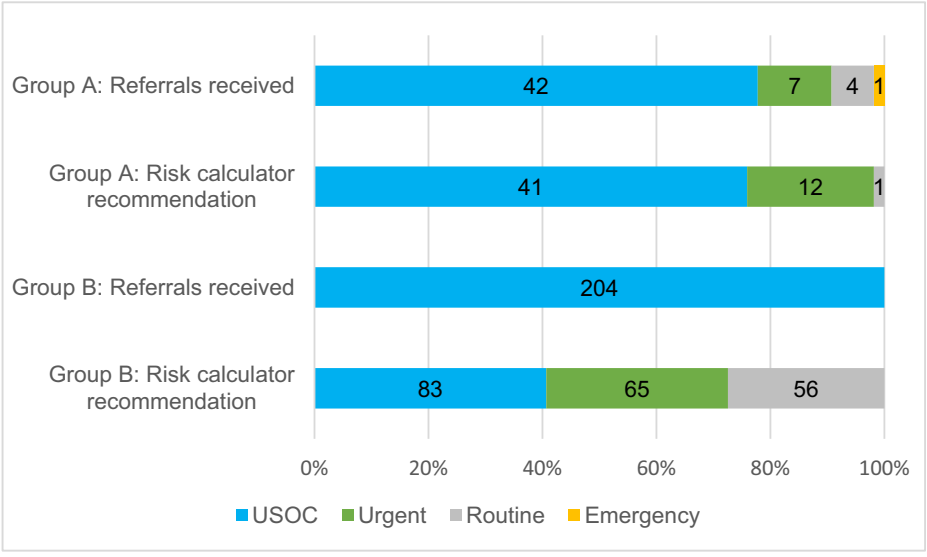

Fig. 2. Comparison of the priority for referrals received, against the recommended referral priority based on the risk calculator percentage (USOC: urgent suspicion of cancer).

Table 4
Contingency table for all urgent suspicion of cancer (USOC) referrals received from 1 January – 30 April 2019, based on the HaNC-RC-v2 recommendation.

Risk calculator recommendation	Group A (n = 11)	Group B (n = 204)	Total
USOC referral	10	83	93
Non-USOC referral	1	121	122
Total	11	204	215

tial[23] and appears in the NICE criteria but would not necessarily generate a high HaNC-RC-v2 score. Clinicians therefore may wish to exercise careful clinical judgement when assessing lesions such as erythroleukoplakia or erythroplakia with the calculator.

The HaNC-RC-v2 has been shown to compare favourably against the 2015 NICE guidance.[12] Our data find the calculator to have a much higher sensitivity when compared with NICE (90.9% vs 75.4%), at the cost of lower specificity (59.3% vs 71%).[11]

It has been established that primary care dentists are inclined to refer patients to specialists when there is any doubt over the diagnosis of a soft tissue lesion, and that social history risk factors increase the likelihood of a referral even for a benign condition.[24] Reasons for the large numbers of inappropriate USOC referrals include limited knowledge of ENT or OMFS pathology,[25] medicolegal concerns,[6] and the large number of patients whose symptoms are compatible with head and neck malignancy but are the result of benign disease.[25] The HaNC-RC-v2, while not a substitute for sound clinical judgement, would give primary care colleagues confidence to determine an appropriate referral priority using a validated and evidence-based resource. Our data support use of the tool for the assessment of OMFS patients.

The Department of Health states that secondary care consultants may not re-categorise a USOC referral as non-urgent.[26] The Scottish Government suggests that the downgrading of referrals is only acceptable on 'rare occasions',[3] and in our sample no USOC referrals were downgraded. The referral of patients on an inappropriately urgent pathway therefore is difficult to correct at the point of secondary care referral triage. ENT units appear to have overcome this by using remote/telephone consultations within two weeks to clarify symptoms, apply the calculator, and determine the appropriate urgency of a subsequent face-to-face assessment or investigation.[13,17,18] However, in an OMFS context, confirming the presence/absence of oral ulceration, oral swelling, or a neck lump, which is required by the calculator, is not easy via remote means and would require a face-to-face assessment. It is therefore imperative that the HaNC-RC-v2 is utilised by primary care clinicians prior to referral to reduce the number of urgent secondary care assessments required.

As an area for future research, the assessment of routine and urgent OMFS referrals using the HaNC-RC-v2 would be valuable. This would quantify the proportion of these referrals that would see their priority 'upgraded' to USOC if the calculator was used consistently in primary care. Such referrals could offset the potential efficiency savings of using the HaNC-RC-v2 as described above.

Limitations of the study

A binary categorisation of USOC referrals as either desirable/appropriate (confirmed HNC cases in Group A) or less desirable/inappropriate (Group B) is an oversimplification. Indeed, alongside fibroepithelial polyps and mandibular tori, Group B diagnoses also included severe epithelial dysplasia, verrucous hyperplasia, and pleomorphic salivary adenoma, which were likely to be appropriate USOC referrals requiring urgent biopsy, subsequent surgical management, or close clinical monitoring. Although the HaNC-RC-v2 is designed to identify frank malignancies, an ideal USOC pathway will also welcome referral of these other potentially malignant lesions, accepting a lower conversion rate as a result.

Due to the brevity of many referral letters, details of clinical signs and symptoms were taken not only from the information provided by the referrer, but also from the clinical notes and correspondence following consultation in secondary care. It is possible that examination by an experienced specialist may be more sensitive in identifying subtle clinical signs, or that new signs or symptoms may have developed in the time between referral and consultation, thus increasing the HaNC-RC-v2 score.

Conclusions

The HaNC-RC-v2 has the potential to reduce the number of inappropriate referrals to OMFS via the USOC pathway, without substantially increasing the number of delayed cancer diagnoses.

Ethics statement/confirmation of patient permission

Local approval for this retrospective study was obtained. Patients' permission not required - no identifiable information was included.

Conflict of interest

We have no conflicts of interest.

References

1. Department of Health. The NHS cancer plan: a plan for investment, a plan for reform. 2000. Available from URL: https: https://webarchive.nationalarchives.gov.uk/ukgwa/+/www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4009609 (last accessed 24 April 2023).
2. Cancer Research UK. Cancer waiting times. 2020. Available from URL: https://www.cancerresearchuk.org/about-cancer/cancer-in-general/cancer-waiting-times (last accessed 24 April 2023).
3. Scottish Government and Scottish Primary Care Cancer Group. Scottish referral guidelines for suspected cancer. 2019. Available from URL: https://www.gov.scot/publications/scottish-referral-guidelines-suspected-cancer-january-2019/documents/ (last accessed 24 April 2023).
4. McKie C, Ahmad UA, Fellows S, et al. The 2-week rule for suspected head and neck cancer in the United Kingdom: referral patterns, diagnostic efficacy of the guidelines and compliance. *Oral Oncol* 2008;**44**:851–856. https://doi.org/10.1016/j.oraloncology.2007.10.010.
5. Langton S, Siau D, Bankhead C. Two-week rule in head and neck cancer 2000–14: a systematic review. *Br J Oral Maxillofac Surg* 2016;**54**:120–131. https://doi.org/10.1016/j.bjoms.2015.09.041.
6. Grey R, Walsh S. A review of the electronic two-week rule referrals for head and neck cancer to Western Sussex Hospitals NHS Foundation Trust. *Br Dent J* 2019;**227**:403–409. https://doi.org/10.1038/s41415-019-0668-x.

7. Drake I, Rogers A, Stewart M, et al. The impact of coronavirus disease 2019 on the head and neck cancer pathway in the West of Scotland. *J Laryngol Otol* 2022;**136**:535–539. https://doi.org/10.1017/S0022215122000603.
8. Hong B, Shaikh Z, Adcock S, et al. Two-week wait false alarms? A prospective investigation of 2WW head and neck cancer referrals. *Br Dent J* 2016;**220**:521–526. https://doi.org/10.1038/sj.bdj.2016.376.
9. NICE. Head and neck cancers- recognition and referral. 2021. Available from URL: https://cks.nice.org.uk/topics/head-neck-cancers-recognition-referral/ (last accessed 24 April 2023).
10. Mettias B, Charlton A, Ashokkumar S. Outcome of two-week head and neck cancer pathway for the otolaryngology department in a tertiary centre. *J Laryngol Otol* 2021;**135**:869–873. https://doi.org/10.1017/S0022215121002061.
11. Allam A, Nijim H. Persistent unilateral sore throat: should it be included in the 2-week wait referral criteria by NICE. *Int J Otolaryngol* 2019;**2019**:4920514. https://doi.org/10.1155/2019/4920514.
12. Tikka T, Pracy P, Paleri V. Refining the head and neck cancer referral guidelines: a two-centre analysis of 4715 referrals. *Br J Oral Maxillofac Surg* 2016;**54**:141–150. https://doi.org/10.1016/j.bjoms.2015.09.022.
13. Kaddour H, Jama GM, Stagnell S, et al. Remote triaging of urgent suspected head and neck cancer referrals: our experience during the first wave of the COVID-19 pandemic. *Eur Arch Otorhinolaryngol* 2022;**279**:1111–1115. https://doi.org/10.1007/s00405-021-07135-3.
14. Grimes D, Patel J, Avery C. New NICE referral guidance for oral cancer: does it risk delay in diagnosis? *Br J Oral Maxillofac Surg* 2017;**55**:404–406. https://doi.org/10.1016/j.bjoms.2016.09.022.
15. Grafton-Clarke C, Chen KW, Wilcock J. Diagnosis and referral delays in primary care for oral squamous cell cancer: a systematic review. *Br J Gen Pract* 2019;**69**:e112–e126. https://doi.org/10.3399/bjgp18X700205.
16. Tikka T, Kavanagh K, Lowit A, 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**:380–388. https://doi.org/10.1111/coa.13511.
17. Hardman JC, Tikka T, Paleri V. ENT UK, BAHNO and INTEGRATE (The UK ENT Trainee Network). Remote triage incorporating symptom-based risk stratification for suspected head and neck cancer referrals: a prospective population-based study. *Cancer* 2021;**127**:4177–4189. https://doi.org/10.1002/cncr.33800.
18. Banerjee S, Voliotidis D, Parvin L, et al. Telephone triage of suspected head and neck cancer patients during the coronavirus disease 2019 pandemic using the Head and Neck Cancer Risk Calculator version 2. *J Laryngol Otol* 2021;**135**:241–245. https://doi.org/10.1017/S0022215121000657.
19. Paleri V, Hardman J, Tikka T, et al. 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**:1674–1680. https://doi.org/10.1002/hed.26219.
20. Rovira A, Brar S, Munroe-Gray T, et al. Telephone consultation for two-week-wait ENT and head and neck cancer referrals: initial evaluation including patient satisfaction. *J Laryngol Otol* 2022;**36**:615–621. https://doi.org/10.1017/S0022215121003157.
21. Rogers SN, Staunton A, Girach R, et al. Audit of the two-week pathway for patients with suspected cancer of the head and neck and the influence of socioeconomic status. *Br J Oral Maxillofac Surg* 2019;**57**:419–424. https://doi.org/10.1016/j.bjoms.2018.09.016.
22. Hobson JC, Malla JV, Sinha J, et al. Outcomes for patients referred urgently with suspected head and neck cancer. *J Laryngol Otol* 2008;**122**:1241–1244, 0.1017/S0022215108002004.
23. Reichart PA, Philipsen HP. Oral erythroplakia - a review. *Oral Oncol* 2005;**41**:551–561. https://doi.org/10.1016/j.oraloncology.2004.12.003.
24. Brocklehurst PR, Baker SR, Speight PM. Factors which determine the referral of potentially malignant disorders by primary care dentists. *J Dent* 2010;**38**:569–578. https://doi.org/10.1016/j.jdent.2010.04.008.
25. Talwar C, McClune A, Kelly D, et al. Two-week rule: suspected head and neck cancer referrals from a general medical practice perspective. *Br J Oral Maxillofac Surg* 2020;**58**:981–985. https://doi.org/10.1016/j.bjoms.2020.05.004.
26. Department of Health. Achieving the two-week standard. Questions & answers: how to help you with issues arising from the two-week wait standard. Available from URL: https://webarchive.nationalarchives.gov.uk/ukgwa/20130107105354/http:/www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_4054826.pdf (last accessed 24 April 2023).