

# Head and neck cancers: Monitoring quality and reporting outcomes

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## Abstract

**Introduction:** Head and neck cancers (HNC) require high level multidisciplinary care to achieve optimal outcomes. Reporting of quality indicators (QIs) has been instigated by some health services in an effort to improve quality of care. The aim of this study was to determine the quality of care provided to patients with HNC at a single institution by analysing compliance with QIs and to explore the feasibility and utility of collecting this data.

**Methods:** This was a single institution retrospective chart review of all patients with squamous cell HNC at Townsville Hospital who were treated with curative intent between June 2011 and June 2019. Data was entered into a RedCap database and then exported to Stata V16 for analysis.

**Results:** A total of 537 patients were included in the overall study, with six patients who had a synchronous non-HNC and two patients who received previous radiotherapy (RT) to the head and neck region excluded from the outcome analysis. Overall, compliance with pre-treatment, treatment and post-treatment QIs was high, with the exception of smoking cessation support (66%), post-treatment dental review and time to post-operative RT (33% of patients within 6 weeks). The 5-year overall survival was 69.4% (CI; 64–73.2%). The cumulative incidence of locoregional relapse for the overall study cohort was 18% (CI; 14.8–21.4%).

**Conclusion:** Collecting and evaluating quality metrics is feasible and helps identify areas for improvement. Centres treating HNC patients should strive towards monitoring quality against benchmarks and demonstrate transparency in outcome data.

**Key words:** head and neck cancer; outcomes; quality improvement; quality indicators.

## Introduction

Head and neck cancers (HNC) are challenging cancers to treat and require well-coordinated and integrated multidisciplinary management for optimal functional and disease outcomes. Several studies have demonstrated the impact of quality of care on patient outcomes.<sup>1–4</sup> This has prompted health services to benchmark and report quality metrics in order to improve quality of care. Quality indicators (QI) as outcome measures to assess quality of care have been proposed and studied in HN cancers in several countries.<sup>5–14</sup> Cramer *et al.* identified five quality metrics for surgically treated HNC patients that were suitable for widespread adoption; negative margins in those treated with primary surgery, neck dissection  $\geq 18$  lymph nodes,

adjuvant radiotherapy (RT) in locally advanced disease, adjuvant chemoradiotherapy in those with extracapsular spread or positive margins at surgical resection and starting adjuvant RT  $\leq 6$  weeks.<sup>1</sup> National evaluation of these quality metrics determined that patients who received high-quality care had a 19% reduced HR of mortality. In a surgical series of laryngeal cancers, high quality care was associated with improved overall survival (OS) and LRF.<sup>3</sup> In radiation oncology poor compliance to protocol resulted in up to 20% reduction in OS and locoregional failure (LRF) in HNC patients treated with radiation therapy.<sup>15,16</sup>

A European study testing five QIs in four EU countries between 2009 and 2011, namely, availability of formalised multidisciplinary team, participation in clinical and translation research, timeliness of care, high quality of

surgery and RT, and pathological reporting, found suboptimal quality of care across all countries.<sup>6</sup> Quality metrics have not been established or evaluated at a national level in Australia, however, a state-wide Cancer Quality Index report from Queensland has demonstrated variability in quality of care and outcomes in HNC.<sup>17</sup> Shellenberger *et al.*<sup>18</sup> demonstrated that establishing and applying benchmarks for QI to measure quality of care allows identification of areas for improvement. We aim to report QIs in HNC and outcomes at our institution over an eight-year period and demonstrate the feasibility and utility of collecting and reporting such data.

## Methods

The primary objective of the study was to determine quality of care in our institution by measuring compliance with QI for patients treated with head and neck squamous cell carcinoma (HNSCC). We also report treatment outcomes (OS and LRF). QI for this study were derived from those defined by the Scottish Head and Neck Task Force, American Head and Neck Society and National Comprehensive Cancer Network (NCCN) guidelines for diagnosis and staging, treatment and follow up (Appendix 1).<sup>9–11,13</sup> While there are other QIs that evolved during the study period, the chosen indicators for this study were the most evaluated, reported and used for national benchmarking.<sup>1–4,10,11,19</sup>

For diagnosis and staging (pre-treatment QI), evidence of histological diagnosis, staging (AJCC 7th ed.), appropriate imaging, multidisciplinary review, pre-treatment dental, diet, speech and swallow assessment and smoking cessation management were evaluated. The AJCC eighth edition staging guidelines came into effect in 2018, which was in the latter part of this study, and as such patients were staged using the 7th edition.<sup>20</sup> Where p16 status for oropharyngeal squamous cell carcinoma (OPSCC) was unknown, it was considered negative for analysis. Treatment related QI included appropriateness of each treatment modality (surgery, chemotherapy, RT), appropriate use of Intensity Modulated Radiation Therapy (IMRT), time to PORT and 30-day mortality. 30-day mortality implies unanticipated death from treatment-related complications.<sup>14</sup> The benchmark for 30-day mortality following treatment has been set at <5% by the Scottish Head and Neck Task Force and was considered appropriate QI to evaluate for this study.<sup>10</sup> Post-treatment QI included follow up frequency, post treatment dental review, screening for hypothyroidism and post treatment imaging (PET/CT for those that received definitive RT). Chest imaging for second cancers in smokers was not evaluated.

## Study design

As shown in Figure 1, this was a single institution retrospective chart review of all patients over 18 years with HNSCC involving oral cavity, pharynx, larynx, paranasal

sinuses, and nasal cavity, diagnosed and treated with curative intent between June 2011 and June 2019. Those with p16 positive metastatic SCC and unknown primary were classified as OPSCC and included in the study. Data was extracted from MOSAIQ oncology management information system (OIMS) and the hospital medical records. Post treatment dental reviews and thyroid function tests were predominantly performed externally; however, no external records were accessed. When patients had >1 head and neck (HN) primary, the earliest was reported. When a patient had synchronous HN primaries, the diagnosis with the most advanced stage was reported. Appropriateness of treatments were evaluated against established guidelines (NCCN)<sup>9</sup> by the study author. Where treatment was not considered to be appropriate, a second RO was consulted. Patients referred for complex surgeries to a tertiary referral centre were included in the study. Patients with recurrent cancers were excluded from the study. A total of 537 patients were included in the study; 6 patients with synchronous non-HNC and 2 patients who previously received RT to HN region precluding definitive RT were excluded for the outcome analysis (529 patients). Ethics approval for this study was granted by the Institutional Human Research Ethics Committee (HREC/16/QTHS/16).

## Statistical analysis

Data was entered into RedCap database and exported to excel for data analysis using Stata V16. Compliance with QIs is reported as descriptive statistics. OS was defined from date of diagnosis to date of death from any cause. For those not known to have died as of study close-outdate, OS was censored at the date last known to be alive. OS was calculated using Kaplan Meier method with corresponding 95% confidence interval (CI). Locoregional (LRR) was defined as date of diagnosis to event (local failure, regional failure, or loco-regional failure). For those not known to have had a relapse as of study close-out date, LRR was censored at the date of the patient's last follow up. Loco-regional control was calculated using cumulative incidence competing risks method. Residual nodal disease following chemoradiation (CRT) that was successfully salvaged by neck dissection was not considered regional failure.

## Results

### Demographics

Eighty-five percent of the 537 patients were male (Table 1). Mean age at diagnosis was 61 years. Oropharynx was the commonest primary site (45.4%) of which 68.4% (167/244) were p16 positive. Smoking status was documented in all but 6 (1.1%) patients. There were 240/537 (44.7%) current smokers. Three quarter of patients

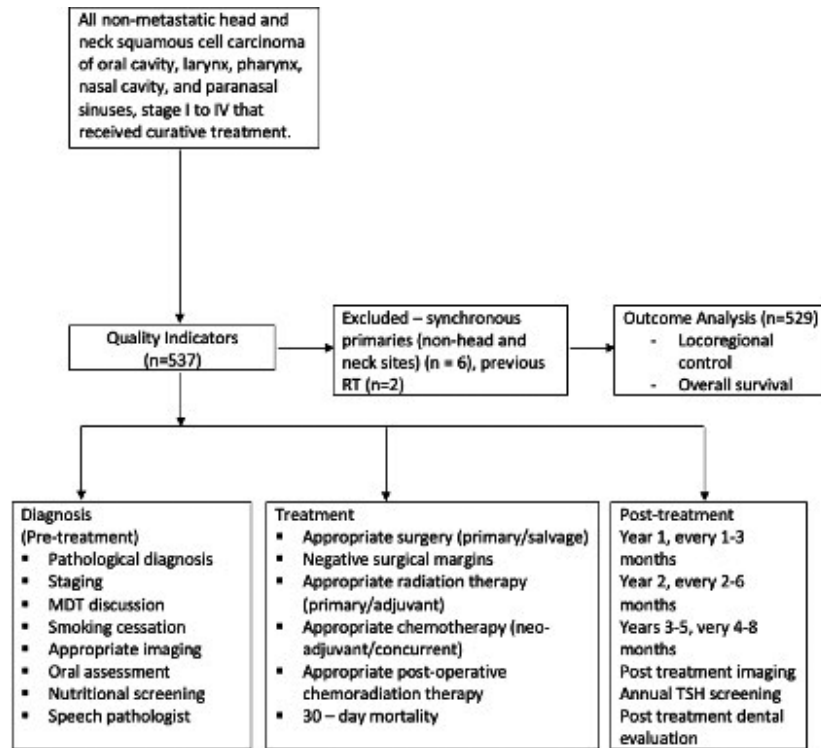


Fig. 1. Study schema.

(76.5%) had advanced stage disease (AJCC 7th ed.). Among patients with OPSCC, 12/244 (4.9%) had unknown p16 status. Charlson Co-morbidity Index (CCI) was three or more in 45% (243/537) of patients. Sixty-nine of 537 patients (13%) were treated with primary surgery alone, 377/537 (70%) were treated with primary RT with or without chemotherapy.

## Quality indicators

### Pre-treatment (diagnosis and staging) QI

Of the diagnosis and treatment QIs, over 99% of patients were seen in the MDT, and had staging recorded, and over 96% underwent relevant imaging and appropriate pre-treatment assessments, including diet, speech pathology and dental assessments (Table 2). However, smoking cessation support was documented in only 66% of smokers.

### Treatment related QI

Compliance to treatment related QIs pertaining to appropriate primary surgery was 100% and primary RT was 95.8%. Of the 17 patients who did not receive appropriate RT, 6 declined post-operative RT (PORT), 2 did not complete RT due to toxicities, 2 were non-compliant and

ceased, 1 was unfit for PORT due to poor performance status, 1 had recurrence before PORT, 2 could not receive PORT due to previous RT and 3 received suboptimal dose (66 Gy conventional fractionation as definitive dose for advanced disease). Post-operative CRT was appropriately given in 81.4% (35/43) patients. Of the eight patients who did not receive post-operative CRT, two declined CRT and six did not receive concurrent chemotherapy with PORT (two were not offered, three were unfit and one did not tolerate). Time to PORT  $\leq$  6 weeks was seen in 33.3% (31/93). Of those that underwent surgery, 7.4% (12/162) demonstrated positive margins. Of these, seven underwent surgery at TUH and five at tertiary centres. Mortality following treatment was assessed for patients and among the entire study cohort, 30-day mortality was 1.5%.

### Post treatment QI

Follow up frequency was optimal and attrition was <3%. The main reason for attrition was emigration. One patient refused follow up after 12 months after treatment and another did not receive follow up appointment due to administrative error. While 53.7% (206/383) of patients had documented evidence of dental review, the timing was variable. Thyroid function surveillance was low with significant missing data.

**Table 1.** Study demographics

	No. of patients (%)†
Sex (n = 537)	
Male	455 (84.7)
Female	82 (15.3)
Age (n = 537)	
<40	9 (1.7)
40–49	46 (8.5)
50–59	189 (35.1)
60–69	169 (31.5)
70–79	101 (18.8)
≥80	23 (4.3)
Charlson Comorbidity Index (n = 537)	
0	45 (8.4)
1–2	249 (46.3)
≥3	243 (45.2)
Site (n = 537)	
Oral cavity	107 (19.9)
Nasopharynx	10 (1.9)
Oropharynx	244 (45.4)
Hypopharynx	45 (8.4)
Larynx	123 (22.9)
Paranasal sinuses	4 (0.7)
Nasal cavity	4 (0.7)
p16 Status (OPSCC, n = 244)	
Positive	167 (68.4)
Negative	65 (26.6)
Unknown	12 (4.9)
Smoking (n = 537)	
Non-smokers	91 (16.9)
Ex-smokers	200 (37.2)
Smoker	240 (44.7)
Unknown	6 (1.1)
T stage‡ (n = 537)	
T0	6 (1.1)
T1	116 (21.6)
T2	187 (34.8)
T3	98 (18.2)
T4	130 (24.2)
N stage‡ (n = 537)	
N0	189 (35.1)
N1	71 (13.2)
N2	260 (48.4)
N3	17 (3.1)
Overall stage‡ (n = 537)	
I	72 (14)
II	54 (10)
III	88 (16)
IV	323 (60)
Treatment (537)	
Primary surgery alone	69
Primary surgery and PORT	56
Primary surgery and post-op CRT	35
Primary RT alone	64
Primary CRT	313

†Percentages may not add to 100 due to rounding.

‡AJCC 7th ed.

**Table 2.** Quality indicators

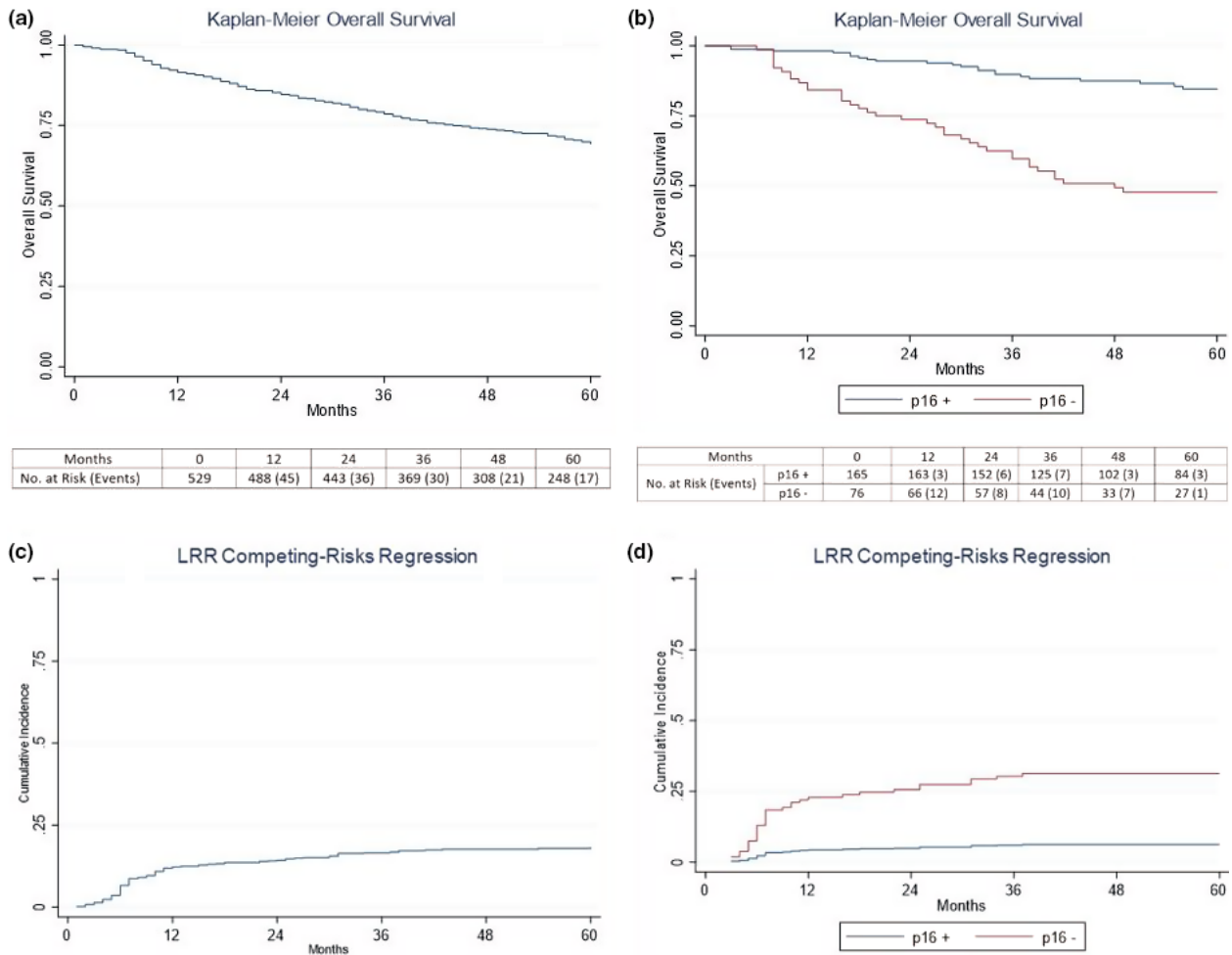
	Number with indicator/number eligible (%)
Diagnosis and staging indicators	
Pathological diagnosis <sup>a</sup>	537/537 (100%)
Staging <sup>a</sup>	536/537 (99.8%)
MDT <sup>a</sup>	534/537 (99.4%)
Appropriate imaging <sup>a</sup>	520/537 (96.8%)
Smoking cessation support <sup>b</sup>	159/240 (66.3%)
Dental assessment <sup>c</sup>	467/473 (98.7%)
Nutritional assessment <sup>a</sup>	520/537 (96.8%)
Speech pathology assessment <sup>a</sup>	522/537 (97.2%)
Treatment indicators	
Appropriate RT <sup>d</sup>	461/478 (96.4%)
Appropriate IMRT <sup>e</sup>	413/478 (86.4%)
Appropriate surgery <sup>f</sup>	162/162 (100%)
Appropriate chemotherapy <sup>g</sup>	310/318 (97.5%)
Surgical margins <sup>h</sup>	12/162 (7.4%)
Time to PORT ≤ 6 weeks <sup>i</sup>	31/93 (33.3%)
Appropriate CRT <sup>j</sup>	35/43 (81.4%)
30-day mortality <sup>a</sup>	8/537 (1.5%)
Post-treatment indicators	
Follow up – first year <sup>k</sup>	519/525 (98.8%)
Follow up – second year <sup>k</sup>	474/483 (98%)
Follow up – years 3 – 5 <sup>k</sup>	410/427 (96%)
Imaging <sup>l</sup>	354/365 (96.9%)
Annual TSH <sup>m</sup>	120/419 (28.6%)
Dental assessment <sup>n</sup>	206/383 (53.7%)

Denominator includes eligible patients.

<sup>a</sup>All patients.<sup>b</sup>Smokers only.<sup>c</sup>Excludes larynx T1/T2, edentulous.<sup>d</sup>All RT patients, excludes those suitable for primary surgery only.<sup>e</sup>All RT patients, includes unilateral neck.<sup>f</sup>Primary surgery, excludes primary RT only.<sup>g</sup>Includes advanced stage only.<sup>h</sup>Primary surgery only.<sup>i</sup>Surgical patients requiring postoperative RT.<sup>j</sup>Includes all post-operative patients with extranodal extension +/- positive resection margins.<sup>k</sup>Patients alive/available for follow up.<sup>l</sup>Post primary RT PET/CT imaging only.<sup>m</sup>Patients who received neck irradiation.<sup>n</sup>Received RT and not edentulous.

## Outcomes

As demonstrated in Figure 2, the 5-year OS was 69.4% (CI; 64.9–73.2%) for those included in outcome analysis (n = 529). OPSCC alone comprised 46% of the cohort (of which 68.5% were p16 positive) and 5-year OS of this subset was 72.6% (CI; 66.1–78.1%). Patients with oropharyngeal SCC demonstrated a 5-year OS of 85% (CI; 77.4–90%) for p16 positive patients (n = 165) and 48% (CI; 35.8–58.8%) for p16 negative patients (n = 76). Cumulative incidence of locoregional relapse for the



**Fig. 2.** (a) Kaplan–Meier OS for whole cohort; (b) Kaplan–Meier OS for p16+ and p16– OPSCC; (c) Locoregional relapse competing risks regression for whole cohort; (d) Locoregional relapse competing risks regression for p16+ and p16– OPSCC.

study cohort at 5 years was 18% (CI; 14.8–21.4%). This subset of patients with oropharyngeal SCC demonstrated a 5-year cumulative incidence of locoregional recurrence of 6.2% (CI; 3.2–10.7%) for p16 positive patients ( $n = 165$ ) and 31.8% (CI; 21.7–42.4%) for p16 negative patients ( $n = 76$ ).

## Discussion

The majority of QIs in the study demonstrated high rates of compliance with the exception of smoking cessation support, time to PORT and post treatment dental review. Five-year OS (69.4%) is comparable to published literature. With almost a third of the patients having p16 positive oropharyngeal cancer, the locoregional recurrence rate of 18% at 5 years is not unexpected. Most p16 positive OPSCC patients classified as advanced stage in this study (163/165) by AJCC 7th ed. would now be reclassified as early stage by AJCC 8th ed. All patients with OPSCC at TUH are now routinely evaluated for p16

status though this was not the case in the early part of the study period.

The high compliance with pre-treatment indicators pertaining to pathological diagnosis, staging and pre-treatment assessments (including allied health assessment) can largely be explained by the HN MDT processes at TUH. The MDT meeting is held weekly where patient details along with relevant pathology and imaging investigations are available. The MDT involves clinical review and is regularly attended by all relevant health professionals including dedicated allied health personnel for appropriate patient assessments (Appendix 2). Centres that establish a comprehensive MDT such as this would be able to achieve similar level of pre-treatment assessments.

Taberna *et al.*<sup>21</sup> provided a comprehensive review of the composition of a HN MDT and respective contributions of the key disciplines during diagnosis, treatment and follow up. MDTs remain the corner stone of cancer care in order to ensure risk-adjusted evidence-based

care plans are made.<sup>22,23</sup> The National HN cancer Audit (HANA) conducted by the Healthcare Quality Improvement Partnership (HQIP) in England and Wales in 2014 has shown that MDTs form part of care at several institutions in England and Wales (97%).<sup>19</sup> Similarly, the Scottish Task Force reported 96.5% of patients being discussed at an MDT in 2018.<sup>11</sup> However, pre-treatment speech and swallow assessment occurred in only 28.8%, dental assessments in 35.2%, and dietetics assessment in 52.5% of patients, with a wide variation between networks in England and Wales. Across Scotland, 58% of patients undergoing curative intent treatment were seen by the speech and language therapist and 79.9% by a dietician with a wide variation across Health Boards. The Dutch HN Audit showed high rates (>90%) of adherence to MDTs across 14 hospitals in Netherlands but variable access for malnutrition screening (2–100%) irrespective of hospital volume.<sup>24</sup> Several challenges remain in pre-treatment dietary, speech, swallow and dental assessments as MDTs nationally and internationally have variable access to allied health services. Appropriate pre-treatment allied health assessment play crucial role in optimal patient outcomes and is an important quality metric.<sup>21,25</sup>

Smoking cessation support is essential to assist smokers to quit. The negative impact of smoking on disease control, survival and toxicities is well established<sup>26</sup> and there are published guidelines supporting smoking cessation programs for cancer patients.<sup>27,28</sup> Several studies have shown that there is wide variation in provision of smoking cessation support prior to treatment (NHS England 2015—12%,<sup>19</sup> NHS Scotland 2016—11.6%<sup>10</sup>). Pre-treatment smoking cessation support was suboptimal in our study at 66% during the entire study period. However, it showed improvement over time (33% between 2011 and 2015). The type of support improved from brief advice by the treating medical practitioner to a more comprehensive support in 2016 when the nurses took an initiative to oversee smoking cessation support with introduction of pharmacotherapy, conducting carbon monoxide breath testing and organising appropriate referrals to the national helpline (Quitline) and/or the general practitioner. A more formal approach by the MDT and funding of a tobacco specialist by the organisation, however, is required to make this consistent and sustainable. There is also a need to determine the optimal method of delivering support. A mixed methods study by Smith *et al.* concluded that cessation programs are best delivered by a dedicated in-hospital support person offering regular education specific to cancer patients, to identify individual barriers to cessation, address comorbid risk factors such as alcohol, depression and marijuana use, and facilitate appropriate referrals (Quitline, general practitioner) for behavioural and pharmacotherapy. The study demonstrated that smoking cessation among HNC patients is complex and while most patients are able to achieve cessation at some

stage, several relapse following treatment.<sup>29</sup> Cessation support should remain a quality metric across services involved in HNC.

QI pertaining to primary treatment demonstrated high rates of compliance with surgery and RT. Despite IMRT starting only in 2011 at TUH, there was rapid uptake over time including in the treatment of unilateral primary and neck. While the evidence for IMRT in bilateral neck to spare salivary gland function is strong, there is rationale to use IMRT in unilateral primary and neck to spare normal tissue such as mandible, oral cavity and pharynx and in early larynx for carotid sparing. Therefore, QI for IMRT included all patients who received RT acknowledging that unilateral neck and early larynx may also be appropriately treated with 3D CRT.

Despite evidence demonstrating the negative impact of delay in starting PORT<sup>30</sup> this metric remains low across a number of studies. A national audit in 2014 reported median time to PORT of 50 days across England and Wales.<sup>19</sup> In a study by Graboyes *et al.*,<sup>31</sup> 44.7% received PORT within 6 weeks and was associated with decreased OS. Cramer *et al.*<sup>1</sup> reported 44% compliance and another study showed that 39% received PORT within 6 weeks.<sup>30</sup> In our study, only a third received PORT within 6 weeks.

Studies have reported 30- and 90-day mortality rates in HNCs as an indicator of avoidable treatment-related harm in radical treatments. Our study demonstrated 30-day mortality of 1.5% across the entire study cohort and compares well with published reports. The Scottish Cancer Taskforce reported 30 and 90-day mortality below 1.5% and 4% respectively.<sup>11</sup> Similarly, 30 and 90-day mortality of 1.7% and 2.7% with surgery and 2.3% and 5.2% with RT and chemoRT was reported by the HQIP.<sup>19</sup>

Follow up is recommended for early detection and management of recurrences, second cancers, and treatment-related toxicities. However, there is variability in how patients undergo surveillance due to paucity of evidence. Therefore, metrics related to risk adjusted follow up rather than standard frequency of follow up visits maybe more appropriate to capture imaging surveillance for second cancers (such as low dose CT chest for those with smoking history), functional outcomes, and treatment related morbidity.<sup>32,33</sup>

Dental assessment and care are essential for HNC patients to prevent potential complication from treatment.<sup>25</sup> In our study, high proportion of patients were reviewed and managed prior to start of treatment. This high compliance was due to the regular attendance of a dentist at the multidisciplinary clinic and screening patients for appropriate dental management. However, post treatment dental review occurred externally thus was difficult to establish compliance with this QI. It should be noted that access to dental care across institutions remains variable in Australia with most patients having to seek dental care privately. There is an urgency to provide public funding to improve access to dental

care for HNC patients as life-long dental care to prevent or manage treatment related complications is essential for these patients.

While QIs have been studied in HN cancers,<sup>9–11,13,34</sup> there is a need for consensus on a generalisable set of indicators. New Zealand has released a draft set of 14 indicators that may be applicable to Australia and more widely. In addition to some previously studied QI, the proposed indicators include timeliness of treatment, patient reported outcomes, morbidity of treatment, and review of RT contouring for curative RT.<sup>34</sup>

Given the geography and population distribution of Australia, careful planning to ensure access to high quality treatment is required. Trama *et al.*<sup>6</sup> recommended that HNC patients be referred to specialised centres or to networks that include specialised centres. While no cut-off has been established for professional or facility case volume, studies have demonstrated better outcomes when patients are treated at high volume centres.<sup>15,35–39</sup> However, a study by Strober *et al.*<sup>40</sup> found that there was wide variation in quality metrics across hospitals in the US irrespective of volume. A review by McDowell and Corry<sup>41</sup> has demonstrated that even in high volume centres, major plan changes are not infrequent and recommend peer review of RT plans in routine clinical practice. This shows that volume alone is not sufficient to achieve high quality of care, and strict quality assurance at all stages of patient journey is essential for any service that treats HNC. While peer review in the form of random audit and second RO contour/plan review have now been incorporated into routine practice at TUH, this evolved over time and was not the case during the early part of the study.

This study demonstrates that as a regional tertiary hospital, TUH had a high rate of compliance with most QIs assessed. This has been largely facilitated by an effective multidisciplinary team and collaboration with tertiary centres for complex surgeries. While the survival outcomes are comparable to published literature, the favourable locoregional control rates are likely due to the large proportion of patients with p16 positive OPSCC.

Our study has helped identify several areas for improvement. Delay in initiating PORT is a major area for improvement and there is a study underway to identify barriers and explore strategies to ensure timely PORT. Smoking cessation support, which has already shown improvement, is under further evaluation. A prospective study is underway to monitor cessation rates. The results will help formulate an optimal smoking cessation strategy for our HNC patients and advocate for resources required to establish a sustainable program.

## Limitations

This was a retrospective study conducted at a single centre with potential bias in collecting, verifying and

interpreting data. There was also missing data especially relating to post treatment QIs. Prospective collection of QIs with appropriate systems in place (e.g. OIMS/RedCap) may overcome these challenges and ensure data quality. Additionally, retrospective data collection was onerous and extended over a length of time, during which time guidelines may have changed. However, when NCCN guidelines of 2016 and 2019 were reviewed, there was little impact on appropriateness of treatments apart from change in AJCC staging system in 2018. Re-staging of patients with new staging system was not undertaken for ease of interpretation of outcome data. There was also evolution of QIs during the study period that were not evaluated in this study. This study did not assess quality of care for palliative patients, those with recurrent cancers and other histological diagnoses. Quality measures such as timeliness of treatment, toxicities and clinical trials participation were also not evaluated in this study. These are meaningful indicators and should be considered for national benchmarking. Access to clinical trials is integral to high quality care. While this quality metric was not assessed in our study, health professionals involved in the HNMDT actively participate in translational research and national and international collaborative clinical trials. Potential trial patients are flagged at the MDT and screened by the clinical trials unit.

In conclusion, collecting and evaluating quality metrics is feasible and helps identify areas for improvement. Centres treating HNC patients should strive towards monitoring quality of care against benchmarks and demonstrate transparency in outcome data. Systems should be implemented to enable prospective collection and sharing of QI and outcome data. There is a need to develop consensus-based QIs and reporting mechanisms at the national level.

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## Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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## Appendix 1

### Study quality indicators based on evaluated quality indicators

Study quality indicators	NCCN guidelines	AHNS quality indicators	Scottish Task Force v1 – quality indicators
<b>Diagnosis and staging indicators</b>			
Pathological diagnosis (biopsy)†	+	+	+
Staging documentation†	+	+	+
MDT†	+	+	+
Appropriate imaging†	+	+‡	+‡
Smoking cessation support/counselling†	+	+	+
Dental assessment†	+		+
Nutritional assessment†	+		+
Speech pathology assessment†	+		+
<b>Treatment indicators</b>			
Appropriate RT§	+		
Appropriate IMRT†			+
Appropriate surgery§	+		
Appropriate chemotherapy§	+		
Surgical margins†			+
Time to PORT ≤ 6 weeks†	+		+
Appropriate CRT†	+¶	+¶	+
30-day mortality†			+
<b>Post-treatment indicators</b>			
Follow up – 1 <sup>st</sup> year†	+	††	+
Follow up – 2 <sup>nd</sup> year†	+	††	+
Follow up – years 3 – 5†	+	††	+
Imaging†	+‡‡		+
Annual TSH†	+	+§§	+
Dental assessment§,‡‡	+		

NCCN (National Cancer Centre Network) Guidelines<sup>10</sup> – Provides guidelines for management of head and neck cancer.

AHNS (American Head and Neck Society) quality indicators<sup>13</sup> – First introduction to quality measures in head and neck cancers (oral cavity) in 2009.

Scottish Task Force v1 – First set of quality performance indicators developed and evaluated in 2016 in Scotland.

†Nationally benchmarked.

‡Imaging of primary, neck and chest.

§Evaluated against guidelines.

¶Referral only.

††Frequency not stated, regular follow up.

‡‡Surveillance for lung metastasis not assessed.

§§Required only at/before 12 months.

## Appendix 2

### Composition of head and neck multidisciplinary team at Townsville University Hospital

Attendees – core members	Frequency
Radiation oncologists	Regular
ENT/Head and neck surgeons	Regular
Maxillofacial surgeon	Regular
Medical oncologist	Regular till 2018
Dietician	Regular
Speech pathologist	Regular
Dentist	Regular
Physiotherapist	Regular
Social worker	Regular
Psychologist	Regular
Cancer care coordinator (nurse)	Regular, also oversee smoking cessation
Indigenous Liaison officer	As required
Oncology nurse	Regular
Additional attendees	Frequency
Radiation oncology trainees	Regular
Surgical trainees	Regular
Dental trainee/student	Often
Medical students	Infrequent
Junior doctors	Infrequent