

# Variation in routine follow-up care after curative treatment for head-and-neck cancer: a population-based study in Ontario

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## ABSTRACT

**Background** The actual practices of routine follow-up after curative treatment for head-and-neck cancer are unknown, and existing guidelines are not evidence-based.

**Methods** This retrospective population-based study used administrative data to describe 5 years of routine follow-up care in 3975 head-and-neck cancer patients diagnosed between 2007 and 2012 in Ontario.

**Results** The mean number of visits per year declined during the follow-up period (from 7.8 to 1.9,  $p < 0.001$ ). The proportion of patients receiving visits in concordance with guidelines ranged from 80% to 45% depending on the follow-up year. In at least 50% of patients, 1 head, neck, or chest imaging test was performed in the first follow-up year; that proportion subsequently declined ( $p < 0.001$ ). Factors associated with follow-up practices included comorbidity, tumour site, treatment, geographic region, and physician specialty ( $p < 0.05$ ).

**Conclusions** Given current practice variation and the absence of an evidence-based standard, the challenge in identifying a single optimal follow-up strategy might be better addressed with a harmonized approach to providing individualized follow-up care.

**Key Words** Head-and-neck cancer, routine follow-up, practice variation, imaging

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## INTRODUCTION

The population of cancer survivors is growing because of an increasing incidence of cancer in an aging population and progress in medical therapies<sup>1</sup>. Providing optimal follow-up care to cancer survivors has subsequently become a prominent research area. Much of the existing literature has focused on the high-incidence cancers of breast<sup>2</sup>, prostate<sup>3</sup>, and colon<sup>4</sup>. Evidence about the characteristics of effective follow-up care for patients with less-common malignancies such as head-and-neck cancer is lacking<sup>5</sup>.

Research into follow-up strategies for head-and-neck cancer has not shown an advantage in overall survival with routine cancer surveillance for timely detection of recurrence<sup>5–10</sup>, and no randomized clinical trials have compared follow-up strategies with no follow-up<sup>11</sup>. The literature pertaining to how follow-up care can most effectively manage morbidity and address other health

needs in head-and-neck cancer patients is limited<sup>12,13</sup>. Consequently, guidelines—from the British Association of Head and Neck Oncologists<sup>14</sup>, the American Head and Neck Society<sup>15</sup>, the U.S. National Comprehensive Cancer Network (NCCN)<sup>16</sup>, the American Cancer Society<sup>17</sup>, Cancer Care Ontario<sup>18</sup>, and the BC Cancer Agency<sup>19</sup>—are based on consensus only and vary with the organization (Tables 1 and 11). Without evidence to support an optimal follow-up schedule, widespread variation in practice has been reported by physicians<sup>20</sup>, and guidelines are likely not informing improvements in patient outcomes or assisting in the allocation of health care resources.

Population-based studies have depicted real-world practices<sup>21</sup> and examined follow-up care for many cancer sites<sup>22–25</sup>. The objectives of the present study were to describe the follow-up care delivered to head-and-neck cancer patients, to compare practices with guideline recommendations, and to assess patient, disease, and system factors associated with the follow-up care delivered.

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**TABLE I** Guideline recommendations for routine follow-up visits in head-and-neck cancer

Organization	Recommendation for ...									
	Year 1		Year 2		Year 3		Year 4		Year 5	
	Frequency (months)	Total visits (n)	Frequency (months)	Total visits (n)	Frequency (months)	Total visits (n)	Frequency (months)	Total visits (n)	Frequency (months)	Total visits (n)
AHNS, 1996 <sup>15,a</sup>	1–3	4–12	2–4	3–6	4–6	2–4	4–6	2–3	4–6	2–3
BAHNO, 2001 <sup>14</sup>	1–1.5	9–12	1–1.5	9–12	3	4	6	4	6	2
BC Cancer Agency, 2003 <sup>19</sup>	1–2	6–12	1–2	6–12	3	4	—	—	—	—
Cancer Care Ontario, 2009 <sup>18</sup>	3	4	4	3	6	2	—	—	—	—
NCCN, 2015 <sup>16</sup> , and ACS, 2016 <sup>17</sup>	1–3	4–12	2–6	2–6	4–8	1.5–3	4–8	1.5–3	4–8	1.5–3

<sup>a</sup> Recently removed the guidelines from its Web resources and endorsed the NCCN guideline. AHNS = American Head and Neck Society; BAHNO = British Association of Head and Neck Oncologists; NCCN = U.S. National Comprehensive Cancer Network; ACS = American Cancer Society.

**TABLE II** Guideline recommendations for imaging of head, neck, and chest during follow-up care in head-and-neck cancer

Organization	Imaging recommendation for ...	
	Head and neck	Chest
AHNS, 1996 <sup>15,a</sup>	6 and 6–12 weeks after treatment, and as indicated thereafter	Annually
BAHNO, 2001 <sup>14</sup>	Symptom-directed only	Annually
BC Cancer Agency, 2003 <sup>19</sup>	6 Weeks after treatment, CT in patients with nodal disease	Not mentioned
Cancer Care Ontario, 2009 <sup>18</sup>	Symptom-directed only	Not mentioned
NCCN, 2015 <sup>16</sup> , and ACS, 2016 <sup>17</sup>	Post-treatment imaging based on T and N staging; routine imaging warranted for some asymptomatic patients	Annual CT in patients with a history of smoking

<sup>a</sup> Recently removed the guidelines from its Web resources and endorsed the NCCN guideline. AHNS = American Head and Neck Society; BAHNO = British Association of Head and Neck Oncologists; CT = computed tomography; NCCN = U.S. National Comprehensive Cancer Network; ACS = American Cancer Society.

## METHODS

### Study Design and Population

This population-based study used administrative health care data to describe follow-up care for head-and-neck cancer patients in the province of Ontario. The study population included patients 35–75 years of age who were diagnosed with squamous cell carcinoma of the head and neck (oral cavity, oropharynx, nasopharynx, hypopharynx, larynx) during 2007–2012, who were treated with curative intent, and who were well enough to be receiving routine follow-up. Patients were excluded if they had received a prior diagnosis of head-and-neck cancer, if they had died before completing curative treatment, or if they had received palliative treatment. Patients with incomplete treatment records were excluded because of uncertainty about treatment intent.

The follow-up period was defined as beginning on the end-of-treatment date and continuing for 5 years unless censored earlier. Patients were censored within each year of follow-up if they had died, experienced a recurrence (receipt of additional treatment), developed a second primary, moved out of the province (becoming ineligible for provincial health insurance), or if the study end date (31 December 2015) preceded completion of follow-up. Patients were censored at 90 days before a recurrence or

second primary diagnosis in case additional and non-routine visits or tests had been ordered. To allow for differentiation between residual disease and recurrence, “end of treatment” was defined as the passage of at least 120 days with no further treatment.

### Data Sources and Linkage

The Ontario Cancer Registry is a population-based cancer registry that houses diagnostic information and patient demographics for at least 98% of all incident cancer cases in Ontario<sup>26</sup>. Additional demographic data were captured from the Registered Persons Database. Hospitalization records in databases held by the Canadian Institute for Health Information were used to obtain information about surgical procedures. Radiation and chemotherapy treatment details were obtained from physician billing records in the OHIP (Ontario Health Insurance Plan) database and in treatment records from the 8 regional cancer centres across Ontario where all patients with head-and-neck diagnoses are treated. The Ontario Registrar General provides vital status on all residents, and Statistics Canada supplies information about neighborhood incomes based on census data. Data linkages were performed using unique encoded identifiers, and data analyses were conducted at the Institute for Clinical Evaluative Sciences.

## Measures and Outcomes

“Physician visits” were defined as outpatient appointments with surgical, radiation, and medical oncologists. Physician type was determined by the fee codes in OHIP billing records. The numbers of follow-up visits were classified as “fewer than recommended,” “recommended,” and “more than recommended” based on recent guidelines published by the NCCN<sup>16</sup>. Canada-specific guidelines were not used because reported Canadian practices<sup>20</sup> were more comparable with the NCCN guidelines and more intensive than those recommended in the Cancer Care Ontario guidelines. The Cancer Care Ontario guidelines (published in 2009)<sup>18</sup> are based on consensus and are adapted from a clinical practice guideline published in 2006 by the Scottish Intercollegiate Guidelines Network<sup>27</sup>. The number of follow-up visits recommended are 4–12 in year 1, 2–6 in year 2, 2–3 in years 3 and 4, and 1–3 in year 5.

Nasopharyngoscopies and imaging tests were identified using OHIP fee codes. Head-and-neck imaging tests included radiography (facial bones, nose, mandible, sinuses, mastoids, neck), computed tomography (CT) of the head and neck, magnetic resonance imaging of head and neck, and neck ultrasonography. Chest imaging tests included radiography, CT, and magnetic resonance imaging.

To allow for treatment groups that were homogenous and large enough for analysis, initial treatment was classified into surgery, radiotherapy, chemoradiotherapy, and surgery followed by radiotherapy or chemoradiotherapy. Treatment groups included patients who received salvage surgery for residual disease within 120 days of the initial treatment modality.

The Elixhauser method<sup>28</sup> with the Quan modification<sup>29</sup> was used to obtain a measure of the number of comorbidities for each patient. This method considers 31 disease categories excluding head-and-neck malignancy and creates a single comorbidity score based on an algorithm that uses the International Classification of Diseases (9th and 10th revisions) diagnosis codes that appear in the records of hospital admissions maintained by the Canadian Institute for Health Information.

Based on 2006 census data, patient postal codes were matched to neighborhood income quintiles as an indicator for socioeconomic status. “Rural” status was assigned if a patient resided in a community of less than 10,000 population.

Ontario is divided into 14 health care regions called Local Health Integration Networks (LHINS). The LHIN of treatment delivery was used to study geographic variation and institutional policies for follow-up care. Designated multidisciplinary clinics for head-and-neck cancer are located in 8 cancer centres found in 6 LHINS. Additional LHINS were included to account for treatment delivered to the occasional patient outside the designated centres.

## Statistical Analysis

Descriptive statistics are used to describe follow-up visits and imaging tests. Poisson and logistic regression were used to compare, respectively, counts and proportions of visits and tests by subgroup. Modified Poisson regression was used to identify factors associated with follow-up care frequencies falling below and above the recommended

frequencies. Imaging tests were investigated based on a dichotomous outcome: at least 1 imaging test performed. Generalized estimating equations accounted for the correlations within subjects in all regression models. Results were considered statistically significant at  $p < 0.05$ .

## RESULTS

### Study Population

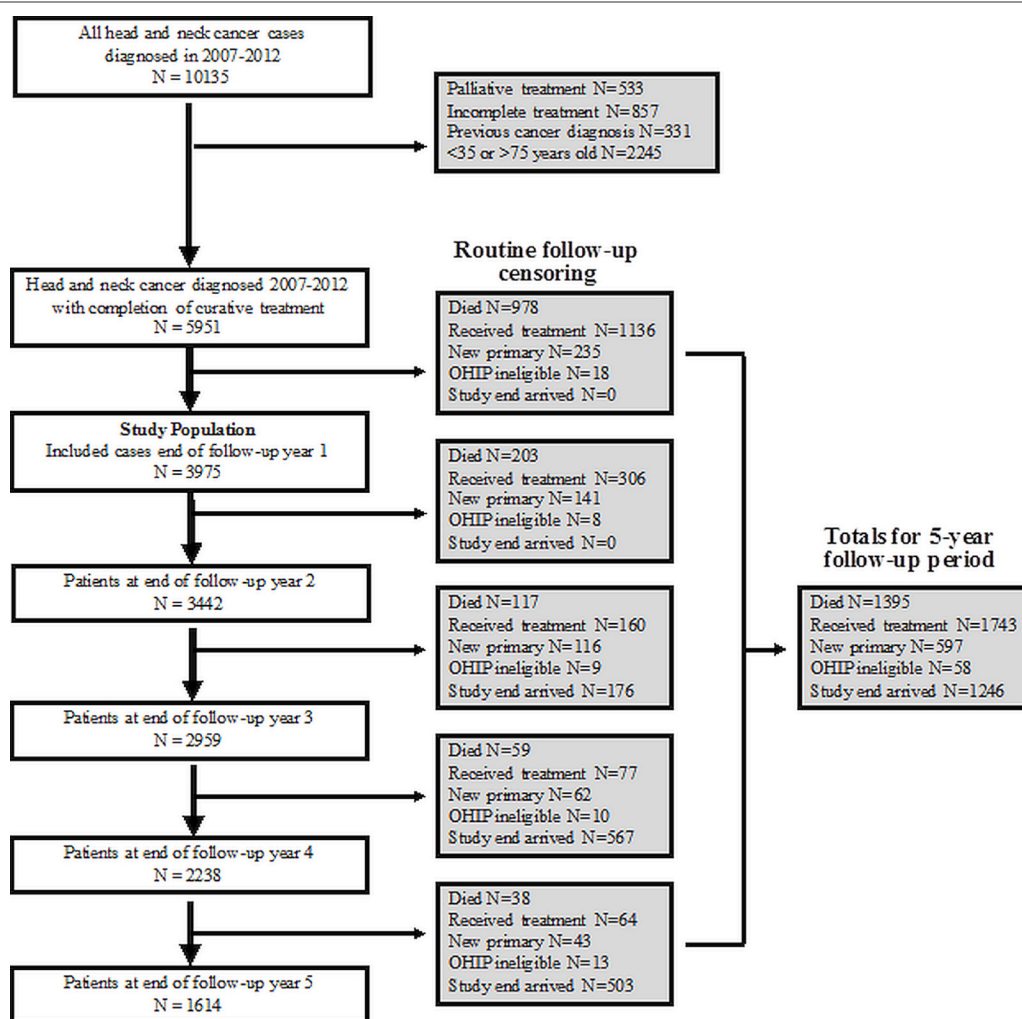
In Ontario from 2007 to 2012, 10,135 patients were diagnosed with head-and-neck cancer (Figure 1). Of the 5951 patients who received curative treatment, the 3-year mortality, recurrence, and new primary diagnosis rates were 22% ( $n = 1298$ ), 27% ( $n = 1602$ ), and 8% ( $n = 492$ ) respectively. The final study population included 3975 patients; Table III shows their characteristics. Mean age at diagnosis in this cohort was 59 years, with 75% being men, 29% having 1 or more comorbidities, and 44% having an oral cavity cancer.

### Physician Visits, Nasopharyngoscopies, and Imaging Tests

Tables IV and V show the mean numbers and proportions of patients having at least 1 physician visit, nasopharyngoscopy, and imaging test during follow-up. The mean number of visits to oncologists ranged from 8 (in follow-up year 1) to 2 (in follow-up year 5) and were most often made to surgeons and radiation oncologists. The proportion of patients having at least 1 visit declined to 79% in follow-up year 5 from 99% in follow-up year 1 ( $p < 0.001$ ). In follow-up year 1, 74% of patients underwent at least 1 nasopharyngoscopy; the proportion declined thereafter ( $p < 0.001$ ). Imaging of head and neck was performed primarily using CT or magnetic resonance imaging, with a mean of 2 imaging tests in follow-up year 1, declining to 0.4 imaging tests in follow-up year 5 ( $p < 0.001$ ). The proportion of patients undergoing at least 1 head-and-neck imaging test showed a downward trend to 19% in follow-up year 5 from 64% in follow-up year 1 ( $p < 0.001$ ). Imaging of chest was performed predominately by radiography, followed by CT. Patients underwent a mean of 1.4 chest imaging exams in follow-up year 1, with 56% of patients undergoing at least 1 such exam—a proportion that declined throughout the follow-up period ( $p < 0.001$ ).

### Visits and Tests by Site, Treatment, and Specialty

Tables VI and VII present patient visits and imaging tests throughout follow-up by tumour site, treatment group, and attending specialty. For all follow-up years, patients with nasopharyngeal cancers had the most intensive follow-up, including the greatest mean number of visits (10 in year 1 to 3 in year 5) and the highest proportions undergoing at least 1 head-and-neck imaging test (95% in year 1 to 54% in year 5). Patients with hypopharyngeal tumours underwent at least 1 chest imaging test in the highest proportion, ranging from 69% to 45% during follow-up. Early in the follow-up period, patients treated with concurrent chemoradiotherapy had a higher mean number of visits (9 in follow-up year 1). Patients treated with surgery alone had a lower mean number of follow-up visits (6 declining to 1) and underwent at least 1 imaging test in a lower proportion (53% declining to 29% for chest imaging, and 33% declining



**FIGURE 1** Identification of study population. OHIP = Ontario Health Insurance Program.

to 13% for head and neck imaging) in most follow-up years. The number of patients seen by each specialty changed as follow-up continued, with an increasing proportion of patients seeing a single specialty.

### Comparing Follow-Up Care with Guideline Recommendations

More than 70% of patients received follow-up visits within the recommended guidelines in follow-up years 1 and 2, and at least 40% of patients received the guideline-recommended visits in years 3–5 (Figure 2). Almost 60% of patients received imaging of the chest, head, and neck in year 1 of follow-up, a proportion that steadily declined in each subsequent follow-up year.

### Factors Associated with Delivered Follow-Up Care

Factors that were found to be associated with receipt of fewer than the recommended follow-up visits included male sex, surgery as treatment, and lower income quintile ( $p < 0.05$ , Table VIII). Receiving more than the recommended follow-up visits was associated with tumours of the hypopharynx and nasopharynx, presence of 2 or more comorbidities, visits to multiple specialists, and later follow-up year ( $p < 0.05$ ).

Older age, the presence of comorbidities, female sex, and earlier follow-up years were associated with an increased likelihood of receiving imaging tests ( $p < 0.01$ ). Patients with laryngeal tumours were less likely to undergo head and neck imaging [relative risk (RR): 0.73; 95% confidence interval (CI): 0.68 to 0.79], and patients treated with concurrent chemoradiotherapy were more likely to undergo chest imaging (RR: 1.21; 95% CI: 1.09 to 1.33). Seeing multiple specialists for follow-up was associated with an increased likelihood of undergoing imaging (head and neck RR: 1.33; 95% CI: 1.26 to 1.41; chest RR: 1.14; 95% CI: 1.09 to 1.19). Significant regional variation by LHN was found for visits made and imaging tests performed ( $p < 0.001$ ).

### DISCUSSION

The objective of the present study was to establish a baseline of contemporary follow-up practices for head-and-neck cancer patients in Ontario. Follow-up care is regarded by physicians and patients alike as an indispensable component of cancer care for surveillance of disease and treatment of morbidity<sup>30</sup>. Substantial variation in follow-up care was found, and practices did not consistently

**TABLE III** Characteristics of 3975 head-and-neck cancer patients diagnosed in Ontario between 2007 and 2012 who were on routine follow-up after curative treatment

Characteristic	Value
<i>Patient-related</i>	
Sex [n (%)]	
Men	2984 (75.1)
Women	991 (24.9)
Mean age (years)	59.2±8.9
Age group [n (%)]	
<40 Years	68 (1.7)
40–49 Years	537 (13.5)
50–59 Years	1386 (34.9)
60–69 Years	1387 (34.9)
≥70 Years	597 (15.0)
Income quintile [n (%)]	
1 (low)	827 (20.8)
2	801 (20.2)
3	761 (19.1)
4	837 (21.1)
5 (high)	732 (18.4)
Unknown	17 (0.4)
Elixhauser comorbidity index [n (%)]	
0	2830 (71.2)
1	661 (16.6)
≥2	484 (12.2)
Residential location <sup>a</sup> [n (%)]	
Urban	3343 (84.1)
Rural	630–635 (15.8–16.0)
<i>Disease-related</i>	
Tumour site [n (%)]	
Oral cavity	1754 (44.1)
Oropharynx	830 (20.9)
Nasopharynx	186 (4.7)
Hypopharynx	129 (3.2)
Larynx	987 (24.8)
Other or unspecified	89 (2.2)
Treatment [n (%)]	
Surgery alone	956 (24.1)
RT alone	684 (17.2)
CTx alone	1153 (29.0)
Surgery, then RT or CTx	1149 (28.9)
Other	33 (0.8)
<i>Health system-related</i>	
LHIN <sup>b</sup> [n (%)]	
A	563 (14.2)
B	113 (2.8)
C	539 (13.6)
D	1773 (44.6)
E	52 (1.3)
F	136 (3.4)
G	387 (9.7)
H	218 (5.5)
Surgery alone (any other LHIN)	119 (3.0)
Unknown	75 (1.9)

<sup>a</sup> Data were unavailable for subgroups of less than 6 patients.  
<sup>b</sup> Where patients received RT or surgery, or both. These LHINs are the only ones where RT for head-and-neck cancer is available.  
 RT = radiation therapy; CTx = chemotherapy; LHIN = Local Health Integration Network.

align with NCCN guidelines. Evidence-based medicine was established to reduce unwarranted practice variation, to promote favourable patient outcomes, and to minimize unnecessary costs<sup>31</sup>. Thus, practice variation can raise concerns about effectiveness, quality, and access to care<sup>32</sup>. In the absence of evidence about survival outcomes on which to base head-and-neck cancer follow-up care, it is no surprise that variation ensues and was confirmed here in a Canadian setting.

Factors associated with delivered follow-up care can provide some rationale for the observed practice variations. In comparing the present study with the report by Eskander *et al.*<sup>33</sup> about physician visits and imaging tests in year 1 of follow-up, the results are similar. Marked variation in practices was found, including by disease-related factors such as tumour site and by geographic region. Geographic variation is likely attributable to entrenched institutional policies, availability of health services, and differences in the presenting case mix<sup>34</sup>. Reasons for deviations by site might include variations in the rates of recurrence and of new primaries based on tumour site<sup>9,35–37</sup> and varying accessibility for physical examinations<sup>38</sup>. Multiple treatment modalities were associated with a greater likelihood of receiving at least the recommended number of follow-up visits and 1 or more imaging tests. In the absence of tumour stage, multiple treatments are serving as a proxy for increased severity of disease. Schwartz *et al.*<sup>7</sup> demonstrated that advanced stage, higher nodal status, and high-risk pathologic features are associated with more intensive follow-up care. Patients also received more visits and tests when additional physicians were involved in their care. Although some differences might be attributed to treatment sequelae or extent of disease, different values might also be placed on certain aspects of follow-up by individual physicians and specialties<sup>39</sup>.

As has been seen for other cancer sites<sup>22,23,25</sup> and guideline recommendations for follow-up care<sup>14–16,18,19,27,40</sup>, the intensity of follow-up was found to decline over time. Most relapses of head-and-neck cancer occur during the first 3 years, with 80% occurring within 2 years of treatment completion and 95% within 3 years<sup>41</sup>, which supports the observed declining intensity trend. In a U.K. study<sup>37</sup>, data collected locally during a 10-year follow-up period were used to study time to first recurrence and to a new primary. The authors found that, of first cancer events, 95% occurred within the first 3 years for oropharyngeal and hypopharyngeal cancers and within 4.7 years for laryngeal cancer. Those observations prompted a reduction in the duration of follow-up care offered at a U.K. centre, with different regimens for each tumour site.

Follow-up care for head-and-neck cancer patients in the present study did not resemble any single recommended schedule of follow-up visits or imaging tests. Being non-evidence-based, consensus-driven, and designed elsewhere for a different health care culture, the existing guidelines are merely suggestions for physicians practicing in Canada; they have not been shown to maximize patient outcomes or to reflect the Canadian context in terms of the availability of health care resources. Furthermore, a “one size fits all” approach is not ideal to effectively provide follow-up care to the entire population of head-and-neck

**TABLE IV** Number and distribution of physician visits by specialty and follow-up year

Physician specialty <sup>a</sup>	Year 1 (3975 pts)		Year 2 (3442 pts)		Year 3 (2959 pts)		Year 4 (2238 pts)		Year 5 (1614 pts)	
	Mean visits (n) <sup>b</sup>	At least 1 visit (%) <sup>b</sup>	Mean visits (n) <sup>b</sup>	At least 1 visit (%) <sup>b</sup>	Mean visits (n) <sup>b</sup>	At least 1 visit (%) <sup>b</sup>	Mean visits (n) <sup>b</sup>	At least 1 visit (%) <sup>b</sup>	Mean visits (n) <sup>b</sup>	At least 1 visit (%) <sup>b</sup>
Oncology (any) <sup>c</sup>	7.8	99.4	4.2	93.5	3.0	89.2	2.3	84.5	1.9	79.0
Radiation oncology <sup>c</sup>	3.7	81.8	1.9	68.0	1.3	59.9	1.0	54.8	0.7	48.0
Surgical oncology <sup>c</sup>	3.5	83.1	2.1	70.7	1.6	65.4	1.3	59.0	1.1	55.5
Medical oncology <sup>c</sup>	0.5	25.6	0.1	6.7	0.1	4.8	0.1	4.6	0.0	3.2

<sup>a</sup> Multiple fee codes billed by the same physician on the same day were counted as 1 visit. Fee codes billed by different specialists on the same day were counted separately.

<sup>b</sup> Per patient per year for all patients.

<sup>c</sup>  $p < 0.0001$  for trend over follow-up period for numbers of visits.

Pts = patients.

**TABLE V** Number and distribution of nasopharyngoscopies and head-and-neck imaging tests by follow-up year

Test	Year 1 (3975 pts)		Year 2 (3442 pts)		Year 3 (2959 pts)		Year 4 (2238 pts)		Year 5 (1614 pts)	
	Mean images (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>	Mean images (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>	Mean images (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>	Mean images (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>	Mean images (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>
Nasopharyngoscopy <sup>b</sup>	2.62	73.96	1.74	66.41	1.29	60.63	1.00	55.94	0.82	51.55
Any imaging <sup>b</sup>	2.03	63.67	0.93	35.94	0.67	26.83	0.51	22.92	0.39	18.59
Neck ultrasonography <sup>b</sup>	0.07	5.38	0.05	4.33	0.04	3.55	0.05	4.42	0.04	3.66
Head and neck <sup>b</sup>										
Radiography	0.04	3.45	0.03	2.03	0.02	1.72	0.02	1.47	0.02	1.61
CT	1.01	50.64	0.40	24.58	0.30	17.91	0.22	14.75	0.15	10.78
MRI	0.91	19.35	0.45	11.24	0.30	7.57	0.22	6.66	0.18	5.27
Chest <sup>b</sup>										
Any imaging	1.45	56.08	0.86	45.26	0.71	41.06	0.67	39.01	0.66	32.96
Radiography	1.04	43.17	0.64	36.72	0.54	34.07	0.55	34.32	0.57	30.36
CT	0.40	26.26	0.20	15.17	0.16	12.61	0.12	9.47	0.09	6.88
MRI	0.00	0.20	0.01	0.32	0.01	0.30	0.01	0.27	0.00	NR

<sup>a</sup> Per patient per year for all patients.

<sup>b</sup>  $p < 0.001$  for trend over follow-up period for numbers of imaging tests.

Pts = patients; CT = computed tomography; MRI = magnetic resonance imaging; NR = not reportable because of small cell size.

cancer patients. In this heterogeneous patient population, malignancy affects a variety of anatomic locations and tissue types. Further contributors to the diversity of this patient population and their health needs in follow-up include the rising incidence of human papillomavirus-related oropharyngeal cancers in younger patients with fewer comorbidities and lifestyle risk factors, and diagnoses of cancers in older patients with more comorbidities and a history of smoking and alcohol consumption<sup>42</sup>.

The present work has several strengths. Our study is the first to evaluate routine follow-up care for head-and-neck cancer in Canada, and it is innovative in both its definition of follow-up (beginning at the end of treatment) and its selection of a study population without evidence of new cancer events. The use of administrative data and

a population-based design reflect real-world practices and, with the inclusion of multiple institutions, minimize selection biases<sup>21</sup>. However, the study's limitations also merit comment. Patient preferences, lifestyle factors, positron-emission tomography imaging, and laboratory tests for tumour markers are not collected in the administrative data sources and were therefore unavailable for study. Staging data in the Ontario Cancer Registry was in an early collection phase and was largely incomplete for head-and-neck cancer patients. With the stage being "unknown" for 76% of the study population (3025 of 3975 patients), an evaluation of the association between extent of disease and follow-up care could not be justified. Measurement error could have occurred if inaccurate dates of treatments, visits, or imaging tests were recorded, although

**TABLE VI** Mean number of oncology physician visits and distribution of imaging tests by tumour site, treatment, and follow-up year

Variable	Year 1 (3975 patients)				Year 2 (3442 patients)				Year 3 (2959 patients)				Year 4 (2238 patients)				Year 5 (1614 patients)			
	Pts [n (%)]	Mean visits (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>		Pts [n (%)]	Mean visits (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>		Pts [n (%)]	Mean visits (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>		Pts [n (%)]	Mean visits (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>		Pts [n (%)]	Mean visits (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>	
			Chest	HN			Chest	HN			Chest	HN			Chest	HN			Chest	HN
<i>Tumour site</i>																				
Oral cavity <sup>b,c</sup>	1754 (44.1)	7.2	55.9	57.2	1518 (44.1)	3.8	40.4	33.0	1298 (43.9)	2.7	37.1	23.8	977 (43.7)	2.2	36.8	21.2	707 (43.8)	1.8	30.1	15.0
Oropharynx <sup>b,c</sup>	830 (20.9)	8.7	58.7	84.2	753 (21.9)	4.4	49.7	45.6	655 (22.1)	3.1	45.2	33.3	488 (21.8)	2.4	38.5	27.7	352 (21.8)	2.0	34.7	23.0
Nasopharynx <sup>b,c</sup>	186 (4.7)	9.7	51.6	94.6	164 (4.8)	5.9	45.1	65.9	143 (4.8)	4.7	38.5	55.2	116 (5.2)	3.5	40.5	56.0	84 (5.2)	2.9	33.3	53.6
Hypopharynx <sup>b,c</sup>	129 (3.2)	9.6	69.0	81.4	96 (2.8)	4.7	59.4	44.8	77 (2.6)	3.5	59.7	37.7	51 (2.3)	2.6	45.1	23.5	33 (2.0)	2.2	45.5	18.2
Larynx <sup>b,c</sup>	987 (24.8)	7.5	52.2	49.0	842 (24.5)	4.2	47.4	24.8	729 (24.6)	2.9	42.1	19.1	568 (25.4)	2.3	42.6	15.3	416 (25.8)	1.8	36.1	14.7
Other or unspecified <sup>b,c</sup>	89 (2.2)	8.1	68.5	71.9	69 (2.0)	4.1	58.0	47.8	57 (1.9)	3.1	52.6	35.1	38 (1.7)	2.7	34.2	18.4	22 (1.4)	2.0	18.2	4.5
<i>Treatment</i>																				
Surgery alone <sup>b,c</sup>	956 (24.1)	5.8	53.2	33.2	815 (23.7)	3.0	33.9	19.5	722 (24.4)	2.1	31.2	14.4	546 (24.4)	1.6	31.1	14.5	396 (24.5)	1.3	28.5	12.9
RT alone <sup>b,c</sup>	684 (17.2)	8.2	55.4	71.5	582 (16.9)	4.5	46.2	39.9	489 (16.5)	3.3	44.0	31.9	385 (17.2)	2.5	37.7	27.8	263 (16.3)	1.8	34.2	23.2
CRT alone <sup>b,c</sup>	1153 (29.0)	9.0	62.8	87.0	1018 (29.6)	4.6	49.7	49.9	866 (29.3)	3.3	47.5	37.3	636 (28.4)	2.5	42.5	29.2	477 (29.6)	2.2	34.6	23.7
Surgery→RT or CRT <sup>b,c</sup>	1149 (28.9)	8.0	51.9	60.9	995 (28.9)	4.5	49.1	32.9	854 (28.9)	3.2	41.3	23.9	649 (29.0)	2.6	42.7	20.6	466 (28.9)	2.1	34.1	15.9
Other <sup>b,c</sup>	33 (0.8)	8.1	63.6	66.7	32 (0.9)	4.0	56.3	34.4	28 (0.9)	2.8	39.3	25.0	22 (1.0)	2.3	50.0	31.8	12 (0.7)	1.9	41.7	8.3

<sup>a</sup> Per patient per year for each tumour site or treatment group.

<sup>b</sup>  $p < 0.0001$  for trend during the follow-up period in numbers of visits and proportions of imaging tests.

<sup>c</sup>  $p < 0.0001$  for differences between subgroups in numbers of visits and proportions of imaging tests.

Pts = patients; HN = head or neck; RT = radiotherapy; CRT = chemoradiotherapy.

**TABLE VII** Oncology physician visits and distribution of imaging tests by oncology specialty and follow-up year

Oncology specialty	Year 1 (3975 patients)				Year 2 (3442 patients)				Year 3 (2959 patients)				Year 4 (2238 patients)				Year 5 (1614 patients)			
	Pts [n (%)]	Mean visits (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>		Pts [n (%)]	Mean visits (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>		Pts [n (%)]	Mean visits (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>		Pts [n (%)]	Mean visits (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>		Pts [n (%)]	Mean visits (n) <sup>a</sup>	At least 1 image (%) <sup>a</sup>	
			Chest	HN			Chest	HN			Chest	HN			Chest	HN			Chest	HN
Surgical only <sup>b,c</sup>	662 (16.7)	4.8	47.1	26.7	816 (23.7)	3.3	38.1	24.3	817 (27.6)	2.5	38.1	17.8	625 (27.9)	2.2	40.6	16.6	477 (29.6)	2.0	34.2	16.8
Radiation only <sup>b,c</sup>	414 (10.4)	4.7	41.1	58.2	705 (20.5)	2.9	44.7	34.2	633 (21.4)	2.2	41.6	27.0	516 (23.1)	1.8	39.2	24.2	348 (21.6)	1.5	36.5	17.2
Medical only <sup>b,c</sup>	7 (0.2)	2.9	71.4	71.4	25 (0.7)	3.0	40.0	28.0	29 (1.0)	2.0	41.4	27.6	27 (1.2)	1.9	55.6	29.6	16 (1.0)	1.5	31.3	25.0
Radiation and medical <sup>b,c</sup>	227 (5.7)	6.8	54.2	89.4	57 (1.7)	4.2	56.1	43.9	41 (1.4)	3.2	43.9	39.0	27 (1.2)	2.7	55.6	29.6	15 (0.9)	2.9	33.3	13.3
Radiation and surgical <sup>b,c</sup>	1856 (46.7)	8.4	58.5	64.9	1467 (42.6)	5.6	48.8	45.0	1046 (35.3)	4.5	45.7	36.5	647 (28.9)	4.0	41.7	33.2	399 (24.7)	3.6	34.8	28.8
Surgical and medical <sup>b,c</sup>	30 (0.8)	7.4	66.7	36.7	36 (1.0)	4.6	63.9	25.0	21 (0.7)	4.5	52.4	57.1	12 (0.5)	3.8	58.3	33.3	8 (0.5)	4.0	75.0	25.0
Radiation, medical, and surgical <sup>b,c</sup>	754 (19.0)	11.2	67.2	90.5	113 (3.3)	8.3	69.9	62.0	51 (1.7)	6.9	58.8	45.1	36 (1.6)	5.7	55.6	36.1	12 (0.7)	5.4	25.0	25.0
No oncologist <sup>b,c</sup>	25 (0.6)	0	28.0	32.0	223 (6.5)	0	32.3	12.1	321 (10.8)	0	28.7	11.5	348 (15.5)	0	25.9	10.3	339 (21.0)	0	24.8	10.0

<sup>a</sup> Per patient per year in each oncology specialty subgroup.

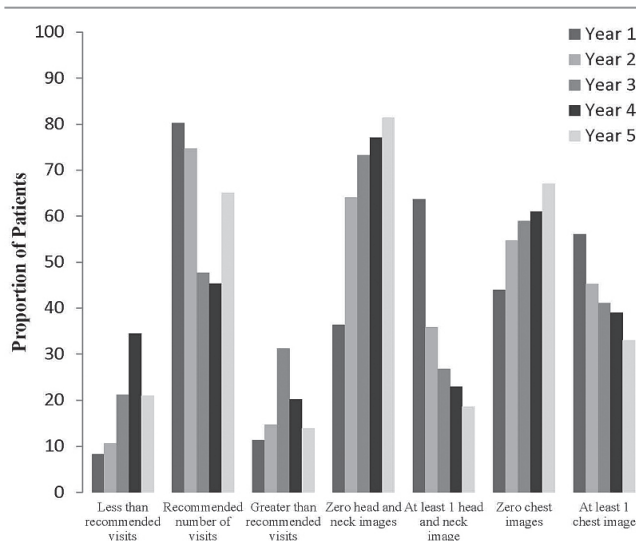
<sup>b</sup>  $p < 0.01$  for trend during the follow-up period for numbers of visits, and  $p < 0.0001$  for trend during the follow-up period for proportions of imaging tests.

<sup>c</sup>  $p < 0.0001$  for differences between subgroups in numbers of visits and proportions of imaging tests.

Pts = patients; HN = head or neck.



good agreement has previously been reported for follow-up care in administrative data and in medical record review<sup>43</sup>.



**FIGURE 2** Follow-up visits compared with recommended visits, and zero images compared with at least 1 head, neck, and chest image performed, by year of follow-up. Recommended visits were defined as 4–12 visits in follow-up year 1 (3975 patients), 2–6 visits in follow-up year 2 (3442 patients), 2–3 visits in follow-up years 3 (2959 patients) and 4 (2238 patients), and 1–3 visits in follow-up year 5 (1614 patients).

## CONCLUSIONS

In the present study, we found that most head-and-neck cancer patients are receiving some form of follow-up care in Ontario, that variation in terms of physician visits and imaging tests performed is evident, and that practices during the period of observation varied from guideline recommendations. In the absence of an evidence-based standard, a harmonized approach to providing individualized follow-up care that makes use of evidence about patient preferences, risk of recurrence, and time to recurrence might be a more feasible option than identifying a single effective approach to follow-up care for head-and-neck cancer patients. Research is needed and is currently underway to determine patient outcomes and perspectives in follow-up care.

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**TABLE VIII** Factors associated with follow-up visits that did not meet recommended guidelines and receipt of at least one imaging test

Factor	Multivariate analyses											
	Recommended follow-up visits						At least 1 imaging test					
	Fewer			More			Head and neck			Chest		
	RR	95% CI	p Value	RR	95% CI	p Value	RR	95% CI	p Value	RR	95% CI	p Value
<i>Patient-related</i>												
Age group			0.551			0.810			<0.001			0.001
<40 Years	Reference			Reference			Reference			Reference		
40–49 Years	0.88	0.74 to 1.04		0.81	0.62 to 1.06		0.99	0.84 to 1.18		1.00	0.81 to 1.25	
50–59 Years	0.89	0.75 to 1.05		0.82	0.64 to 1.06		0.97	0.82 to 1.15		1.10	0.89 to 1.35	
60–69 Years	0.86	0.72 to 1.01		0.80	0.62 to 1.04		0.88	0.75 to 1.05		1.17	0.95 to 1.44	
≥70 Years	0.88	0.74 to 1.06		0.82	0.62 to 1.07		0.85	0.72 to 1.02		1.15	0.93 to 1.42	
Sex			0.001			0.500			0.005			0.066
Men	Reference			Reference			Reference			Reference		
Women	0.89	0.83 to 0.96		1.01	0.93 to 1.10		1.08	1.02 to 1.13		1.04	0.99 to 1.10	
Income quintile			0.002			0.299			0.644			0.644
1 (low)	Reference			Reference			Reference			Reference		
2	0.98	0.90 to 1.07		0.95	0.85 to 1.06		0.99	0.93 to 1.06		0.98	0.91 to 1.04	
3	0.93	0.85 to 1.01		1.01	0.91 to 1.12		1.02	0.96 to 1.09		0.97	0.90 to 1.03	
4	0.85	0.78 to 0.93		0.93	0.84 to 1.04		0.99	0.92 to 1.06		0.92	0.86 to 0.99	
5 (high)	0.89	0.81 to 0.97		0.91	0.81 to 1.02		0.97	0.91 to 1.0a		0.94	0.88 to 1.01	
Residential location			0.363			0.975			0.464			0.503
Urban	Reference			Reference			Reference			Reference		
Rural	1.05	0.95 to 1.15		0.98	0.88 to 1.08		0.98	0.92 to 1.04		1.01	0.95 to 1.08	

TABLE VIII Continued

Factor	Multivariate analyses											
	Recommended follow-up visits						At least 1 imaging test					
	Fewer			More			Head and neck			Chest		
	RR	95% CI	p Value	RR	95% CI	p Value	RR	95% CI	p Value	RR	95% CI	p Value
<i>Patient-related continued</i>												
Elixhauser comorbidity index			0.284			0.027			0.007			<0.001
0	Reference			Reference			Reference			Reference		
1	1.04	0.95 to 1.13		1.01	0.91 to 1.13		1.09	1.03 to 1.15		1.17	1.10 to 1.24	
≥2	1.07	0.98 to 1.17		1.16	1.04 to 1.30		1.06	0.99 to 1.14		1.31	1.24 to 1.39	
<i>Disease-related</i>												
Tumour site			0.454			<0.001			<0.001			0.017
Oral cavity	Reference			Reference			Reference			Reference		
Oropharynx	0.99	0.91 to 1.09		1.05	0.95 to 1.16		1.02	0.96 to 1.07		1.02	0.95 to 1.08	
Nasopharynx	0.99	0.79 to 1.24		1.36	1.20 to 1.55		1.20	1.12 to 1.29		0.89	0.79 to 1.00	
Hypopharynx	0.96	0.74 to 1.24		1.41	1.16 to 1.71		1.05	0.95 to 1.17		1.16	1.04 to 1.30	
Larynx	1.07	0.99 to 1.16		1.10	0.98 to 1.23		0.73	0.68 to 0.79		1.01	0.95 to 1.08	
Treatment			0.008			0.148			<0.001			<0.001
Surgery alone	Reference			Reference			Reference			Reference		
RT alone	0.90	0.80 to 1.01		0.94	0.77 to 1.15		1.83	1.61 to 2.08		1.07	0.96 to 1.18	
CRT alone	0.81	0.73 to 0.91		1.05	0.87 to 1.27		2.09	1.85 to 2.37		1.21	1.09 to 1.33	
Surgery→RT or CRT	0.89	0.79 to 0.99		0.96	0.79 to 1.16		1.66	1.47 to 1.89		1.06	0.96 to 1.17	
Time from Dx date to treatment end			0.147			0.837			<0.001			0.877
<2 Months	Reference			Reference			Reference			Reference		
2–3 Months	1.10	1.00 to 1.20		1.00	0.84 to 1.19		0.95	0.84 to 1.08		0.99	0.91 to 1.08	
3–4 Months	1.12	1.01 to 1.25		1.04	0.87 to 1.26		1.04	0.92 to 1.18		0.98	0.89 to 1.08	
>4 Months	1.15	1.01 to 1.30		1.04	0.86 to 1.26		0.93	0.82 to 1.06		0.97	0.87 to 1.07	
Follow-up year			<0.001			<0.001			<0.001			<0.001
1	Reference			Reference			Reference			Reference		
2	0.53	0.47 to 0.60		1.71	1.55 to 1.89		0.62	0.59 to 0.65		0.85	0.82 to 0.89	
3	0.88	0.78 to 0.99		4.32	3.93 to 4.74		0.48	0.45 to 0.51		0.80	0.76 to 0.84	
4	1.19	1.05 to 1.33		3.22	2.88 to 3.61		0.43	0.40 to 0.46		0.77	0.72 to 0.82	
5	0.56	0.51 to 0.63		2.36	2.05 to 2.72		0.37	0.33 to 0.41		0.66	0.61 to 0.71	
<i>Health system-related</i>												
Oncology specialties seen during visit <sup>a</sup>			<0.001			<0.001			<0.001			<0.001
Single	Reference			Reference			Reference			Reference		
Multiple	0.06	0.04 to 0.08		4.94	4.40 to 5.56		1.33	1.26 to 1.41		1.14	1.09 to 1.19	
None	4.77	4.46 to 5.10		—			0.55	0.46 to 0.67		0.75	0.67 to 0.83	
LHIN			<0.001			<0.001			<0.001			<0.001
A	1.05	0.96 to 1.16		0.63	0.54 to 0.73		0.71	0.66 to 0.77		0.89	0.82 to 0.95	
B	1.14	0.98 to 1.33		0.52	0.39 to 0.70		0.90	0.78 to 1.05		0.71	0.60 to 0.85	
C	1.27	1.18 to 1.37		0.76	0.65 to 0.89		0.84	0.79 to 0.90		1.09	1.02 to 1.16	
D	Reference			Reference			Reference			Reference		
E	1.13	0.84 to 1.51		1.44	1.22 to 1.70		0.89	0.74 to 1.06		1.23	1.09 to 1.39	
F	0.70	0.54 to 0.91		1.00	0.79 to 1.27		0.97	0.88 to 1.06		0.94	0.83 to 1.07	

TABLE VIII Continued

Factor	Multivariate analyses											
	Recommended follow-up visits						At least 1 imaging test					
	Fewer			More			Head and neck			Chest		
	RR	95% CI	p Value	RR	95% CI	p Value	RR	95% CI	p Value	RR	95% CI	p Value
<i>Health system-related continued</i>												
LHIN continued			<0.001			<0.001			<0.001			<0.001
G	1.06	0.95 to 1.18		1.47	1.35 to 1.61		0.64	0.59 to 0.71		0.88	0.81 to 0.96	
H	1.04	0.89 to 1.23		0.91	0.77 to 1.07		0.83	0.74 to 0.93		1.16	1.07 to 1.26	

<sup>a</sup> In the model for patients receiving more than the recommended follow-up visits compared with patients receiving the recommended number of visits, all patients were seen by an oncology specialty—that is, no visits fell into the “none” category. RR = relative risk; CI = confidence interval; RT = radiotherapy; CRT = chemoradiotherapy; Dx = diagnosis; LHIN = Local Health Integration Network.

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**CONFLICT OF INTEREST DISCLOSURES**

We have read and understood *Current Oncology's* policy on disclosing conflicts of interest, and we declare that we have none.

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