

A Qualitative Examination of Perceptions Surrounding Transcranial Magnetic Stimulation Preferences in Head, Neck, and Lung Cancer Survivors

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Abstract

Purpose

Head and neck cancer (HNC) and lung cancer (LC) survivors smoke at elevated rates at the time of diagnosis compared to other cancer survivors, and standard cessation interventions show suboptimal efficacy in this population. Transcranial magnetic stimulation (TMS) is FDA-cleared for smoking cessation, and it may also address co-occurring depressive symptoms undermining cessation in cancer survivors. No studies have examined TMS acceptability for smoking cessation in cancer populations.

Objective

To examine HNC/LC survivors' perceptions of TMS for smoking cessation as part of the assessment phase of the ADAPT-ITT framework.

Methods

HNC/LC survivors diagnosed within six months who currently smoked were recruited, and semi-structured interviews (45–60 minutes) were conducted via videoconference. Participants viewed a two-minute TMS educational video midway through the interview. Interview transcripts were analyzed using content and thematic analysis.

Results

Nine participants (7 head and neck cancer, 2 lung cancer survivors) provided data for this qualitative study. Smoking history ranged from 16 to 87.6 pack-years. Cancer diagnosis increased quit motivation, yet cessation was elusive. Despite no prior TMS knowledge, all nine participants expressed willingness to try TMS after the educational video, citing its non-invasive nature and independence from medications. The primary barrier was the six-week time commitment, with participants open to flexible, shorter treatment protocols. Facilitators included intrinsic motivation, family support, and structured accountability of clinic-based treatment. Participants recommended co-locating TMS with cancer care and providing educational materials through oncology providers.

Conclusions

HNC/LC survivors were receptive to TMS for smoking cessation after brief education. Findings support proceeding to subsequent ADAPT-ITT phases.

INTRODUCTION

Head and neck cancer (HNC) and lung cancer (LC) continue to be significant public health challenges.[1, 2] HNC and LC survivors exhibit the highest rates of current smoking at the time of diagnosis among all cancer types, with prevalence estimates ranging from 29–57% compared to approximately 11–14% among cancer survivors overall.[3–6] Continued smoking after diagnosis, occurring in over half of HNC and LC survivors who reported smoking near the time of diagnosis,[5] diminishes the effectiveness of chemotherapy and/or radiation treatments. This worsens prognosis by increasing locoregional recurrence (LRR), the occurrence of second primary tumors, and rehospitalization, and decreasing disease-free survival.[7–11] Smoking cessation among HNC and LC survivors improves cancer-specific and overall survival (OS), reduces LRR after treatment, and improves quality of life.[11–14] Tobacco use declines in the months after diagnoses, possibly due to the impact of the diagnosis and the physical, emotional, and cognitive impacts of the disease and treatment.[15, 16] However, smoking relapse after cancer diagnosis remains common; among head and neck and lung cancer patients, the 12-month relapse rates range from 13% for those who quit prior to surgery to 60% for those who smoked until the week before surgery.[17] Overall, systematic reviews report a weighted relapse rate of 44% (range 5–57%) across cancer populations who initially quit at diagnosis.[17] HNC and LC survivors also face many challenges interfering with successful cessation, like elevated rates of depressive and anxiety symptoms, [18, 19] fatigue, [20, 21] and pain.[22, 23] Novel interventions are much needed to improve abstinence rates in HNC and LC survivors, while also addressing their comorbidities, to decrease their mortality from cigarette smoking [7] and increase their OS. [12, 24]

Transcranial magnetic stimulation (TMS) is a noninvasive neuromodulation modality that is FDA-approved as an adjunct intervention for smoking cessation in non-cancer patients.[25, 26] TMS has potential for smoking cessation in HNC and LC survivors because it can address challenges that interfere with successful cessation, like depressive symptoms,[27] fatigue, [28, 29] and pain [30]. The favorable side-effect profile of TMS, which avoids the systemic effects and drug interactions associated with pharmacotherapy, makes it a particularly attractive intervention for medically complex HNC and LC survivors who are already managing multiple medications and treatment-related toxicities. [31–34] The current FDA-approved TMS protocol for smoking cessation, which was developed and evaluated in the general population without co-occurring medical conditions, employs a standardized regimen, daily sessions of 10 Hz stimulation five days per week for three weeks, followed by weekly sessions for an additional three weeks. [25] This “one-size-fits-all” protocol does not account for the unique clinical complexity of HNC/LC survivors, including their cancer treatment schedules, physical limitations, concurrent symptom burden, or the psychosocial complexity of their care.[35] Adapting this protocol for cancer survivors, particularly HNC/LC survivors, requires a systematic approach that incorporates the perspectives of multiple stakeholders, including oncology clinicians, tobacco treatment specialists, TMS psychiatrists, social workers, administrators, and, critically, the patients themselves.[35]

The ADAPT-ITT model (Assessment, Decision, Administration, Production, Topical experts, Integration, Training, Testing) provides a systematic, empirically grounded framework for adapting evidence-based interventions to new populations.[36] Originally developed for HIV prevention, the ADAPT-ITT framework has been successfully applied to diverse health behavior interventions and emphasizes community

stakeholder engagement throughout the adaptation process.[36] A central component of the ADAPT-ITT framework is the use of qualitative research methods, including semi-structured interviews and focus groups, to elicit the knowledge, attitudes, preferences, and perceived barriers of the target population and key stakeholders.[36] These qualitative data inform the systematic modification of intervention content, delivery, and implementation to ensure the adapted protocol is acceptable, feasible, and responsive to the specific needs of the new population.[36]

The present study represents the Assessment phase of the ADAPT-ITT framework, employing a semi-structured qualitative approach to examine the knowledge, attitudes, and perceptions of HNC/LC survivors regarding the adaptation of TMS for smoking cessation. By systematically eliciting perspectives on the acceptability of TMS among HNC/LC survivors, perceived barriers to implementation, and recommendations for protocol modifications, this study aims to generate formative evidence to guide subsequent phases of intervention adaptation. Findings from this work will directly inform the development of a tailored TMS smoking cessation protocol that addresses the distinctive clinical, psychosocial, and logistical needs of HNC/LC survivors, ultimately advancing the goal of integrating neuromodulation-based cessation interventions into comprehensive cancer care.

METHODS

HNC/LC survivors were recruited from outpatient clinics at an NCI-designated comprehensive cancer center in the southeastern US. Patients aged 18–85 years, diagnosed with HNC/LC in the last six months, who smoked tobacco cigarettes and were motivated to quit within the next three months, were approached for informed consent to participate in the study. If they agreed to participate, a 60-minute semi-structured interview was conducted via HIPAA-compliant Zoom videoconference after obtaining informed consent. A semi-structured interview guide was used, with the exact number and nature of follow-up questions tailored to each participant's response to a core set of prompts and open-ended questions with appropriate probes (see Appendix 1). The interview explored participants' tobacco use history, quit attempts, and perceived relationship between smoking and their cancer diagnosis and treatment. After assessing baseline awareness of TMS and showing a brief educational video, questions probed participants' initial reactions to TMS, perceived feasibility of standard and accelerated treatment schedules, cancer-specific considerations, willingness to try TMS, and preferences regarding information delivery, logistical convenience, and family support (see Appendix 1). A two-minute video produced by our lab staff was shown to participants midway through the interview.[37] The video featured background narration and depicted a participant undergoing a TMS session, with a MagVenture device, covering the basic mechanism of TMS, a visual walkthrough of the procedure, and its potential adverse effects.[37] Following the video, participants were asked about their perceptions of TMS and factors that would make TMS feasible and acceptable for smoking cessation. Participants received \$50 compensation for completing the qualitative interview.

All interview recordings were transcribed verbatim and analyzed using content and thematic analysis via NVivo, qualitative data management software. A codebook was developed from semi-structured

interview guide questions, with operational definitions and coding criteria established by the research team. Two coders (VB and KLH) independently coded all transcripts, with discrepancies resolved through discussion with a third team member (JSE) serving as adjudicator. Thematic saturation was assessed iteratively, and after the ninth interview, no new codes emerged, indicating that saturation had been reached.

RESULTS

Demographics

Twenty-seven patients were approached about the study while attending appointments at the Head/Neck and Respiratory Clinic at Markey Cancer Center. Of those, approximately 67% (n = 18) met eligibility criteria, and of these 18 participants, nearly 72% (n = 13) provided informed consent and enrolled in the study. Of the 13 patients who consented, 9 completed the interview. The mean and standard deviation of participants' age were 57.22 (9.55) years. All participants were White, and nearly 44% (n = 4) lived in rural areas, according to the most up-to-date Rural-Urban Commuting Area (RUCA) codes. Two participants had LC, and seven had HNC. Smoking history ranged from 16 to 87.6 pack-years. Detailed demographic information, including their cancer and smoking history, is provided in Table 1.

Table 1
Participant Demographics and Details

Participant ID	Age	Sex	Race	Cancer Site	Rural/Urban Dwelling	Smoking History Packs per day (PPD) Pack-years (PY)
1	64	F	White	LC	Urban (RUCA 4)	1 PPD for 43.1 yrs, 43.1 PY
2	64	F	White	LC	Rural (RUCA 10)	0.5 PPD, 45.4 yrs, 22.7 PY
3	37	M	White	HNC	Urban (RUCA 1)	1 PPD for 16 yrs, 16 PY
4	57	M	White	HNC	Urban (RUCA 2)	1 PPD for 36.5 yrs, 36.5 PY
5	56	F	White	HNC	Urban (RUCA 4)	2 PPD for 43.8 yrs, 87.6PY
6	62	M	White	HNC	Rural (RUCA 5)	0.5 PPD for 47 yrs, 23.5 PY
7	48	F	White	HNC	Rural (RUCA 6)	0.5 PPD for 34 yrs, 17 PY
8	59	M	White	HNC	Urban (RUCA 4)	1 PPD for 20 yrs, 20 PY
9	68	M	White	HNC	Rural (RUCA 6)	1 PPD for 51.2 yrs, 51.2 PY

Contextual/Background Themes Related to Tobacco Use and Cancer Experience

Key themes emerged from the data that provide some context for understanding how HNC/LC survivors who participated in this study view tobacco use, especially considering their experience with cancer (see Table 1).

Theme 1. Tobacco Use Experience

All participants shared that they have smoked for most of their lives, starting when they were teenagers or young adults. Most participants reported consistently smoking a pack a day or more, though some are smoking less and are trying to cut back. The majority also indicated having attempted to quit smoking at least once, if not multiple times, using a variety of methods (e.g., cold-turkey, medications, replacing cigarettes with candy and gum). However, they endorsed notable barriers to tobacco abstinence. While these barriers differed from individual to individual, there were commonalities among participants. Many participants spoke about the stress and anxiety of daily life, making it difficult to quit

smoking; others discussed how challenging it is to break the routine and habit of smoking cigarettes, and some spoke about social settings and exposure to others who smoke, keeping them from being able to fully quit.

Theme 2. Cancer Experience

All participants shared that their cancer diagnosis has had an impact on their smoking habits by increasing their motivation to quit. All 9 participants expressed that it was very important for them to quit, with some saying their cancer diagnosis was a “wake-up call” for them. A few participants reported cutting back on their smoking once they received their cancer diagnosis; however, one participant shared that “the emotional toll of being diagnosed with cancer led to increased smoking, despite feeling higher motivation to quit”.

Key Themes Related to Acceptability and Feasibility of TMS

Theme 3. TMS Knowledge and Attitudes

None of the participants were familiar with TMS prior to being approached about the present study. However, even without prior familiarity with TMS, participants perceived it as a helpful and efficient smoking-cessation tool after viewing a brief video on TMS and its potential risks and benefits. Participants noted that it may be especially helpful as it is a non-invasive option, and they wouldn’t need to take medications to complete the treatment. For example, one participant remarked: *“I mean, I think it would be wonderful. I mean, it’s something that’s ...not invasive... It would be more of a maybe possibly a more immediate help than say you try to do the nicotine patch, and you need to do...all this other stuff”* (ID 2, Table 1). Participants also suggested that TMS may be a more effective option for long-time smokers who have not had success with other forms of tobacco cessation treatment (e.g., nicotine patches, medications). Overall, participants expressed a willingness to try TMS for tobacco cessation.

Theme 4. Barriers to Receiving TMS

While expressing an openness to trying TMS, participants expressed concern about a few potential barriers to completing TMS for tobacco cessation. Highly cited was the time commitment required by the treatment protocol (one-hour sessions daily, five days a week, for three weeks). Most participants were still employed or had other obligations that limited their ability to commit to the treatment protocol. When offered the ability to complete the session over a shorter period (five-hour sessions daily, for five consecutive days), responses were split. Some acknowledged the shorter timeframe would be helpful, but some said the time commitment is still too great. A small number of participants expressed concerns about the clinical implications of receiving the treatment over a shorter period, namely, the potential risks associated with an increased daily TMS dose. Participants also discussed transportation

as a potential barrier, especially if they live many miles from the clinic. For example, one participant remarked: *"It's just the time constraints and being able to get away to be able to go and do it are probably the one thing that would keep me from being able to do it."* (ID 6, Table 1)

Theme 5. Facilitators to Receiving TMS

Participants also identified several facilitators of TMS as a potential tobacco cessation treatment. High motivation among participants to quit smoking was discussed by several participants as a facilitator, with one participant saying that if quitting was important enough to a patient, they would commit to the treatment regardless of the time involved. All participants expressed that support from friends and family would facilitate their completion of TMS treatment. One participant remarked: *"I, one of the main factors is that smoking my whole life possibly could kill me. I'm not going to know that until Thursday, but just the scare factor and just a wake-up call of how horrible it is, and then the fact that I've tried to quit, but here I am still smoking, so obviously what I've tried in the past hasn't worked. So pretty much all that plays a huge factor in my willingness to participate."* (ID 3, Table 1)

Theme 6. Suggestions & Recommendations

After discussing the potential barriers and facilitators to TMS, participants offered suggestions to modify the TMS treatment protocol to make it easier for those interested in participating. Offering TMS treatments at clinics near home (as opposed to the cancer center) to shorten participants' travel time was suggested by several participants to address concerns about the protocol's time commitment and potential transportation issues. Others shared the importance of integrating TMS into ongoing cancer care, noting that same-day appointments would help to further reduce logistical challenges of completing TMS.

All participants expressed a desire to learn more about TMS, including background information, the rationale for its use as a tobacco-cessation treatment, potential side effects, and its short- and long-term effects. It was recommended that this information be communicated by their physician or another member of their care team, as their providers are more familiar with their medical history and unique experiences and can recommend whether TMS is appropriate. While there was no clear preference for how patient education materials could be provided, participants indicated that pamphlets, websites, and videos would help them better understand TMS. For example, one participant remarked: *"Like the video was describing the possible side effects, but also the possible benefits. Maybe some form of a pamphlet or something like that to let them take home and look at and review. I wouldn't necessarily have to have statistics on it or anything of that nature, but just how it came to be developed, maybe a pamphlet and how it did become FDA approved. And maybe if there's other states, other organizations that are doing it, maybe include a little bit of their, I'm going to call it pass/fail rate. X amount of people out of 100. 75 of these people, they've quit smoking or that's a high number, 50–50 or whatever to give somebody an idea of, well, if ...many people can do it, I think I can do it and I need to do it."* (ID 6, Table 1)

DISCUSSION

This study represents the Assessment phase of the ADAPT-ITT framework, examining the knowledge, attitudes, and perceptions of nine HNC/LC survivors regarding TMS as a smoking cessation intervention [36]. To our knowledge, this is the first study to explore the acceptability of TMS for smoking cessation in any cancer population. Our findings reveal that, despite having no prior familiarity with TMS, HNC/LC survivors were receptive to it as a cessation tool after viewing a brief educational video, and identified key barriers and facilitators that must be addressed before proceeding to subsequent ADAPT-ITT phases.

All participants had smoked for decades, most at a pack-per-day or more, and had attempted cessation multiple times using currently available pharmacological treatments and even cold-turkey approaches. This pattern of persistent tobacco use despite multiple quit attempts is consistent with the broader literature demonstrating suboptimal cessation rates in HNC/LC populations, where even our most efficacious pharmacotherapy, varenicline, achieves only 20–30% abstinence rates. [38, 39] For these individuals, TMS represented something qualitatively different from interventions they had already tried, a brain-based treatment that does not rely on pharmacotherapy. The non-invasive nature of TMS and the absence of systemic medications were specifically cited by participants as advantageous, a finding particularly relevant for this medically complex population already managing multiple medications and treatment-related toxicities.

The cancer diagnosis itself emerged as a powerful motivational catalyst for quitting. All participants reported that their diagnosis increased their desire to quit, with several describing it as a "wake-up call." This heightened motivation represents a clinically actionable window for intervention and is consistent with previous studies showing cancer diagnoses serving as "teachable moments" in survivors due to their composite effects on 1) perception of risk to physical health and wellbeing, 2) affective responses like depressive and anxiety symptoms, and 3) a shift in identity as a cancer survivor and societal roles. [15] However, motivation alone was insufficient. Participants acknowledged that despite wanting to quit more than ever, they continued to smoke, underscoring the gap between motivation and behavior change that a neurobiological intervention like TMS could help bridge. Notably, one participant reported that the emotional toll of diagnosis increased smoking, highlighting the bidirectional relationship between cancer-related distress and tobacco use, and further supporting the rationale for TMS given its dual efficacy for both smoking cessation and depressive symptoms. [25, 40]

Participants' perceptions of TMS shifted meaningfully after viewing the two-minute educational video. [37] All nine participants expressed willingness to try the treatment, perceived it as potentially more effective than previous cessation methods, and viewed it as particularly suitable for long-time smokers who had exhausted other options. Building on a previous study in pregnant women, [41] this finding underscores the importance of patient education for the adoption of novel neuromodulation interventions and suggests that even brief, accessible educational materials can shift attitudes from unfamiliarity to openness. The video resource we created was brief, highlighting basic information and the process flow of a TMS session to introduce TMS without overwhelming participants.[37] However, participants endorsed the need for a longer video resource with more information on the positive

aspects of TMS, the scientific rationale for using TMS in smoking cessation, detailed side-effect profiles, long-term outcomes, and success rates reported in existing studies. Participants specifically recommended that this information be communicated by their own care team, reflecting the trust that cancer patients may place in their oncology providers and the importance of provider endorsement for novel interventions. These findings directly inform the subsequent production phase of ADAPT-ITT, suggesting that educational materials could include both brief and extended video resources for patients, in addition to pamphlets and websites, and that oncology providers should be equipped to use these resources when discussing TMS with their patients. [36]

The most salient barrier identified was the 6-week time commitment required by the current FDA-approved protocol. [25] The standard regimen of daily one-hour sessions, five days per week for three weeks, followed by weekly sessions for three additional weeks, was perceived as incompatible with participants' work schedules, caregiving responsibilities, and the demands of concurrent cancer treatment. TMS offers flexibility in its dosing delivery, allowing more than one session per day, depending on patient need and feasibility.[42] When an accelerated protocol was proposed (five-hour daily sessions for five consecutive days), responses were mixed - some participants found the compressed schedule more manageable, while others raised concerns about both the logistical burden of extended daily sessions and the clinical safety of increased daily TMS dosing. Transportation was identified as an additional barrier favoring compressed accelerated protocols, particularly for participants living in rural areas at considerable distances from the academic medical center.

Accelerated protocols are FDA-approved for major depressive disorder, with retention of more than 90% across trials for the 5-day protocol.[43, 44] A few trials have attempted these protocols for smoking cessation and stimulant use disorder.[45] The TMS trial that led to FDA approval for smoking cessation delivered one session daily and had a 28% attrition rate, consistent with the nearly 30% documented in substance use trials with in-person psychosocial interventions and the 15–35% documented in smoking cessation trials among cancer survivors.[25, 46, 47] Although we do not have direct evidence of accelerated protocols improving attrition in substance use disorder trials, it is plausible that expedited reduction in craving and withdrawal may lead to higher retention. Collectively, these findings point to the need for flexible dosing schedules, co-location of TMS with cancer treatment facilities, and exploration of accelerated protocols that can compact the 6-week protocol to a minimum of three weeks by doubling the number of daily sessions.

Several facilitators were also identified that could support TMS implementation. High intrinsic motivation to quit, driven by the cancer diagnosis, was the most prominent facilitator. Support from friends and family was universally cited as important for completing treatment, suggesting that psychosocial support structures (e.g., ride-sharing) should be incorporated into TMS protocol design. Importantly, some participants noted that the structured, clinic-based nature of TMS, requiring regular in-person attendance and clinician-guided administration, could be advantageous compared with self-administered treatments such as nicotine patches or gum, where adherence depends entirely on the

patient.[35] Patient care navigators could also play a role in helping patients maintain adherence with TMS sessions.

Participants' suggestions for protocol adaptation converged on several actionable recommendations. Offering TMS at local or satellite clinics to reduce travel burden, integrating TMS sessions with existing cancer care appointments to minimize additional clinic visits, and providing comprehensive educational materials through multiple modalities were consistently endorsed. These recommendations align with implementation science principles that emphasize integrating novel interventions into existing care workflows to maximize uptake and adherence.[35]

Limitations and Conclusion

This study has several limitations. **First**, the sample size of nine participants is small, though consistent with qualitative research methodology where data saturation, rather than statistical power, guides sample adequacy, and thematic saturation was achieved within this sample. **Second**, participants were recruited from a single academic cancer center in central Kentucky, which may limit generalizability to other geographic and demographic contexts, particularly regarding the identified transportation and access barriers. **Third**, participants' perceptions of TMS were based on a brief two-minute educational video rather than direct experience with the treatment, and attitudes may shift once participants undergo TMS. **Fourth**, the study focused exclusively on HNC/LC survivors, and findings may not generalize to survivors of other cancer types where smoking also impacts outcomes. **Finally**, the study captured a snapshot of attitudes in the period immediately preceding cancer diagnosis (within 6 months), and perceptions may evolve as patients progress through treatment and survivorship.

Despite these limitations, this study provides the first formative evidence for adapting TMS for smoking cessation among cancer survivors and fulfills the Assessment phase of the ADAPT-ITT framework.[36] Findings directly inform the subsequent Decision and Production phases, where the research team will use these data to make evidence-informed decisions about which protocol elements to modify and to produce adapted intervention materials, including expanded educational content and a revised TMS protocol that addresses the time, transportation, and informational barriers identified by participants. Future research should include focus groups with oncology clinicians, tobacco treatment specialists, and TMS providers to capture providers' perspectives on implementation, followed by a pilot feasibility test of the adapted protocol in a small open-label trial to establish preliminary safety, acceptability, and cessation outcomes in this population.[35]

Declarations

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Ethics Approval - This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional Review Board at the University of Kentucky College of Medicine

Consent to Participate - Informed consent was obtained from all individual participants included in the study.

Clinical Trial Number – Not applicable

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