DRIVING BEHAVIORS IN PATIENTS WITH HEAD AND NECK CANCER DURING AND AFTER CANCER TREATMENT: A PRELIMINARY REPORT

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Abstract: Background. The purpose of this study was to explore the driving behaviors of head and neck cancer patients during and after cancer therapy.

Methods. Eighty-three patients completed a questionnaire related to driving behaviors.

Results. The survey revealed that 67.5% of respondents reported that they drove less or stopped driving during cancer therapy, and 26.5% continued to drive less or stopped driving after the completion of cancer therapy. Respondents typically reported greater concern about driving and relied more on other people for transportation during and after cancer therapy than before their diagnosis. Results indicated that the odds for self-restricted driving after cancer therapy were higher for those who were more concerned about driving under challenging driving situations and perceived impaired cognitive function that affected their driving ability.

Conclusions. These results suggest that perceived impairment resulting from cancer therapy has a significant impact on head and neck cancer patients’ driving behaviors.

Keywords: automobile driving; head and neck neoplasms; questionnaire; risk-taking; cross-sectional studies

Standard treatment for the cancer of head and neck includes surgery and radiation therapy, with chemotherapy playing a role in combined therapies and in palliative care for advanced disease. This treatment places patients at significant risk for head and neck mobility restriction, cognitive impairment, pain, and psychological distress. However, the impact of these dysfunctions on the activities of daily living (ADL), such as driving a motor vehicle, has not yet been reported.

Neck dissection for head and neck cancer may lead to motor dysfunction of the neck and shoulder muscles (eg, trapezius, sternocleidomastoid), resulting in decreased mobility of the head and neck (eg, limited head rotation and lateral flexion of the neck). In addition, radiation-induced fibrosis can lead to a significant decrease (about 20%) in mobility.
the range of motion (ROM) of the neck. More than two thirds of patients with head and neck cancer who undergo radiation therapy experienced neck fibrosis. 

Restricted neck rotation limits one's ability to see the entire field of traffic especially when turning to reverse a vehicle. Limited neck ROM was one of the factors independently associated with self-reported adverse driving events after adjusting for driving frequency. Further, people with limited neck ROM were 1.4 times more likely to be involved in a traffic accident when compared with those without this restriction. Safe driving clearly requires sufficient head and neck mobility.

Chemotherapeutic agents commonly used in the treatment of head and neck cancer include cisplatin, carboplatin, 5-fluourouracil, paclitaxel, and docetaxel, which may cause central neurotoxicity in addition to the more commonly observed side-effect of peripheral neurotoxicity.

The adverse effects of neurotoxicity from chemotherapy and radiation therapy on the central nervous system (CNS) are well documented. Cognitive, psychomotor, and visuoperceptual functions can be compromised in patients with head and neck cancer who receive cancer treatment. Reduced head and neck mobility, cognitive impairment, pain, and psychological distress, the primary side effects of cancer treatment, may predispose patients with head and neck cancer to greater driving risks and adverse outcomes. The present study is a cross-sectional survey that explores head and neck cancer patients’ driving behaviors, their associations with the adverse effects of cancer treatment, and concern about driving under challenging driving situations during and after cancer therapy.

**MATERIALS AND METHODS**

**Subjects.** Patients from the cancer registry of the Hollings Cancer Center (HCC), Medical University of South Carolina (MUSC), and Head and Neck Tumor Program clinic at HCC were invited to participate if they met the following inclusion criteria: (1) diagnosis of head and neck cancer, (2) age greater than 18 years, and (3) previous treatment with either radiation therapy or chemotherapy. Patients were excluded if they received surgery as the sole treatment modality, had never driven a motor vehicle, or did not possess a valid driver's license.

**Procedure.** Patients who met the stated inclusion criteria were solicited to participate in the survey via mail. Additional respondents were recruited during their physician appointments at the Head and Neck Tumor Program of HCC. A 7-page, 72-item questionnaire, developed by the first author in conjunction with a clinical psychologist, was designed to investigate the following:

1. **Perception of the impact of limited neck mobility, cognitive impairment, and cancer-related distress on driving ability.**
2. **Level of concern about driving under various challenging driving situations.**
3. **Perception of transportation assistance needs.**
4. **Amount of driving, number of traffic violations and accidents, and percentages of driving related to various ADLs (work, running errands, and social and leisure) before diagnosis, as well as during and after cancer therapy.**

The questionnaire was mailed to 183 patients who had been diagnosed with head and neck cancer since 1998, 90% of whom had been diagnosed...
between 2001 and 2004. An additional 15 patients were recruited on site. As an incentive to complete the questionnaire, patients received a $20 gift certificate. The study was reviewed and approved by the MUSC’s Institutional Review Board.

**Questionnaire.** The impact of various cancer-related adverse effects on driving ability after cancer therapy was addressed by 7 questions. These questions investigated whether limited neck mobility, pain, fatigue, anxiety, depression, difficulty thinking clearly, and paying attention as a result of cancer treatment have a negative impact on driving ability after cancer therapy. Each question was rated on a 5-point Likert-type scale ranging from 1 = “Strongly Disagree” to 5 = “Strongly Agree.” A composite mean score of perceived impaired cognitive function was ascertained from the 2 questions on clarity of thought and level of attention, with a higher score reflecting a more severe adverse impact on driving ability. The internal consistency coefficient (as estimated by Cronbach’s alpha) for these 2 items was 0.90. Another composite mean score of cancer-related distress was obtained from the 4 questions on pain, fatigue, anxiety, and depression. The alpha coefficient for these 4 items was 0.92.

Subjective level of concern about driving under 8 challenging driving situations (night, bad weather, heavy traffic, interstates/highways, unfamiliar environments, making left turns across intersections, changing lanes, and backing up) were compared at the time points before, during, and after cancer therapy. Each question was rated on a 4-point scale ranging from 1 = “Not Concerned At All” to 4 = “Very Concerned.” At each time point, a composite mean score was formed from these 8 questions with a higher score indicating more concern about driving under challenging driving situations. The alpha coefficients of these 8 items were 0.94 for before diagnosis, 0.96 for during cancer therapy, and 0.95 for after therapy.

The percentage of time patients depended on others for transportation needs and, percentages of driving related to work, household errands, and social and leisure activities were rated in a 5-point scale with 0 = 0%, 1 = 25%, 2 = 50%, 3 = 75%, and 4 = 100%. The amount of driving during and after cancer therapy when compared with before diagnosis was rated in a 4-point scale with 3 = more, 2 = same, 1 = less, and 0 = stop driving.

**Data Analysis.** The continuous data were not normally distributed (eg, rate of traffic offenses per month after cancer therapy was positively skewed because of a relatively low rate of occurrences). Additionally, the scoring of the percentage of time depending on others for transportation needs and percentages of driving related to various ADLs variables was ordinal. Because of these data condition, Wilcoxon signed-rank tests for 2 related samples were used to compare the mean rank scores before head and neck cancer diagnosis to that during or after cancer therapy. Significance of the results were based on 2-sided tests controlling for the type-I error rate at 0.025. Spearman rank correlations were used to analyze the association between mean rank scores of the variables.

In addition, the 4-point rating on the amount of driving was dichotomously classified into 2 = driving more or the same amount and 1 = driving less or stop driving (self-restricted driving) for comparison. Ordinary and multiple logistic regression models were used to explore the association of a set of predictors with respondents who decided to limit their driving (in binary classification) after cancer therapy. This set of predictors included: (1) sociodemographic characteristics (age when respondents completed cancer treatment, sex, race, educational level, marital and employment statuses, and presence of another person in the household with transportation); (2) type of cancer treatment; (3) cancer-related adverse effects (limited neck mobility, perceived impaired cognitive function, and cancer-related distress) that affect driving after cancer therapy; and (4) concern about driving under challenging driving situations. Univariate logistic regression analysis of these variables guided selection of candidate predictors for multivariate regression modeling. Predictors associated with respondents’ self-restricted driving that are significant at the alpha = 0.25 level were considered as candidate predictors for a multiple logistic regression model.26 A forward stepwise selection method was used to identify the final set of predictors associated with respondents’ self-restricted driving after cancer therapy. Odds ratios and 95% confidence intervals (CIs) were obtained for each predictor variable. All the logistic regression models were appropriate at alpha = 0.05. All analyses were performed using SPSS v.12.0 software (SPSS Inc., Chicago, IL).

**RESULTS**

Eighty-six of the 183 questionnaires were returned. The questionnaires of 18 respondents were not included for data analysis because the respondents were deceased or had never driven. Fifteen
patients from the HCC Head and Neck Tumor Program clinic completed the questionnaire. Therefore, data from 83 patients were available for the final analysis.

**Socio-Demographic.** The mean age of the patients was 61.4 (SD = 10.8) years old (range, 27 to 85 years); 65 (78.3%) were male, 69 (83.1%) were white, and 10 (12.0%) were black. Fifty-seven (68.7%) were married, 37.3% were employed with high school diplomas or more education. About two thirds (62.7%) reported that the cancer affected their oropharynx (eg, throat and tonsil), and 39.8% claimed the cancer affected their mouth cavity (eg, lips, tongue, and palate). Treatment received included chemotherapy (2.4% of the patients), radiation (39.8%), and chemoradiation (57.8%). In addition to radiation or chemotherapy, 58.3% of the patients had surgery. The mean driving experience of the patients before head and neck cancer diagnosis was 41.7 (SD = 13.2, median = 43.0) years. The mean duration between the head and neck cancer diagnosis and survey completion was 25.0 (SD = 22.1, median = 17.4) months, and the mean duration between the completion of cancer therapy and survey completion was 20.3 (SD = 22.1, median = 12.0) months.

**Driving Behaviors during and after Cancer Therapy.** The driving items revealed that 67.5% of patients reported that they drove less or stopped driving during cancer therapy, and 26.5% of patients continued to drive less or stopped driving after the completion of cancer therapy. Twenty-three (about 28%) patients reported that they stopped driving during cancer therapy, and 8 patients (about 10%) continued not driving after the completion of cancer therapy. Stopping driving after the completion of cancer therapy was not associated to age of the patients. For the patients who resumed driving, the majority did so at an average of 6 months after the completion of cancer treatment. Patients who did not resume driving after the completion of cancer therapy largely attributed their not driving to the adverse effects of their cancer and cancer treatment.

There was a significant reduction in the amount of daily mileage in the patients’ driving during cancer therapy ($Z = 3.725, p = .000$) and after the completion of cancer therapy ($Z = 3.381, p = .001$) when compared with before they were diagnosed with head and neck cancer. Significant correlations between the amount of daily mileage in patients’ driving and the amount of driving both during and after cancer therapy were found (see Table 1).

**Driving Related to Activities of Daily Living during and after Cancer Therapy.** With a decrease in the amount of driving, there was a significant increase in dependence on others for transportation during ($Z = 6.746, p = .000$) and after ($Z = 3.882, p = .000$) cancer therapy when compared with before the patients were diagnosed with head and neck cancer. Furthermore, compared with before head and neck cancer diagnosis, patients’ percentages of driving related to work ($Z = 5.240, p = .000$), social and leisure activities ($Z = 5.373, p = .000$), and household errands ($Z = 5.169, p = .000$) were significantly reduced during cancer therapy. This trend of significant reduction in driving related to work ($Z = 3.535, p = .000$) and social and leisure activities ($Z = 2.323, p = .020$) continued even after the completion of cancer therapy.

<table>
<thead>
<tr>
<th>Amount of driving</th>
<th>Daily mileage</th>
<th>Transportation needs</th>
<th>Concern about driving</th>
<th>Driving related to work</th>
<th>Driving related to errand</th>
<th>Driving related to social &amp; leisure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of driving</td>
<td>1</td>
<td>.801**</td>
<td>−.803**</td>
<td>−.290*</td>
<td>.270*</td>
<td>.540**</td>
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<tr>
<td>Daily mileage</td>
<td>.514**</td>
<td>1</td>
<td>−.753**</td>
<td>−.305*</td>
<td>.214</td>
<td>.444**</td>
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<td>Transportation needs</td>
<td>−.627**</td>
<td>−.596**</td>
<td>1</td>
<td>.248</td>
<td>−.145</td>
<td>−.594**</td>
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<td>Concern about driving</td>
<td>−.429**</td>
<td>−.418**</td>
<td>.416**</td>
<td>1</td>
<td>−.065</td>
<td>.100</td>
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<tr>
<td>Driving related to work</td>
<td>.254*</td>
<td>.257*</td>
<td>−.262*</td>
<td>.071</td>
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<td>.063</td>
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<tr>
<td>Driving related to errand</td>
<td>−.005</td>
<td>−.114</td>
<td>−.059</td>
<td>.028</td>
<td>−.162</td>
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<tr>
<td>Driving related to social &amp; leisure</td>
<td>.110</td>
<td>.221</td>
<td>−.216</td>
<td>−.230*</td>
<td>−.067</td>
<td>.269*</td>
</tr>
</tbody>
</table>

**Table 1.** Correlation matrix of variables related to head and neck cancer patients’ driving behaviors before and after cancer therapy.

**Significant at the 0.01 level (2-tailed).**

**Significant at the 0.05 level (2-tailed).**
Concern About Driving during and after Cancer Therapy. Patients were significantly more concerned about driving under challenging driving situations during \((Z = 2.830, p = .005)\) and after \((Z = 3.524, p = .000)\) cancer therapy when compared with before their head and neck cancer diagnosis.

Traffic Offenses after Cancer Therapy. Traffic offense data (ie, history of traffic accidents and citations, and speeding tickets) were transformed to rate of occurrence per month of driving experience. Traffic violations or accidents after cancer treatment were reported by 6 patients, and they were all driving either the same amount or more compared to before their diagnosis. On comparing the rate of traffic offenses before head and neck cancer diagnosis with that after cancer therapy, patients reported more traffic violations and accidents after the completion of cancer therapy \((Z = 4.626, p = .000)\).

Factors Related to Self-Restricted Driving after Cancer Therapy. The unadjusted and adjusted odds ratios (ORs) associated with the patients’ self-restricted driving after cancer therapy, together with various predictors, are presented in Table 2. Results of the ordinary logistic regression indicated that for a 1-unit increase in concern about driving under challenging driving situations, the OR for the patients to limit their driving increased by a factor of 4.45 \((95\%)\ CI = 2.11 to 9.38\); \(p = .000\). Similarly, the ORs for the patients to limit their driving for a 1-unit increase in the perceived impaired cognitive function, cancer-related distress, and limited neck mobility that affect driving were \(4.11 \ (95\%\ CI = 1.90 to 8.88; \ p = .000)\), \(3.10 \ (95\%\ CI = 1.67 to 5.78; \ p = .000)\), and \(1.83 \ (95\%\ CI = 1.22 to 2.77; \ p = .004)\), respectively.

These candidate predictors were then refined through an exploratory model building process. Results of the multiple logistic regression model indicated that concern about driving under challenging driving situations and perceived impaired cognitive function were in the final model to predict the likelihood of self-restricted driving after cancer therapy.

Surgery status was not statistically associated with the decision to drive less or stop driving during \((p = .503)\) or after \((p = .354)\) cancer therapy. Nor was surgery status significantly associated with any cancer-related adverse effects (including limited neck mobility) and concern about driving a vehicle under challenging driving situations (including backing up).

DISCUSSION

The present study found that about two thirds of surveyed patients with head and neck cancer reported driving less or not at all during cancer therapy, and more than a quarter of them continued to do so even after the completion of the cancer therapy. Based on the results of the regression model, the reduction in the amount of driving after cancer therapy is related to cancer treatment. In contrast to common belief, undergoing surgery in addition to cancer therapy was not related to the patients’ self-restricted driving during or after cancer therapy. In fact, surgery in addition to cancer therapy is independent of the typical treatment-related adverse effects (ie, limited neck mobility, perceived impaired cognitive function, pain, and psychological distress) that may impact driving ability of head and neck cancer patients. However, study is needed to investigate the impact on driving behaviors of surgery as the sole therapeutic intervention.

According to the regression model, the impact of perceived impaired cognitive function plays a significant role to predict head and neck cancer patients’ limiting their driving after cancer therapy. However, the association between this construct and the self-restricted driving requires additional research to further establish causation.

Of major concern is a significant reduction of driving related to social and leisure activities, which can have an impact on quality of life and emotional state of patients with head and neck cancer.

<table>
<thead>
<tr>
<th>Table 2. Unadjusted and adjusted odds ratios for head and neck cancer patients’ decision to limit driving after cancer therapy.</th>
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<tbody>
<tr>
<td>Variables</td>
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<tr>
<td></td>
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<tr>
<td>Level of concern about driving</td>
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<tr>
<td>Perceived cognitive impairment</td>
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<tr>
<td>Cancer-related distress</td>
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<tr>
<td>Limited neck mobility</td>
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</table>

cancer. Patients with head and neck cancer have reported having a significant reduction in social and leisure activities and quality of life after treatment. Further research on the impact of self-restricted driving on reduced social and leisure activities is a worthwhile pursuit.

While the results of this study suggested that a substantial number of patients with head and neck cancer limit their driving during and after cancer therapy, the findings must be considered in light of several limitations of the study. One of the principle limitations is the relatively small convenience sample. In addition, the return rate of the survey is less than satisfactory, as only a select subgroup of patients with certain characteristics responded; therefore, the study sample may be biased. As a result, generalizability of the findings is limited. The information on driving behaviors during and after cancer therapy was collected by questionnaire. This data collection method may have certain limitations, including overreporting in some areas, underreporting in others, as well as recall bias.

Since this study has identified key variables related to driving behaviors in this group of cancer patients, future study on constructing questions to investigate their driving behaviors can be more specific. This will shorten and simplify the questionnaire, which may lead to a higher return rate. Also, the present cross-sectional design does not allow for an accurate estimation of the impact of cancer on driving behaviors in patients with head and neck cancer; further study should employ a prospective longitudinal design. In addition, systematic investigation of driving behaviors in relation to the site of head and neck cancer, TNM (tumor, nodes, and metastasis) classification and stage, type of surgery, location of surgery or radiation, intensity of cancer therapy (duration, number of cycles, and dosage of chemotherapy or radiation therapy), and delayed neurotoxic effects caused by cancer therapy will help develop a comprehensive predictive model to determine the contributing factors that limit the patients’ driving.

CONCLUSION

This study documents that a substantial number of patients with head and neck cancer limit their driving during and after cancer therapy, regardless of whether they have undergone surgery or not. Limited driving after cancer therapy was independently associated with concern about driving under challenging driving situations and perceived impaired cognitive function. Patients typically reported greater concern about driving under challenging driving situations, relied more on other people for transportation, and reduced driving related to work and social and leisure activities than before diagnosis. In addition, the rate of traffic violations and accidents among patients with head and neck cancer after cancer therapy were significantly higher compared with before diagnosis. Results of this study provide preliminary evidence for the significant impact of treatment-related adverse effects on driving behaviors in patients with head and neck cancer especially after cancer therapy. They serve as an initial step toward developing a comprehensive model that identifies determinants to predict patients with head and neck cancer who limit driving during and after cancer therapy.

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REFERENCES