Title

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Readmission After Surgery for Oropharyngeal Cancer: An Analysis of Rates, Causes, and Risk Factors

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Objectives/Hypothesis: Determine the rate, diagnoses, and risk factors associated with 30-day nonelective readmissions for patients undergoing surgery for oropharyngeal cancer.

Study Design: Retrospective cohort study.

Methods: We analyzed the Nationwide Readmissions Database for patients who underwent oropharyngeal cancer surgery between 2010 and 2014. Rates and causes of 30-day readmissions were determined. Multivariate logistic regression was used to identify risk factors for readmission.

Results: Among 16,902 identified cases, the 30-day, nonelective readmission rate was 10.2%, with an average cost per readmission of $14,170. The most common readmission diagnoses were postoperative bleeding (14.1%) and wound complications (12.6%) (surgical site infection [8.6%], dehiscence [2.3%], and fistula [1.7%]). On multivariate regression, significant risk factors for readmission were major ablative surgery (which included total glossectomy, pharyngectomy, and mandibulectomy) (odds ratio [OR]: 1.29, 95% confidence interval [CI]: 1.06-1.60), advanced Charlson/Deyo comorbidity (OR: 2.00, 95% CI: 1.43-2.79), history of radiation (OR: 1.58, 95% CI: 1.15-2.17), Medicare (OR: 1.34, 95% CI: 1.06-1.69) or Medicaid (OR: 1.82, 95% CI: 1.32-2.50) payer status, index admission from the emergency department (OR: 1.19, 95% CI: 1.02-1.40), and length of stay ≥6 days (OR: 1.57, 95% CI: 1.19-2.08).

Conclusions: In this large database analysis, we found that approximately one in 10 patients undergoing surgery for oropharyngeal cancer is readmitted within 30 days. Procedural complexity, insurance status, and advanced comorbidity are independent risk factors, whereas postoperative bleeding and wound complications are the most common reasons for readmission.

Key Words: Oropharyngeal cancer, hospital readmission, Nationwide Readmissions Database, quality of care.

Level of Evidence: 4

***Laryngoscope*, 00:1–9, 2018**

INTRODUCTION

Thirty-day readmissions have become a major focus of hospitals, clinicians, and policymakers in their efforts to improve quality of care and contain healthcare costs. As part of the Hospital Readmission Reduction Program,[1] the Center for Medicare and Medicaid Services (CMS) has instituted financial penalties for excess 30-day unplanned readmissions for a growing set of medical and surgical admissions. Medicare penalties assessed in 2017 are expected to total $528 million, representing an increase of $108 million from the prior year.[2] Although head and neck surgeries are not yet subject to such penalties, anticipated expansion in the scope of the program is likely to involve our specialty.

At the same time, the incidence of human papillomavirus (HPV)–associated oropharyngeal cancer continues to climb. This disease process affects a younger and healthier population, and has become a driving force for change in management strategies within the head and neck cancer population.[3,4] In combating an earlier-staged disease with improved survival and treatment sensitivity than HPV-negative disease, minimally invasive transoral surgery is being rapidly adopted by academic and community centers.[5,6] The rise in cancer diagnoses has led to increased primary and salvage surgical volume, which has translated to a greater percentage of hospitalizations owing to oropharyngeal cancer surgery. Therefore, a thorough understanding of the perioperative period is critical to the management of these patients, including elucidating the risk factors and etiologies of hospital readmission.

Reported rates of readmission following head and neck cancer surgery have varied from 5.1% to 24.4% depending on anatomic site and surgical complexity; however, the factors specifically related to the oropharyngeal cancer population have yet to be described.[7–10] Given the changing demographics, associated comorbidities, and

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advances in surgical technique, the circumstances surrounding rehospitalization for oropharyngeal cancer care are unique and merit independent assessment. Additionally, understanding readmissions among a cancer population not only aids in reducing avoidable readmissions, but also improves care in those patients where time to adjuvant therapy impacts prognosis. The purpose of this study, therefore, was to evaluate the causes of and risk factors for readmissions in oropharyngeal cancer surgery patients utilizing a national database that covers comorbidities, socioeconomic costs, and readmissions at both index and nonindex hospitals.

MATERIALS AND METHODS

Data Source and Study Population

We performed a retrospective cohort study using data from the Nationwide Readmissions Database (NRD) from 2010 to 2014. The NRD is a database of all-payer hospital inpatient stays developed as part of the Healthcare Cost and Utilization Project (HCUP) by the Agency for Healthcare Research and Quality.[11] NRD data are constructed as a compilation from individual state inpatient databases, which from 2010 to 2014 included data from 22 states accounting for nearly 50% of all US hospitalizations. Sample weights provided by the database allow investigators to produce estimates representative of 100% of national discharges. The database includes data typical of a hospital discharge record including predefined variables for demographics, hospital characteristics, and admission characteristics. The NRD also contains verified patient-linkage numbers that can track patients across hospitals within a state for that year. The patient-linkage numbers do not track patients across years. To account for this, we excluded patients who were discharged in December to allow a 30-day follow-up period for every index hospitalization, as has been done previously.[8,10] Further details regarding the NRD is available through HCUP.[11] Because the database uses publicly available information with no personal identifiers, full review by the University of California–Los Angeles Institutional Review Board was not required.

The *International Classification of Disease, Ninth Revision, Clinical Modification* (ICD-9-CM) codes were used to identify hospital discharges for adult patients (≥18 years of age) who underwent an ablative procedure for a malignant oropharyngeal neoplasm between 2010 and 2014 (see Supporting Information, Appendix 1, in the online version of this article).[12] We excluded patients who died during the index admission. We also excluded patients with out-of-state residence due to potential loss of follow-up.

Definitions of Index Admission and Readmission

We defined an index admission as a hospitalization during which a patient underwent an ablative procedure for a malignant oropharyngeal neoplasm. We defined a readmission as a nonelective readmission to the same (index) or different (nonindex) hospital within 30-days of discharge from the index admission. Readmissions on the same day as the index hospital discharge were not included, as these could represent hospital transfers rather than true readmissions. We determined the reason for readmission by searching the primary ICD-9-CM diagnosis code associated with the readmission (see Supporting Information, Appendix 1, in the online version of this article). Among patients readmitted for postoperative bleeding, we determined the rate of return to the operating room for control of hemorrhage using codes 39.98 and 28.7.

Study Variables

Patient-level characteristics included demographics, comorbidity burden, primary payer, and procedures performed at the index admission. Comorbidity was graded using the Charlson index[13] as implemented by Deyo et al.,[14] excluding ICD-9-CM codes for the index cancer diagnosis from the solid tumor category.[15] Tumor staging information is not available in the NRD, and ICD-9-CM codes for metastases have not been shown to be a reliable proxy for disease stage and therefore were excluded.[15,16] We also evaluated the impact of prior radiation exposure (V15.3). We used ICD-9-CM procedure codes to define ablative procedures and other related procedures that may have been performed during the index admission (see Supporting Information, Appendix 1, in the online version of this article). Ablative procedures were categorized by severity as minor (excision/destruction of lesion, tonsillectomy, or partial glossectomy) and major (total glossectomy, pharyngectomy, or mandibulectomy).[9] Flap reconstruction, neck dissection, and transoral robotic surgery (TORS) were also examined as separate variables. Cases of TORS were identified by codes indicating a robotic-assisted procedure (17.4). All other ablative procedures, including open and transoral laser microsurgery approaches, were categorized as non-TORS procedures.

Admission-level characteristics included admission source, admission type (elective vs. nonelective admission), discharge destination, and length of stay ≥6 days. The cutoff point of ≥6 days for length of stay has been previously described as a threshold for adverse outcomes in head and neck surgery.[9,17,18] Hospital-level characteristics included hospital size, teaching status, annual oropharyngeal cancer surgery volume, and safety-net hospital status. The annual oropharyngeal cancer surgery volume was obtained by calculating the mean of the number of cases performed each year for a given hospital, for years in which that hospital performed at least one oropharyngeal cancer surgery. Hospital volume was stratified into tertiles with resulting cutoffs of 1 to 7, 8 to 17, and 18+ annual cases. Safety-net burden was defined as the percentage of treated patients per hospital with Medicaid or uninsured payer status.[19] Safety-net hospitals were defined as those hospitals in the highest quartile of safety-net burden.

Outcomes Measures

The primary outcome was 30-day nonelective readmission. Secondary outcomes included reasons for readmission; patient-, admission-, and hospital-level risk factors for readmission; and cost of readmission.

Statistical Analysis

We compared index admission characteristics of readmitted and nonreadmitted patients using Rao-Scott χ^2 tests for categorical variables and independent t tests for continuous variables. We generated national estimates using survey weights from the NRD. Inpatient costs were converted from NRD charges using the hospital-specific cost-to-charge ratios provided by the NRD, and adjusted for inflation to 2014 dollars using the medical component of the consumer price index.[20] Additionally, we accounted for regional cost differences by adjusting for the wage index, which is a measure of the local costs of hospital labor.[21]

Univariate analysis was performed to identify associations between patient-, admission-, and hospital-level factors and the risk of readmission. To assess the independent contribution of

each variable to the risk of readmission, variables significantly associated with readmission on univariate analysis ($P < .05$) were included in the multivariate model. Statistical tests were two-sided. Statistical significance was indicated by P values <.05. Statistical analyses were performed using Stata 14 (StataCorp, College Station, TX).

RESULTS

Readmission Details

We identified a weighted total of 22,509 patients who underwent surgery for oropharyngeal cancer in the United States from 2010 to 2014. After excluding patients for age <18 years (n = 25), death during the index admission (n = 122), out-of-state residence (n = 3,627), and procedures performed in December (n = 1,833), we were left with a final cohort of 16,902 patients. Overall, the 30-day nonelective readmission rate was 10.2%. Of these patients, 31.3% were readmitted to a hospital other than the hospital at which the oropharyngeal cancer surgery was performed.

Timeline, Causes, and Costs of Readmissions

The timeline and etiologies of nonelective readmissions are shown in Figures 1 and 2. Readmissions were scattered throughout the postdischarge period, although 50% of readmissions occurred during the first week, and 73% occurred during the first 2 weeks. The median length of stay for the readmission hospitalization was 5 days (interquartile range [IQR], 2–7 days). The rate of mortality for the readmission hospitalization was 3.3%.

Postoperative bleeding was the most common reason for readmission, accounting for 14.1% of all 30-day readmissions. The median time to readmission for postoperative bleed was 4 days (IQR, 2–9 days). Among patients readmitted for bleeding, 43.9% required return to the operating room for control of hemorrhage. Wound complications were the second most common factor for readmission, representing 12.6% of total rehospitalizations (surgical site infection [8.6%], dehiscence [2.3%], and fistula [1.7%]). Electrolyte/nutrition/digestive problems (8.4%) and other medical complications (8.1%) also constituted a considerable portion of the reasons for readmission.

Nonelective readmissions accounted for an average of $5,408,972 in total cost per 11-month period from January to November. The mean cost per readmission was $14,170, and the median cost was $9,212 (IQR, $4,944–$15,554). The mean cost of the index admission was $27,101, and the median cost was $18,917 (IQR, $11,157–$35,631). There was no significant difference in cost between a readmission to the index hospital or to a nonindex hospital. The mean cost of the index admission for non-TORS procedures ($28,298, standard error of the mean [SEM] = $440) was significantly higher than for TORS procedures ($20,306, SEM = $585), although there was no significant difference in mean costs of readmission after TORS and non-TORS procedures. When stratified by reason for readmission, respiratory failure ($30,940, SEM = $2,316) and sepsis/septicemia ($25,013, SEM = $2,069) led to the costliest readmissions, whereas electrolyte/nutrition/digestive problems ($8,814, SEM = $690) and surgical site infection ($12,353, SEM = $694) were the least costly (Fig. 3).

Patient-Level Risk Factors for Readmission

Patient demographics and procedures are shown in Table I. Univariate analysis of procedures performed during the index admission revealed that major ablative procedures (odds ratio [OR]: 1.66; 95% confidence interval

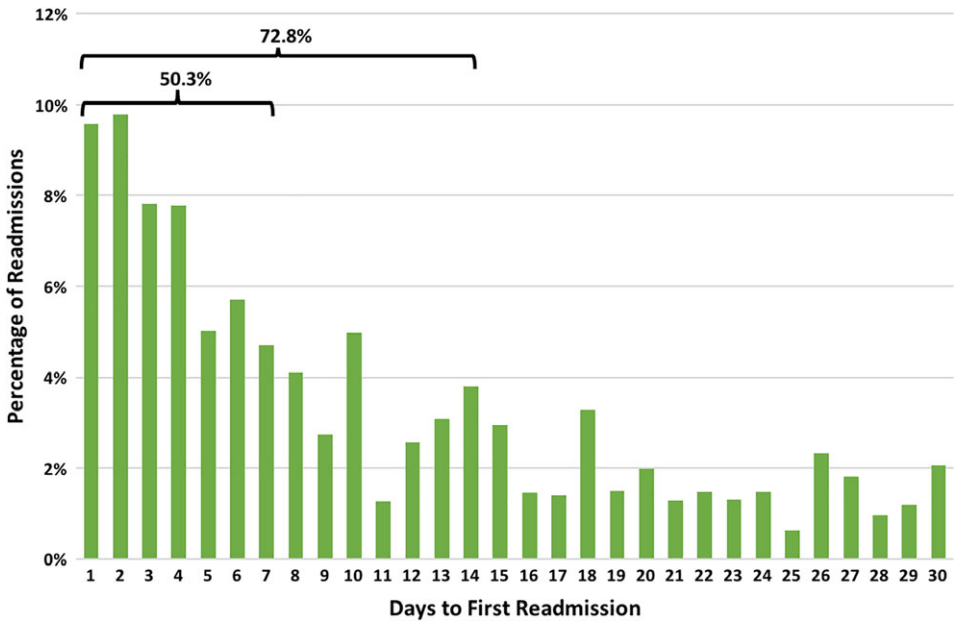

Fig. 1. Over half of oropharyngeal cancer surgery readmissions occurred during the first week after discharge, and 73% occurred during the first 2 weeks. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

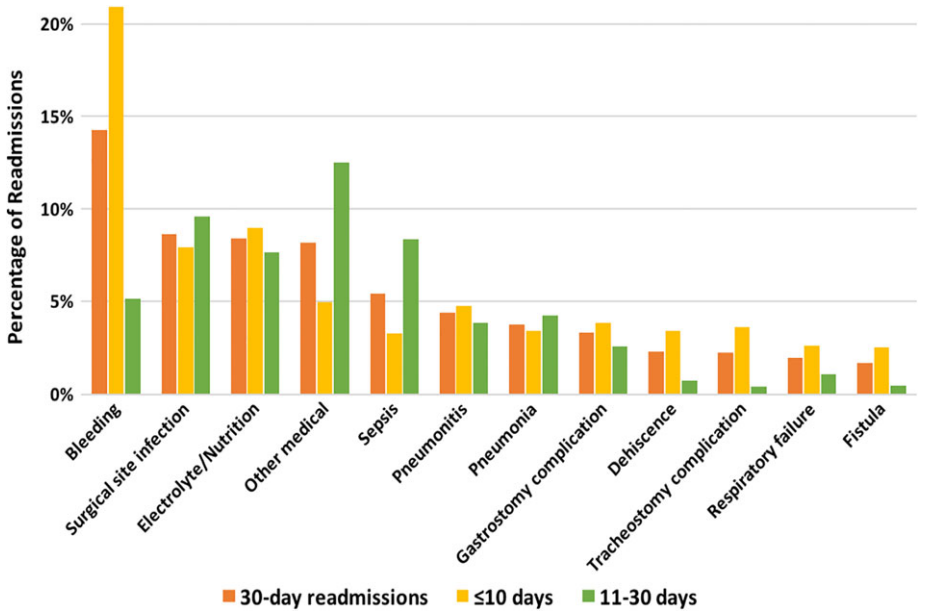

Fig. 2. For all 30-day readmissions, postoperative bleeding (14.1%) was the most common readmission diagnosis. For early readmissions (≤10 days after discharge), bleeding remained the most common readmission diagnosis (20.9%), but for late readmissions (11–30 days after discharge), other medical diagnoses (12.5%), surgical site infection (9.6%), and sepsis (8.4%) were more common. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

[CI]: 1.36-2.02), flap reconstruction (OR: 1.81; 95% CI: 1.40-2.32), blood transfusion (OR: 2.20; 95% CI: 1.69-2.87), percutaneous gastrostomy (OR: 1.77; 95% CI: 1.41-2.23), and mechanical ventilation for up to 96 hours postoperatively (OR: 1.56; 95% CI: 1.12-2.19) were associated with increased risk of readmission (Table I). Patients undergoing TORS had a similar rate of readmission (9.1%) as those undergoing non-TORS (10.4%) procedures. Hospital volume of oropharyngeal cancer cases was not associated with readmission (Table I). On multivariate analysis, only major ablative surgery remained a significant predictor of 30-day nonelective readmission (OR: 1.29; 95% CI: 1.04-1.60; $P = .02$) (Table II).

Patients with at least one readmission tended to be older (median age, 62 years; IQR, 55–70 years) than those who were not readmitted (median age, 60 years; IQR, 53–68 years). After adjusting for confounders, Charlson/Deyo scores of 2 (OR: 1.90; 95% CI: 1.36-2.64; $P < .001$) or 3 (OR: 2.00; 95% CI: 1.43-2.79; $P < .001$) were significantly associated with readmission, relative to a score of

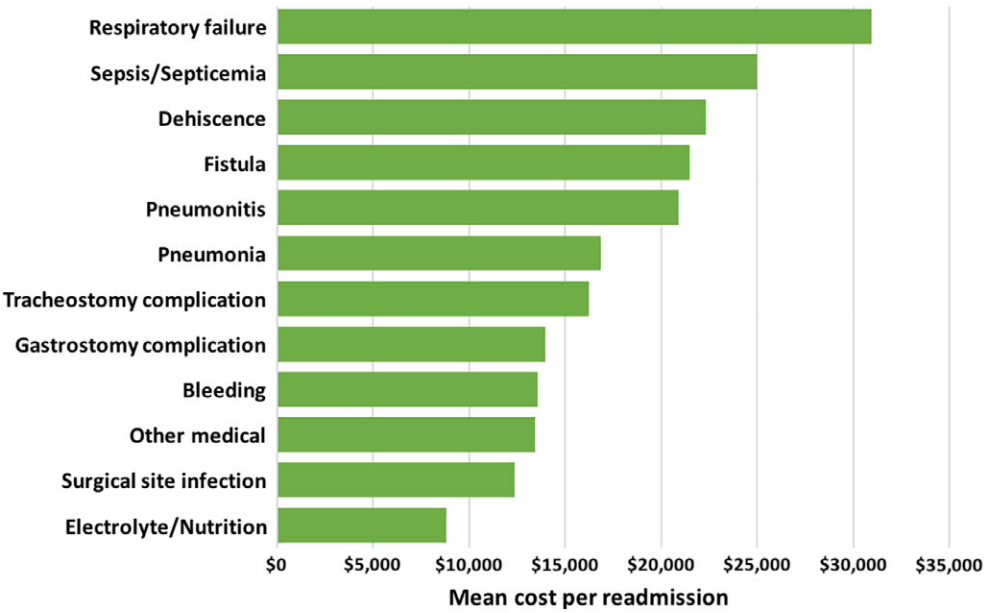

Fig. 3. The mean cost per readmission varied widely by the primary diagnosis at readmission, with the highest costs associated with respiratory failure and sepsis/septicemia. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

TABLE I.
Demographic, Procedure, and Hospital Characteristics Among Patients Undergoing Oropharyngeal Cancer Surgery by 30-Day Readmission Status.

Variable	Total Patients (N = 16,902), No. (%)	Patients Without Readmission (n = 15,178), No. (%)	Patients With Readmission (n = 1,724), No. (%)	Univariate OR (95% CI)	*P* Value
Age, yr					
<45	1,103 (6.5)	1,007 (91.3)	96 (8.7)	Ref.	Ref.
45–59	6,832 (40.4)	6,180 (90.5)	652 (9.5)	1.11 (0.72-1.72)	.62
60–74	6,944 (41.1)	6,228 (89.7)	716 (10.3)	1.21 (0.79-1.86)	.38
≥75	2,023 (12.0)	1,763 (87.2)	260 (12.8)	1.55 (0.98-2.44)	.06
Sex					
Female	4,543 (26.9)	4,082 (89.8)	1,262 (10.2)	Ref.	Ref.
Male	12,359 (73.1)	11,097 (89.8)	1,262 (10.2)	1.01 (0.82-1.24)	.95
Payer					
Private	7,462 (44.3)	6,931 (92.9)	531 (7.1)	Ref.	Ref.
Medicare	6,526 (38.7)	5,730 (87.8)	796 (12.2)	1.81 (1.45-2.27)	<.001
Medicaid	1,778 (10.5)	1,481 (83.3)	298 (16.7)	2.63 (1.93-3.57)	<.001
Self-pay	370 (2.2)	339 (91.5)	31 (8.5)	1.21 (0.55-2.64)	.63
Other	722 (4.3)	657 (91.0)	65 (9.0)	1.29 (0.77-2.16)	.33
Median household income quartile for zip code					
≤25th percentile	4,203 (25.3)	3,721 (88.5)	482 (11.5)	Ref.	Ref.
26th–50th percentile	4,152 (25.0)	3,738 (90.0)	414 (10.0)	0.86 (0.64-1.13)	.28
51st–75th percentile	3,896 (23.4)	3,516 (90.3)	380 (9.7)	0.83 (0.63-1.10)	.21
76th–100th percentile	4,386 (26.4)	3,961 (90.3)	425 (9.7)	0.83 (0.63-1.09)	.18
Comorbidity score					
0	9,590 (56.7)	8,834 (92.1)	756 (7.9)	Ref.	Ref.
1	4,857 (28.7)	4,328 (89.1)	529 (10.9)	1.42 (1.14-1.79)	.002
2	1,497 (8.9)	1,241 (82.9)	256 (17.1)	2.41 (1.75-3.32)	<.001
≥3	957 (5.7)	776 (81.1)	181 (18.9)	2.73 (1.99-3.75)	<.001
Prior radiation	1,400 (8.3)	1,163 (82.5)	237 (17.5)	1.92 (1.41-2.62)	<.001
Procedure type					
Major ablative procedure	5,660 (33.5)	4,899 (86.5)	761 (13.5)	1.66 (1.36-2.02)	<.001
Ablative procedures					
Oropharynx excision	2,879 (17.0)	2,514 (87.3)	365 (12.7)	1.36 (1.05-1.75)	.02
Tonsillectomy	5,673 (33.6)	5,155 (90.9)	519 (9.1)	0.84 (0.67-1.04)	.11
Partial glossectomy	7,961 (47.1)	7,176 (90.1)	785 (9.9)	0.93 (0.77-1.13)	.49
Total glossectomy	1,037 (6.1)	879 (84.7)	158 (15.3)	1.65 (1.24-2.20)	.001
Pharyngectomy	3,871 (22.9)	3,350 (86.5)	521 (13.5)	1.53 (1.22-1.91)	<.001
Mandibulectomy	1,513 (9.0)	1,281 (84.6)	232 (15.4)	1.69 (1.29-2.21)	<.001
Concurrent procedures					
Neck dissection	11,296 (66.8)	10,182 (90.1)	1,114 (9.9)	0.90 (0.74-1.09)	.27
Pedicle or free flap reconstruction	1,945 (11.5)	1,636 (84.1)	309 (15.9)	1.81 (1.40-2.32)	<.001
Transoral robotic surgery	2,576 (15.2)	2,340 (90.9)	236 (9.1)	0.87 (0.66-1.14)	.30
Blood transfusion	1,242 (7.3)	1,008 (81.2)	234 (18.8)	2.20 (1.69-2.87)	<.001
Central venous catheter placement	278 (1.6)	236 (84.9)	42 (15.1)	1.57 (0.96-2.58)	.07
Percutaneous gastrostomy	2,557 (15.1)	2,165 (84.6)	393 (15.4)	1.77 (1.41-2.23)	<.001
Invasive mechanical ventilation for <96 hours postoperatively	932 (5.5)	795 (85.3)	137 (14.7)	1.56 (1.12-2.19)	.01
Admission characteristics					
Index admission from ED					
No	16,354 (96.8)	14,768 (90.3)	1,586 (9.7)	Ref.	Ref.
Yes	549 (3.2)	411 (74.9)	138 (25.1)	3.12 (2.28-4.26)	<.001

(Continues)

TABLE I.
(Continued)

Variable	Total Patients (N = 16,902), No. (%)	Patients Without Readmission (n = 15,178), No. (%)	Patients With Readmission (n = 1,724), No. (%)	Univariate OR (95% CI)	*P* Value
Elective index admission					
No	1,566 (9.3)	1,322 (84.4)	244 (15.6)	Ref.	Ref.
Yes	15,321 (90.7)	13,841 (91.3)	1,480 (85.9)	0.58 (0.46-0.73)	<.001
Length of stay					
1–5 days	9,524 (56.3)	8,891 (93.4)	633 (6.6)	Ref.	Ref.
≥6 days	7,378 (43.7)	6,288 (85.2)	1,090 (14.8)	2.44 (1.99-2.98)	<.001
Discharge destination					
Home	11,022 (65.2)	10,163 (92.2)	858 (49.8)	Ref.	Ref.
Home with care	4,429 (26.2)	3,848 (86.9)	581 (33.7)	1.79 (1.43-2.24)	<.001
Nursing facility	1,309 (7.7)	1,041 (79.5)	268 (15.5)	3.05 (2.30-4.04)	<.001
Short-term hospital	107 (0.6)	95 (88.8)	12 (0.7)	1.49 (0.69-3.73)	.39
Other	37 (0.2)	*	*	1.85 (0.39-8.73)	.44
Hospital characteristics					
Bed size					
Small	1,286 (7.6)	1,165 (90.6)	121 (9.4)	Ref.	Ref.
Medium	2,362 (14.0)	2,147 (90.9)	215 (9.1)	0.96 (0.64-1.44)	.86
Large	13,254 (78.4)	11,867 (89.5)	1,387 (10.5)	1.12 (0.82-1.54)	.48
Teaching status					
Metropolitan nonteaching	1,961 (11.6)	1,775 (90.5)	186 (9.5)	Ref.	Ref.
Metropolitan teaching	14,609 (86.4)	13,105 (89.7)	1,504 (10.3)	1.10 (0.84-1.44)	.50
Nonmetropolitan	333 (2.0)	299 (89.9)	34 (10.1)	1.08 (0.54-2.16)	.83
Ownership					
Government, nonfederal	3,245 (19.2)	2,904 (89.5)	341 (10.5)	Ref.	Ref.
Private, nonprofit	12,617 (74.6)	11,369 (90.1)	1,248 (9.9)	0.93 (0.74-1.19)	.58
Private, investor owned	1,040 (6.2)	907 (87.2)	133 (12.8)	1.25 (0.80-1.97)	.33
Annual case volume					
1–7 cases	5,650 (33.4)	5,098 (90.2)	552 (9.8)	Ref.	Ref.
8–17 cases	5,542 (32.8)	4,980 (89.9)	562 (10.1)	1.04 (0.81-1.33)	.74
≥18 cases	5,710 (33.8)	5,101 (89.3)	609 (10.7)	1.10 (0.88-1.38)	.39
Safety-net hospital					
No	12,728 (75.3)	11,500 (90.4)	1,228 (9.6)	Ref.	Ref.
Yes	4,174 (24.7)	3,679 (88.1)	495 (11.9)	1.26 (1.01-1.59)	.04

*Censored due to fewer than the HCUP minimum of 11 cases.
CI = confidence interval; ED = emergency department; HCUP = Healthcare Cost and Utilization Project; OR = odds ratio; Ref. = reference.

0. Additionally, a history of prior radiation (OR: 1.58; 95% CI: 1.15-2.17; $P = .004$) was a significant predictor of readmission (Table II).

Hospital- and Admission-Level Risk Factors for Readmission

Hospital and admission characteristics are shown in Table I. The median length of stay during the index hospitalization was greater for patients who were readmitted (7 days; IQR, 4–12 days) than those who were not readmitted (4 days; IQR, 2–8 days). After adjusting for confounders, hospital length of stay ≥6 days was significantly associated with increased risk of readmission (OR: 1.57; 95% CI: 1.19-2.08; $P = .001$) (Table II). Additionally, patients with Medicaid (OR: 1.82; 95% CI: 1.32-2.50; $P < .001$) or Medicare (OR: 1.34; 95% CI: 1.06-1.69; $P = .01$) as their primary payer had increased odds of readmission relative to those with private insurance (Table II). Index admission from the emergency department was also associated with increased risk of readmission (OR: 1.19; 95% CI: 1.02-1.40; $P = .03$). Patients discharged to home with home care (OR: 1.79; 95% CI: 1.43-2.24) or a nursing facility (OR: 3.05; 95% CI: 2.30-4.04) were at increased odds of readmission in the univariate model, although this association was not significant after controlling for other covariates. Additionally, hospital-level characteristics, which included size, location, ownership, and teaching status, were not associated with readmission.

DISCUSSION

The overall rate of 30-day readmission after oropharyngeal cancer surgery (10.2%) in our study is

TABLE II.
Multivariate Analysis of Factors Associated With 30-Day Readmission.

Variable	OR (95% CI)	*P* Value
Payer		
Private	Ref.	Ref.
Medicare	1.34 (1.06-1.69)	.01
Medicaid	1.82 (1.32-2.50)	<.001
Self-pay	1.07 (0.49-2.37)	.86
Other	1.10 (0.66-1.85)	.71
Major ablative procedure	1.29 (1.04-1.60)	.02
Pedicle or free flap reconstruction	1.10 (0.84-1.45)	.47
Comorbidity score		
0	Ref.	Ref.
1	1.19 (0.94-1.50)	.15
2	1.90 (1.36-2.64)	<.001
≥3	2.00 (1.43-2.79)	<.001
Prior radiation	1.58 (1.15-2.17)	.004
Blood transfusion	1.20 (0.89-1.55)	.23
Percutaneous gastrostomy	1.03 (0.80-1.33)	.82
Invasive mechanical ventilation for <96 hours	1.09 (0.75-1.52)	.78
Elective index admission	0.78 (0.59-1.03)	.08
Index admission from ED	1.19 (1.02-1.40)	.03
Length of stay ≥6 days	1.57 (1.19-2.08)	.001
Discharge destination		
Home	Ref.	Ref.
Home with care	1.06 (0.82-1.39)	.60
Nursing facility	1.36 (0.98-1.94)	.08
Short-term hospital	0.70 (0.26-1.87)	.39
Other	1.05 (0.26-4.58)	.95
Safety-net hospital	1.07 (0.85-1.35)	.54

CI = confidence interval; ED = emergency department; OR = odds ratio; Ref. = reference.

within the range of prior studies, which have reported rates of readmission from 7.2% to 24.4%.[7,9,22] Chaudhary et al. found a readmission rate of 24.4% in a cohort of Medicare patients.[9] The study, however, is limited by the use of Medicare-only data, a cohort that tends to have higher rates of readmission, as compared to the general population, given their older age, increased frailty, and less support for managing complications following hospital discharge.[23] Bur et al. used the American College of Surgeons National Surgical Quality Improvement (ACS-NSQIP) database and found an unplanned readmission rate for patients undergoing oropharyngeal cancer surgery of 7.2%.[7] This study likely underestimates the true rate of readmission as defined by the CMS because the ACS-NSQIP only captures readmissions that occur within 30 days of surgery, rather than 30 days of discharge. Topf et al. analyzed patients at a single institution undergoing TORS for squamous cell carcinoma and found an unplanned readmission rate of 7.7%.[22] The use of single-institution data, however, also underestimates the true rate, as readmissions to outside hospitals cannot be captured. By utilizing an all-payer, national database that captures readmissions at both index and outside hospitals over a 30-day postdischarge window, our analysis avoids the limitations of prior studies in estimating a baseline rate of readmission after oropharyngeal cancer surgery.

Postoperative bleeding was the most common etiology of readmission. Bleeding is a potentially life-threatening complication of oropharyngeal surgery that can lead to airway compromise, asphyxiation, or cardiopulmonary arrest, particularly when severe. An oncologic indication for surgery significantly increases the risk of bleeding, as resection of a known primary cancer may necessitate a deeper plain of resection than required for other surgical indications, thereby placing vascular structures at risk.[24,25] Strategies to reduce postoperative bleeding are not well-defined, but have included discontinuation of antithrombotic medications[26] and prophylactic transcervical arterial ligation of branches of the external carotid system.[24,27] Additionally, educating patients and caregivers of potentially subtle symptoms of bleeding such as epistaxis or melena may allow for earlier detection. Fifty percent of bleeding events in our study occurred within 4 days of discharge. Longer postoperative observation of patients who are at elevated bleeding risk, such as those with tonsillar tumors[25] or prior radiotherapy,[24] may be a means to prevent some of these readmissions.

A history of prior radiation was a significant predictor of readmission. The factors associated with readmission in patients who have a history of radiotherapy are vast. In the oropharyngeal cancer population, radiated patients have been found to be at greater risk of hemorrhage following salvage surgery.[28,29] Radiotherapy may obscure surgical landmarks through fibrosis or obliteration of tissue planes, making dissection in the oropharynx much more difficult. Even with surgical magnification, Kubik et al. found prior radiotherapy was the strongest predictor of major hemorrhage in 265 patients undergoing TORS for oropharyngeal cancer.[24] Additionally, the physiologic effects on irradiated vasculature including premature atherosclerosis, weakening of the arterial wall, and disintegration of the elastic fibers place patients at increased risk of deterioriation.[30]

The readmission rate among the subset of patients who underwent TORS was similar to those undergoing non-TORS procedures. This rate of rehospitalization is comparable to the few prior studies of TORS, which range from 7.7% to 10.4%.[22,25] Transoral robotic techniques reduce the need for high-morbidity surgical maneuvers like pharyngotomy or mandibulotomy and have been associated with decreased length of hospital stay, total costs, and rates of gastrostomy tube and tracheostomy tube placement compared to other surgical techniques.[31] Previous research has also found that patients undergoing TORS experience fewer acute medical complications but a similar rate of surgical complications (including hemorrhage) as those undergoing non-TORS oropharyngeal procedures. Whether the reasons for readmission across TORS and non-TORS patients follow a similar pattern exceeded the scope of this article, but is an interesting question for further research.

Patients with Medicaid or Medicare were more likely to be readmitted than those with private insurance. This is important to factor into risk-adjustment indices of a hospital's patient population, which would otherwise unfairly penalize hospitals with a disproportionate share of Medicaid/Medicare patients. Consideration must be taken to avoid exacerbating disparities in access to care through financial penalties that discourage caring for sicker or more disadvantaged patients.

Advanced composite comorbidity score was significantly associated with readmission. This is similar to previous surgical studies that suggest rehospitalizations can often be attributed to complications from preexisting medical conditions.[8,32,33] Preoperative clinic visits for health optimization have been explored as a means to prevent such readmissions and demonstrated early promise. Dziegielewski et al. observed that patients who attended presurgical clinic had an eightfold reduction in the likelihood of readmission.[34] Similarly, Graboyes et al. attributed their low rate of medical complications to high attendance rates at preoperative visits.[32] Such encounters might include further imaging, cardiopulmonary studies to evaluate underlying medical conditions, or perioperative adjustment of drug dosages. Further research, including multi-institution data, is warranted to understand if these visits could decrease readmission rates and which patients might benefit the most.

Our study is not without limitations. The use of administrative data relies on ICD-9-CM coding practices, which may contain errors and may not adequately capture coexisting conditions, especially with regard to nonreimbursable care (e.g., history of prior radiation). However, the ICD-9-CM coding system has been frequently used and validated to identify the diagnoses and procedures defined in our study.[12,16,35] Same-day hospitalizations are combined into a single record in the NRD as a means to address the known challenges of using administrative data to distinguish same-day readmissions from hospital transfers[11]; as a result, we are unable to capture readmissions that might occur on the same day of initial discharge, such as from bleeding the night of surgery. Furthermore, because we evaluated postoperative bleeding only as a readmission diagnosis, our analysis does not capture bleeding events that might have occurred during hospitalization. Data on current medication use was not available, particularly regarding antithrombotic agents, which are a known risk factor for postoperative hemorrhage. The costs presented in our study represent univariate costs, shown to demonstrate the overall financial impact of readmissions. However, deriving how costs are related to specific covariates (e.g., the effect of readmission status on the cost of the total episode of care) requires multivariate cost analysis, which was not performed in this study. Primary diagnosis codes of a readmission may not always correlate with the true reason for readmission.[36] The sampling frame of the NRD does not contain the entire universe of US hospitals, only those hospitals in states for which all-payer discharge data were made available to HCUP. Provided discharge weights are designed to compensate for over- or underrepresented types of hospitals, but may not fully account for differences between states in the sampling frame and other states. Finally, the NRD does not contain tumor-specific information which prevented us from adjusting for cancer stage or pathologic characteristics in our analysis.

CONCLUSION

In this large database analysis, we found that approximately one in 10 patients undergoing oropharyngeal cancer surgery are readmitted within 30 days. Readmissions are most commonly associated with postoperative bleeding and wound complications and occur early after discharge. Procedural complexity, insurance status, and patient comorbidities contribute to readmissions and should be considered in risk-adjustment models of a hospital's patient population. The risk factors and diagnoses identified in our study may serve as the basis for quality improvement initiatives aimed at reducing hospital readmissions and improving quality of care.

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