

ORIGINAL ARTICLE

Utilization of rehabilitation services in patients with head and neck cancer in the United States: A SEER-Medicare analysis

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Abstract

Background: Head and neck cancer (HNC) and its treatment lead to functional impairments. Rehabilitation by speech-language pathology (SLP) and occupational/physical therapy (OT/PT) can decrease morbidity.

Methods: The Surveillance, Epidemiology and End Results–Medicare data for patients with HNC diagnosed between 2002 and 2011 was utilized to evaluate posttreatment rehabilitation.

Results: In 16 194 patients, the overall utilization rate was 20.7% for SLP and 26.2% for OT/PT services. Treatment modality was significantly associated rehabilitation utilization. Compared to patients treated with primary surgery, those treated with primary radiotherapy had significantly lower odds of OT/PT utilization. Patients treated with surgery plus adjuvant treatment and primary concurrent chemoradiation had higher odds of SLP utilization compared to patients treated with surgery alone.

Conclusions: Rehabilitation services appeared to be underutilized by patients with HNC in the United States and vary with treatment modality. There is a need to improve integration of rehabilitation services into the HNC care continuum.

Summary

Rehabilitation services are underutilized by patients with HNC during posttreatment surveillance in the United States. Treatment modality significantly impacts rehabilitation utilization patterns.

KEYWORDS

head and neck cancer, occupational therapy, physical and rehabilitation medicine, rehabilitation research, speech-language pathology, survivorship

1 | INTRODUCTION

With an emphasis on organ preservation, treatment algorithms in head and neck cancer (HNC) have evolved over the years.

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The utilization of primary radiotherapy with or without chemotherapy has increased, particularly for oropharynx and larynx cancers.¹ Due to the physiologic importance of structures involved in HNC, patients often experience significant disease- and treatment-related morbidities.² These include functional impairments such as pain, fatigue, deconditioning, dysphagia, speech dysfunction, cervical and shoulder

dysfunction, impaired mobility, lymphedema, and disfigurement.³⁻⁶ With regards to treatment, while the extent and location of tumor resection affect function in surgically treated patients, organ preservation approaches may also result in acute and long-term dysfunction due to normal tissue injury. Despite advancements in radiation techniques, radiation-induced toxicities affect a substantial proportion of patients with HNC.⁷ For example, radiated patients develop mucositis, xerostomia, trismus, soft tissue necrosis, and fibrosis.⁸ They exhibit impairments such as reduced tongue base contact with the posterior pharyngeal wall, reduced laryngeal elevation, and reduced vestibule and vocal cord closure, which in turn lead to dysphagia and aspiration.⁸⁻¹¹ In addition, physical impairments resulting from radiation treatment including pain, weight loss, cervical contracture, shoulder disability, cranial nerve palsies, and lymphedema of the neck and face.¹² These impairments limit performance status and decrease quality of life.^{13,14}

Rehabilitation strategies are effective in improving function and quality of life in patients with cancer, including HNC.¹⁵⁻¹⁸ Cancer rehabilitation teams comprised a variety of health care professionals including speech-language pathologists, occupational therapists, and physical therapists. Given that most HNC and their treatments impact speech and swallow function, speech-language pathology (SLP) plays a central role in HNC rehabilitation. In addition, occupational and physical therapists aim to improve quality of life by reestablishing impaired functions. Specifically, although physical therapy (PT) interventions focus on improving physical functions such as neck and shoulder range of motion, occupational therapy (OT) interventions prioritize maintaining participation in meaningful activities (ie, IADLs and ADLs) and improving cognitive ability.

There is a paucity of evidence examining utilization of rehabilitation services in patients with HNC. Unmet rehabilitation needs have been identified by patients, family members, and health care professionals.^{19,20} However, current utilization patterns have not been examined at the population level in the United States, and areas requiring improvement have not been identified. Specifically, it remains unknown whether treatment modality impacts rehabilitation services utilization and integration. The aims of the current study were to (a) utilize population-level data to assess patterns of post-treatment SLP, and PT/OT services utilization in patients with HNC in the United States and (b) assess whether treatment modality impacts rehabilitation services utilization.

2 | MATERIALS AND METHODS

2.1 | Data source

The Surveillance, Epidemiology, and End Results (SEER) 18-Medicare linked Database includes cancer registries data

collected across 18 geographic areas in the United States and provides cancer incidence and survival statistics for approximately 26% of the population.²¹ The Medicare program provides insurance for hospital, physician, and outpatient medical services for 97% of the U.S. citizens who are 65 years of age and older. The SEER-Medicare Linked database was created to link SEER cancer registry data with Medicare claims and census information.

Diagnoses and procedures for each patient were identified using the Patient Entitlement and Diagnosis Summary File (PEDSF), as well as all available Medicare claims. All data were deidentified. The University of Texas MD Anderson Cancer Center institutional review board exempted this study from formal institutional review board review.

2.2 | Cohort eligibility

Patients diagnosed with index HNC between 2002 and 2011 with Medicare claims through 2013 were identified from the SEER-Medicare database. All HNC histologic subtypes were included with squamous cell carcinoma being the most common (81.4%). For inclusion, patients required pathologically confirmed HNC not diagnosed at death or autopsy. Patients with all disease stages, including distant disease at diagnosis, were included. Additional inclusion criteria include (a) known date of diagnosis, (b) enrollment in both Medicare A and B (to capture both inpatient and outpatient utilization) from 12 months before and 24 months after cancer diagnosis, and (c) known initial treatment modality. Exclusion criteria include (a) history of cancer, (b) synchronous HNC primaries, and (c) death within the first surveillance year. The SEER codes of interest were cancers of the lip (20010), tongue (20020), floor of mouth (20040), gum and other mouth (20050), nasopharynx (20060), tonsil (20070), oropharynx (20080), hypopharynx (20090), and larynx (22020). The International Classification of Disease (ICD-9) diagnosis codes of interest are shown in Appendix Table A1.

2.3 | Outcome measures

The primary outcome of interest was the prevalence of SLP and OT/PT services utilization during the posttreatment period. An additional outcome of interest was treatment factors associated with the use of SLP and OT/PT services. End of treatment was defined as 4 months after HNC diagnosis, consistent with SEER reporting and coding guidelines. Prevalence and frequency of posttreatment utilization within 2 years (4-28 months postdiagnosis) were calculated. The utilization of SLP and OT/PT services was captured from Medicare claims data using Current Procedural Terminology (CPT)/Healthcare Common Procedure Coding System (HCPCS) codes as outlined in Appendix Table A1.

2.4 | Variables

Demographic variables collected included age at diagnosis, ethnicity, sex, year of diagnosis, education, income, and area of residence. Age was divided into four categories based on quartiles (<69, 69-74, 74-79, >79 years). Clinical variables collected included anatomical subsite, stage at diagnosis, comorbidity, initial treatment modality, as well as history of dysphagia, stricture, tracheostomy, and neck dissection during primary HNC treatment. Anatomical subsites included were nasopharynx, oropharynx, oral cavity, hypopharynx, and larynx. Stage at diagnosis was coded as available in SEER as follows: in situ (no invasion of basement membrane)/localized (confined to organ of origin), regional (extends beyond organ of origin, regional lymph nodes), and distant (spread remote from primary tumor). Comorbidity was captured by searching billing codes for inpatient and outpatient claims for various conditions during the year before HNC diagnosis as developed by Klabunde. The Deyo implementation of the Charlson Comorbidity Index was utilized to derive a comorbidity index of 0, 1, or 2. A score of 0 indicates “no comorbid conditions recorded from the included list of comorbidities”.^{22,23} Initial treatment was categorized into four groups: surgery alone, surgery with adjuvant therapy (radiation with or without chemotherapy), radiation alone, and chemoradiotherapy. CPT, HCPCS, and ICD-9 codes for surgery, radiation, and chemotherapy occurring within 4 months of HNC diagnosis were used to identify primary treatment modality. Place of service codes within National Claims History was used to identify inpatient vs outpatient rehabilitation services utilization.

2.5 | Statistical analysis

Statistical analyses were conducted using SAS statistical software, version 9.4 (SAS Institute, Cary, North Carolina). Prevalence rates of SLP and OT/PT services utilization within 2 years of HNC treatment were calculated along with 95% confidence intervals. Prevalence rates for utilization were compared across time using the chi-square test. Univariate and multivariable logistic regression models were utilized to examine the relationship between treatment modality and rehabilitation services utilization. Multivariable models were constructed by utilizing backwards selection and forcing in known confounders. Odds ratio with 95% confidence intervals were calculated. The Wald chi-square statistics with associated *P*-values were computed for each with alpha level set at .05.

3 | RESULTS

3.1 | Cohort characteristics

A total of 16 194 patients with HNC were included in the analyses. The majority were white (84.7%) and men

(65.34%). The median age at HNC diagnosis was 74 years (range, 66-104 years; mean, 75.0; SD, 6.71). The most common anatomic subsite was oral cavity (39.3%) followed by larynx (34.1%). The proportions of patients with oropharynx cancer (8.1%) and nasopharyngeal cancer (2.2%) were small within this study population. The majority of patients presented with disease localized to the primary site and/or regional lymph nodes. A small proportion of patients (8.5%) had distant metastasis at the time of presentation. Initial treatment modalities utilized included surgery alone (25.6%), primary radiotherapy alone (25.5%), surgery with adjuvant radiotherapy with or without chemotherapy (27.4%), and primary chemoradiotherapy (21.5%). Although most patients did not have significant comorbidities, 42.3% of patients had one or more recorded comorbidities. The incidence of HNC did not significantly vary across time (2002-2011). Patient characteristics are summarized in Table 1.

3.2 | Utilization of SLP Services

A total of 3349 (20.7%; 95% CI, 20.1%-21.3%) patients utilized SLP services within the first 2 posttreatment years (Table 1). The prevalence rates of utilization significantly increased over time from 15.9% in 2002 to 25.2% in 2011 (Figure 1). A total of 2422 (15.0%) patients utilized SLP services within the first posttreatment year. Utilization within the second year decreased to 7.1% (*n* = 1154). The majority of patients had a low-frequency utilization pattern, using SLP services 1-2 times during posttreatment period. Only a small proportion of patients, 7.1% (*n* = 173) in the first year and 6.1% (*n* = 70) in the second year, utilized SLP services more than 10 times (Table S3). The vast majority of SLP services were administered in the outpatient setting as only 24 of 32 501 (0.07%) utilizations occurred as inpatient services. The variables significantly associated with SLP service utilization in univariate analyses are shown in Table S1.

3.3 | Utilization of OT and PT Services

Within the first 2 years of posttreatment years, the prevalence rate for OT/PT services was 26.2% (95% CI, 25.5%-26.9%) (Table 1). The prevalence rates of utilization significantly increased over time from 24.1% in 2002 to 29.1% in 2011 (Figure 1). A total of 2696 patients (16.6%) utilized OT/PT services within the first posttreatment year. The total percentage OT/PT service utilization within the second posttreatment year was 12.2% (*n* = 1978). Of patients utilizing OT/PT services, the greatest proportion of patients utilized services 10 times or more (35.2% within the first year, 38.8% within the second year) (Table S3). Similar to SLP services, the majority of utilizations were from outpatient services. Only 34 of 143 685 (0.02%) utilizations were

TABLE 1 Distribution of patient characteristics by patients' OT/PT and SLP status (n = 16 194)

	Total (%)	OT/PT services (%)	SLP (%)
Two-year utilization prevalence		3349 (20.68)	4240 (26.18)
Primary treatment modality			
Surgery alone	4147 (25.61)	1196 (28.84)	478 (11.53)
Radiotherapy alone	4130 (25.50)	906 (21.94)	699 (16.92)
Surgery + adjuvant radiation	4430 (27.36)	1239 (27.97)	1017 (22.96)
Concurrent chemoradiotherapy	3487 (21.53)	899 (25.78)	1155 (33.12)
Sex			
Female	5606 (34.62)	1660 (29.61)	1041 (18.57)
Male	10 588 (65.38)	2580 (24.37)	2308 (21.80)
Ethnicity			
Other	721 (4.45)	165 (22.88)	122 (16.92)
Hispanic	763 (4.71)	179 (23.46)	172 (22.54)
Black	1001 (6.18)	203 (20.28)	250 (24.98)
White	13 709 (84.65)	3693 (26.94)	2805 (20.46)
Age quartiles (y)			
>79	4687 (28.94)	1290 (27.52)	819 (17.47)
74-79	3722 (22.98)	978 (26.28)	763 (20.50)
69-74	4674 (28.86)	1229 (26.29)	1058 (22.64)
<69	3111 (19.21)	743 (23.88)	709 (22.79)
Anatomical subsite			
Nasopharynx	360 (2.22)	78 (21.67)	83 (23.06)
Oropharynx	1308 (8.08)	340 (25.99)	325 (24.85)
Larynx	5521 (34.09)	1270 (23.00)	1431 (25.92)
Oral cavity	6371 (39.34)	1861 (29.21)	1299 (20.39)
Missing	2634 (16.27)	691 (26.23)	211 (8.01)
SEER stage			
Distant	1372 (8.47)	341 (24.85)	350 (25.51)
Regional	5131 (31.68)	1409 (27.46)	1267 (24.69)
In situ/localized	5349 (33.03)	1470 (27.48)	695 (12.99)
Missing	4342 (26.81)	1020 (23.49)	1037 (23.88)
Comorbidity			
0	11 072 (68.37)	2169 (19.59)	2759 (24.92)
1	3469 (21.42)	805 (23.21)	987 (28.45)
2+	1653 (10.21)	375 (22.69)	494 (29.89)
Residence			
Big Metro	8372 (51.70)	2351(28.08)	1771 (21.15)
Metro	4805 (29.67)	1231 (25.62)	972 (20.23)
Urban	980 (6.05)	223 (22.76)	196 (20.00)
Less urban/rural	1914 (11.82)	403 (21.06)	388 (20.27)
Missing	123 (0.76)	32 (26.02)	22 (17.89)

(Continues)

TABLE 1 (Continued)

	Total (%)	OT/PT services (%)	SLP (%)
Education			
Lowest education	4019 (24.82)	816 (20.3)	847 (21.07)
2nd quartile	4020 (24.82)	833 (20.72)	974 (24.23)
3rd quartile	4015 (24.79)	826 (20.57)	1093 (27.22)
Highest education	4140 (25.57)	874 (21.11)	1326 (32.03)
Dysphagia			
No	8859 (54.71)	347 (3.92)	1981 (22.36)
Yes	7335 (45.29)	3002 (40.93)	2259 (30.8)
Strictures			
No	14 545 (89.82)	2454 (16.87)	3714 (25.53)
Yes	1649 (10.18)	895 (54.28)	526 (31.9)
Tracheostomy			
No	14 149 (87.37)	2178 (15.39)	3624 (25.61)
Yes	2045 (12.63)	1171 (57.26)	616 (30.12)
Neck dissection			
No	14 957 (92.36)	2863 (19.14)	3845 (25.71)
Yes	1237 (7.64)	486 (39.29)	395 (31.93)
Year group			
2002-2006	7755 (47.89)	1841 (23.74)	2193 (28.28)
2007-2011	8439 (52.11)	1508 (17.87)	2047 (24.26)

Abbreviations: OT/PT, occupational/physical therapy; SLP, speech-language pathology.

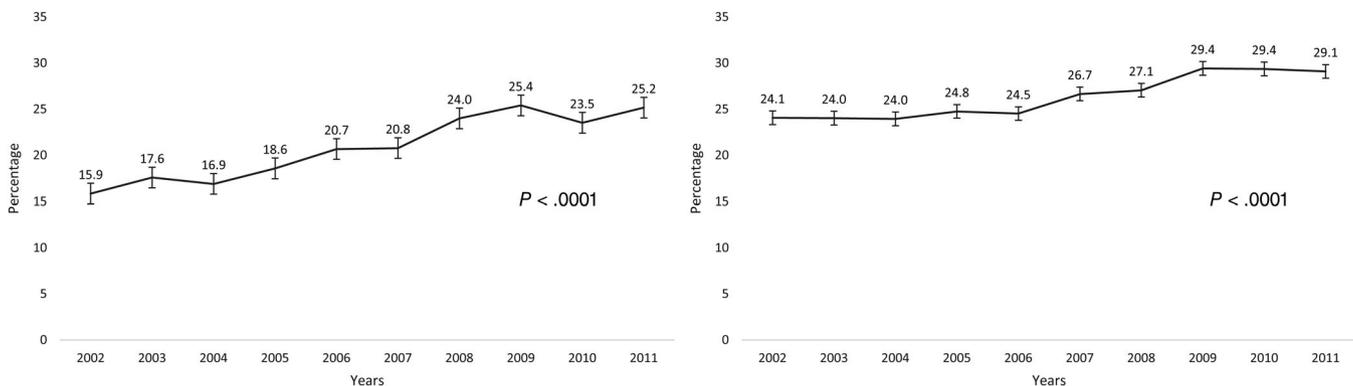


FIGURE 1 Trends of prevalence of occupational/physical therapy (OT/PT) and speech-language pathology (SLP) utilization in patients with head and neck cancer between 2002 and 2011. Utilization of SLP services (left) and OT/PT services (right), $n = 16\ 194$

administered as inpatient services. The variables significantly associated with OT/PT service utilization in univariate analyses are shown in Table S1.

3.4 | Treatment modality and rehabilitation services utilization

After adjusting for confounders, treatment modality was significantly associated with the odds of OT/PT and SLP

services utilization. Results of multivariable regression models with adjusted ORs are shown in Table 2. Compared to patients treated with surgery only, patients treated with radiotherapy only or concurrent chemoradiotherapy were 22% and 21% less likely to utilize OT/PT services, respectively. There was no significant difference in the odds of OT/PT utilization between patients treated with surgery only and those treated with surgery followed by adjuvant therapies. For SLP utilization, patients treated with surgery

followed by adjuvant therapy and those treated with primary concurrent chemoradiation were 34% and 18% more likely to utilize services compared to patients treated with surgery alone, respectively. Although there was a trend toward decreased odds of utilization observed in patients treated with primary radiotherapy compared to primary surgery, it did not achieve statistical significance.

To explore the effect of treatment intensity, stratified analyses were performed to separately examine single and multimodality treatments (Table 3). A total of 8277 patients were treated with single modality treatment (primary surgery only or primary radiotherapy only), whereas 7919 patients were treated with multimodality treatment (primary surgery followed by adjuvant radiotherapy with or without chemotherapy or primary radiotherapy with concurrent chemotherapy). After adjustments, the odds of OT/PT and SLP utilization were significantly lower in patients treated with radiotherapy alone compared to surgery alone. In patients

treated with multimodality treatment, the odds of OT/PT and SLP utilization were also significantly lower in patients treated nonsurgically.

4 | DISCUSSION

The aims of this study were to assess utilization patterns of rehabilitation services in patients with HNC in the United States and to examine the impact of treatment modality on utilization. We found that within this group of Medicare patients who were 65 years of age and older at the time of diagnosis, only 26% utilized OT/PT services within the first 2 posttreatment years. An even smaller proportion of patients (21%) utilized SLP services. This study found that the patterns of use differed for OT/PT and SLP services. Although a substantial number of patients utilized OT/PT services frequently (more than 10 times) within the first 2 posttreatment years, the majority of patients utilized SLP services only once or twice. While these differences in utilization frequencies may reflect differences in patient need, access to SLP and OT/PT services likely also play a role. Despite overall increases in rehabilitation services utilization over time, most recent utilization rates persisted below 30%, demonstrating that rehabilitation services remain underutilized in patients with HNC. Supporting this, unmet rehabilitation needs have been identified in 60%-70% of patients with HNC.^{20,24}

Growing evidence demonstrates that rehabilitation interventions in HNC are safe, cost-effective, and lead to improvements in function and quality of life.^{15-18,25} However, rehabilitation services have not been consistently integrated into HNC care in the United States. One important barrier to rehabilitation utilization, which was repeatedly identified by patients with HNC, family members, and

TABLE 2 Association between treatment modality and use of OT/PT and SLP services regressed in multivariable models

Treatment modality	OT/PT services aOR (95% CI)	SLP services aOR (95% CI)
Surgery alone	1.00 (Reference)	1.00 (Reference)
Radiation alone	0.78 (0.69-0.88)	0.89 (0.75-1.04)
Surgery + adjuvant radiation	0.94 (0.84-1.04)	1.34 (1.16-1.56)
Concurrent chemoradiation	0.79 (0.70-0.90)	1.18 (1.01-1.38)
	<i>P</i> < .0001	<i>P</i> < .0001

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; OT/PT, occupational/physical therapy; SLP, speech-language pathology. Multivariable model adjusted for: year of diagnosis, ethnicity, age, anatomical subsite, sex, comorbidity score, SEER stage, residence, education, and the presence of dysphagia, strictures, neck dissection, and tracheostomy. *P*-value was determined by the Wald test.

TABLE 3 Association between the use of OT/PT and SLP services and single modality or multimodality treatments in multivariable models

	OT/PT services		SLP services	
	No. of patients (%)	aOR (95% CI)	No. of patients (%)	aOR (95% CI)
Single modality treatment				
Radiation alone	906/4130 (21.9)	0.80 (0.69-0.92)	699/4130 (16.9)	0.79 (0.65-0.96)
Surgery alone	1196/4147 (28.8)	Ref	478/4147 (11.5)	Ref
Total	2102/8277		1177/8277	
Multimodality treatment				
Concurrent chemoradiotherapy	899/3487 (25.8)	0.82 (0.73-0.92)	1155/3487 (33.1)	0.85 (0.75-0.97)
Surgery + adjuvant	1239/4430 (28.0)	Ref	1017/4430 (23.0)	Ref
Total	2138/7917		2172/7917	

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; OT/PT, occupational/physical therapy; SLP, speech-language pathology. Multivariable model adjusted for: year of diagnosis, ethnicity, age, anatomical subsite, sex, comorbidity score, SEER stage, residence, education, and the presence of dysphagia, strictures, neck dissection, and tracheostomy.

health care professionals, was a lack of access to rehabilitation services.¹⁹ In our study, we found that treatment modality was significantly associated with rehabilitation services utilization and may impact access to rehabilitation services. Specifically, we found that compared to patients treated with surgery as their primary treatment modality, patients treated with primary radiotherapy were significantly less likely to utilize OT/PT services during the posttreatment period. Although a similar trend was observed for SLP services in subgroup analyses, the data were less consistent, with the overall analysis demonstrating that SLP utilization increased with treatment intensity. In contrast to surgical treatments that require hospitalization for postoperative care, primary radiotherapy, with or without chemotherapy, is administered in the outpatient setting in the United States. Because referral to rehabilitation services is commonly initiated during inpatient treatment to facilitate discharge planning, this may account for the lower rates of utilization observed in nonsurgically treated patients. Referral during inpatient treatment enables patients to become aware of rehabilitation services and provides the opportunity for patients to gain access to additional services during the posttreatment period. During inpatient care, SLP services may be initiated for swallowing assessment and to provide communications strategies. PT services may be initiated to improve shoulder mobility after neck dissection and to assist with ambulation or transfer. OT services may be initiated for home safety optimization, functional restoration after reconstruction, and acquisition of durable medical equipment for discharge. Similar findings were reported in breast cancer where rehabilitation interventions were 88% more likely to occur for physical impairments detected during hospitalization.²⁶ However, despite a relatively higher rate of utilization in surgically treated patients, the absolute utilization rates were low, suggesting that unmet rehabilitation needs likely also exist in this patient population.

Although inpatient cancer rehabilitation units exist in the United States, they are limited in number and are typically utilized during the acute care period (ie, after surgical resection).²⁷ In this study, which focused on the posttreatment period of 4-28 months after HNC diagnosis, the vast majority of rehabilitation services were administered in the outpatient setting. Prior literature has shown that functional and physical impairments requiring rehabilitation services were prevalent among outpatients with cancer but often go unrecognized.²⁸ In a survey of 759 speech language pathologists who treat HNC in the United States, 70.6% reported that they worked in institutions without policies for referring patients with HNC undergoing radiotherapy for SLP. Referrals are generated on a case-by-case basis.²⁹ Barriers to outpatient referral include a failure to recognize and document impairments by clinicians as well as a failure to further

evaluate patient-reported impairments. In fact, there exists a large discrepancy between perceived needs reported by patients and documentation by clinicians. For example, clinicians only documented difficulty with ambulation in 24% of patients who self-reported it as a problem.³⁰ Clinician documentation of functional impairments such as difficulties with IADLs was even lower, approaching 0%.³⁰ Standardized assessment of functional impairments during the HNC care continuum may improve recognition by clinicians and facilitate early referral to rehabilitation services.³¹⁻³⁴ For example, it has been proposed that computerized screening processes can be utilized to detect functional impairments in patients with HNC during radiotherapy and systemically trigger referral to allied health professionals.³⁵

The lack of HNC-specific rehabilitation services is another barrier to access and utilization identified by clinicians.¹⁸ With a growing body of evidence supporting its utility, SLP services have become incorporated into multidisciplinary clinics in some high-volume HNC practices in recent years, thereby increasing the capacity for referrals in the outpatient setting.^{15,18,32,33,36} This may partially account for findings in this study where treatment with surgery vs radiation did not consistently associate with SLP utilization. It is plausible that even without referral during initial outpatient treatment, symptoms and functional impairments acquired during treatment intensification triggered subsequent referral to available SLP services during posttreatment surveillance in certain institutions. In contrast, HNC-specific OT/PT services remain severely fragmented in the outpatient setting, even in high-volume cancer centers.^{19,33} As such, both physicians and rehabilitation therapists have reported reluctance to refer patients with HNC to general community-based services due to concerns about quality and lack of communication.¹⁹ Findings from this study provide further evidence that impairment-specific rehabilitation services should be better integrated into the HNC care continuum, particularly for patients treated with nonsurgically.

A limitation of the present study was that it only included patients with HNC who were 65 years of age and older at the time of diagnosis. As such, findings from this study cannot be generalized to a younger HNC population. Rehabilitation needs and utilization patterns are likely different in a younger population and need to be evaluated using alternative data sources. In addition, the age range of the present study led to the underrepresentation of patients with oropharynx cancer. Oropharynx cancer is more common than larynx cancer in most contemporary HNC cohorts. However, human papillomavirus-related oropharynx cancer, which accounts for 50%-80% of oropharynx cancers, affects a younger group of patients with a median age at diagnosis of 54 years.³⁷ As such, it may not have been adequately captured in this group of Medicare patients. In addition,

utilization of SEER-Medicare database did not provide information on specific impairments triggering rehabilitation services referrals. As such, future studies are needed to identify and quantify specific rehabilitation needs of patients with HNC. Additional studies utilizing a clinically curated database with more complete demographic and clinical data can facilitate ascertainment of additional independent predictors of rehabilitation services utilization.

5 | CONCLUSIONS

Little is known about the rehabilitation needs and service utilization patterns in HNC at the population level in the United States, which has important implications for improving quality of life outcomes in this group of high-risk patients. This is the first study to examine the posttreatment utilization of rehabilitation services in HNC in the United States. Data from this large, population-based study demonstrated that rehabilitation services are underutilized in patients with HNC. Underutilization was particularly prevalent within nonsurgically treated patients. In order to maximize quality of life and outcomes in HNC, more patients with functional impairments need to be identified and appropriately referred to HNC-specific SLP and OT/PT services during the posttreatment care continuum, particularly in patients who receive outpatient treatments only.

AUTHOR CONTRIBUTIONS

J.R.W. contributed to conceptualization, data analysis and curation, methodology, and manuscript writing—original draft, review and editing. Z.N., S.F. contributed to data curation, methodology, and data analysis. S.T., H.Z., S.G., K.A.H. contributed to methodology, data analysis, manuscript writing—review and editing. C.M.L. contributed to conceptualization, methodology, project administration, data curation, and manuscript writing—review and editing.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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APPENDIX TABLE

TABLE A1 International Classification of Disease (ICD)-9 diagnosis codes of interest

Variable	Codes
Radiotherapy	ICD-9 procedure codes: 92.21-92.27, 92.29 ICD-9 diagnosis codes: V58.0, V66.1-V67.1 CPT/HCPCS codes: 77401-77525, 77761-77799 Revenue Center codes: 0330, 0333
Surgery	ICD-9 procedure codes: 24.31, 25.1-25.4, 27.3, 27.32, 27.4, 27.42-43, 27.49, 27.72, 28.92, 29.33, 29.39, 30.0, 30.09, 30.1, 30.21-30.22, 30.29, 30.3-30.5, 76.2, 76.31, 76.39-76.42, 76.44-45. CPT/HCPCS codes: 21044-21045, 31365, 31367-31368, 31370, 31375, 31380, 31382, 31390, 31395, 31420, 38700, 38720, 38724, 40810, 40812, 40814, 40816, 40819, 41110, 41112-41116, 41120, 41130, 41135, 41140, 41145, 41150, 41153, 41155, 42104, 42106-42107, 42120, 42140, 42842, 42844-42845, 42890.
Chemotherapy	ICD-9 procedure code: 99.25. ICD-9 diagnosis codes: V58.1, V58.11, V58.12, V66.2, or V67.2. CPT/HCPCS codes: 96400 to 96599, J8999 to J9999, J8520, J8521, or Q0083 to Q0085. Revenue Center codes: 0331, 0332, or 0335.
Occupational and physical therapy services	CPT/HCPCS codes: G0283, 29105, 29125, 29126, 29130, 29131, 29200, 29240, 29260, 29280, 29505, 29515, 29520, 29530, 29540, 29550, 29580-29584, 64550, 90901, 90911, 95831-95834, 95851, 95852, 96125, 97010, 97012, 97014, 97016, 97018, 97022, 97024, 97026, 97028, 97032, 97033, 97034, 97035, 97036, 97039, 97001, 97002, 97003, 97004, 97110, 97112, 97113, 97124, 97139, 97140, 97150, 97530, 97532 (97127), 97533, 97535, 97537, 97542, 97545, 97546, 97610, 97755, 97760-97762, 97799.
Speech-language pathology services	ICD-9 codes: 93.72 aphasia treatment; 93.73 motor speech treatment; 93.74 speech defect training. HCPCS codes: 92506 (92521-92524), 92507, 92508, 92520, 92526, 92607-92612, 92616, 92597, 96105, 96110, 96125.