


# Effect of Augmentative Technology on Communication and Quality of Life After Tracheostomy or Total Laryngectomy

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## Abstract

**Objective.** Surgical procedures that render patients acutely aphonic can cause them to experience significant anxiety and distress. We queried patient perceptions after tracheostomy or laryngectomy and investigated whether introducing augmentative technology was associated with improvement in patient-reported outcomes.

**Methods.** Participants included hospitalized patients who acutely lost the ability to speak due to tracheostomy or total laryngectomy from April 2018 to December 2019. We distributed questions regarding the patient communication experience and relevant questions from the validated V-RQOL questionnaire (Voice-Related Quality of Life). Patients were offered a tablet with the electronic communication application Verbally. Pre- and postintervention groups were compared with chi-square analyses.

**Results.** Surveys were completed by 35 patients ( $n = 18$ , pre-intervention;  $n = 17$ , postintervention). Prior to using augmentative technology, 89% of patients who were aphonic reported difficulty communicating, specifically noting breathing or suctioning (56%), treatment and discharge plans (78%), or immediate needs, such as pain and using the bathroom (39%). Communication difficulties caused anxiety (55%), depression (44%), or frustration (62%), and 92% of patients were interested in using an electronic communication device. Patients reported less trouble communicating after the intervention versus before (53% vs 89%,  $P = .03$ ), including less difficulty communicating about treatment or discharge plans (35% vs 78%,  $P < .01$ ). V-RQOL scores were unchanged.

**Discussion.** Acute loss of phonation arising from surgery can be highly distressing for patients, and use of augmentative technology may alleviate some of these challenges by improving communication. Further studies are needed to identify what additional strategies may improve overall well-being.

**Implications for Practice.** Electronic communication devices may benefit patients with acute aphonia.

## Keywords

patient safety, quality improvement, communication, quality of life, aphonia, tracheostomy, laryngectomy, augmentative technology, voice

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Patients with head and neck cancer (HNC) experience high rates of psychologic distress,<sup>1</sup> and suicide rates far exceed those in the general population.<sup>2</sup> Causative factors are multifactorial but can be partially attributed to the significant physical and functional challenges related to tumor burden or to the treatment rendered.<sup>3,4</sup>

Curative treatment for HNC consists of either surgery or radiation for early-stage disease and a combination of surgery, radiation, and/or chemotherapy for advanced disease.<sup>5–8</sup> The burden of HNC and the treatment delivered can be extensive and frequently include cosmetic defects, dysphagia, voice alterations, mucositis, xerostomia, and fatigue. Surgical procedures may also render the patient temporarily aphonic due to the need for tracheostomy or laryngectomy.<sup>9</sup>

The overall incidence of HNC is decreasing; however, there is an increasing incidence of HPV-related cancers of the oropharynx.<sup>10</sup> These patients tend to be younger and have improved prognosis.<sup>1</sup> With a growing number of survivors of HNC, the American Cancer Society has provided guidelines for survivorship care in patients with HNC.<sup>11</sup> These

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guidelines address key areas, such as assessment of physical and psychosocial effects of cancer treatment,<sup>11-13</sup> expanding beyond what used to be limited to oncologic surveillance.

After total laryngectomy and tracheostomy, patients must learn and adapt to new ways of communicating. Studies demonstrate that quality of life after laryngectomy is negatively affected for the first few months after surgery and subsequently improves for many patients by 1 year.<sup>9,14-16</sup> Similarly, studies show that the presence of tracheostomy in patients with HNC predicts worse quality of life.<sup>9</sup>

Acquired neurologic conditions such as amyotrophic lateral sclerosis, traumatic brain injury, and stroke-related aphasia also affect communication. Studies show that individuals with communication disability are more likely to experience worse quality of care and increased rates of preventable adverse events.<sup>17,18</sup> Augmentative and alternative communication (AAC) interventions refer to communication methods used to supplement or replace speech or writing for individuals with communication difficulties.<sup>19</sup> Studies demonstrate that AAC interventions can improve quality of life in patients with acquired neurologic conditions by optimizing function, empowering decision making, and providing opportunities for continued growth and education.<sup>20,21</sup> With the advances in technology and widespread use of smart devices, many patients now have access to a variety of electronic applications for AAC.<sup>19</sup>

Patients with HNC undergoing laryngectomy or tracheostomy work closely with speech-language pathologists pre- and postoperatively for language rehabilitation, yet there are few published studies of the use of AAC in this patient population. Small existing studies show that AAC interventions improve communication effectiveness in adults after phonomicrosurgery<sup>22</sup> and in children before tracheostomy.<sup>23</sup> In the HNC population, small pilot studies have demonstrated the feasibility and usefulness of AAC interventions,<sup>24-26</sup> but further studies are needed to determine if these interventions improve quality of life after surgery.

In this study, we performed a prospective cohort study to characterize the impact of iatrogenic aphonia on quality of life in patients undergoing major HNC surgery. We implemented the use of an electronic communication application in patients who underwent total laryngectomy or tracheostomy for HNC. We assessed the impact that this quality improvement initiative had on the patient communication experience and well-being.

## Methods

### Context

The University of Michigan Department of Otolaryngology—Head and Neck Surgery performs 200 to 300 operations per year involving tracheostomy or total laryngectomy for HNC. These cases are managed in a step-down unit with nurses dedicated to the care of otolaryngologic patients with airway problems or free flap reconstruction. Patients who are unable to use spoken voice to communicate are given a whiteboard and a pen to communicate postoperatively. Many of these

patients have difficulty using the whiteboard and pen due to free flap donor site morbidity, poor reading and writing comprehension, or medical comorbidities such as tremor. Some patients experience frustration, anger, or fear related to their inability to communicate.

Our practice at Michigan Medicine is to see patients for a postoperative visit 1 week after discharge as coordinated with speech-language pathologists to discuss voice rehabilitation. Through focus groups, we ascertained patient concerns related to communication in the acute postoperative period, leading to the intervention described here.

### Interventions

We implemented the use of an electronic communication application on an iPad in patients who acutely lost the ability to speak due to tracheostomy or total laryngectomy for HNC treatment from April 2018 through December 2019. After a careful review, the communication application Verbally was selected. This application had several key features rated to be important by patients undergoing these surgical procedures,<sup>27</sup> including keyboard, commonly used words, predictive speech, text-to-speech capabilities with male or female voice, chime sounds to call attention, frequently used phrases, and recently used phrases (<https://apps.apple.com/us/app/verbally/id418671377>). The patients were provided with a smart device with this communication application on postoperative day 1. Our dedicated head and neck nurse practitioners distributed and encouraged use of these iPads.

### Study of Interventions

To investigate the preintervention state, patients who underwent tracheostomy or laryngectomy for HNC treatment (N = 18) were provided with a standard whiteboard and pen to aid in communication on postoperative day 1. We assessed their communication experience and quality of life with a survey administered on postoperative days 3 to 5. The survey included questions to assess the patient communication experience and questions adapted from the validated V-RQOL measure (Voice-Related Quality of Life). Surveys were provided to patients in hard copy format. Nursing staff dictated responses when vision, reading, or writing challenges limited independent responses.

In the postintervention group, patients who underwent tracheostomy or laryngectomy (n = 17) were provided with the electronic communication application uploaded on an iPad. We evaluated the effect of the intervention on postoperative communication and quality of life with the same survey, administered on postoperative days 3 to 5. We compared survey results between the pre- and postintervention groups.

### Measures

**Patient Communication Experience.** To our knowledge, there are no validated questionnaires that assess patient communication experience in the immediate postoperative experience. For this reason, we developed a survey that asked patients targeted questions about their experience with

**Table 1.** Patient Demographic Data.<sup>a</sup>

Characteristic	Preintervention (n = 18)	Postintervention (n = 17)	P value
Surgical details			
Laryngectomy	22 (4/18)	53 (9/17)	.06
Tracheostomy	78 (14/18)	47 (8/17)	.06
Free flap reconstruction	83 (16/18)	88 (16/17)	.7
Male sex	83 (15/18)	88 (15/17)	.9
Age, y, mean (SD)	64 (12)	63 (9)	.9
Comorbidities limiting written communication	73 (8/11)	53 (9/17)	.3

<sup>a</sup>Values are presented as % (No.) unless noted otherwise.

communication postoperatively (Supplement S1a, available online).

**Quality of Life.** To assess impact of communication loss on quality of life, we presented questions adapted from the validated V-RQOL measure.<sup>28</sup> The V-RQOL assesses physical and social-emotional functioning. The questions asked in our study represent 2 of the 4 social-emotional domain questions on the V-RQOL: “I am sometimes anxious or frustrated because of my ability to communicate” and “I sometimes get depressed because of my voice” (Supplement S1b, available online).

### Analysis

The V-RQOL is scored on a Likert scale. For analyses, we recoded these results into binary variables such that no level of anxiety, depression, or frustration related to communication was scored 0 and any level of impairment was scored 1. SPSS (version 27; IBM) and Prism (version 8; GraphPad) were used to tabulate data. Categorical variables were compared through Pearson chi-square analyses. Statistical significance was attributed to a *P* value <.05. This is a pilot study; thus, no power analysis was performed to calculate a required sample size to detect statistically significant differences in our groups.

### Ethical Considerations

This study was approved by the University of Michigan Institutional Review Board (HUM00066405).

## Results

### Patient Characteristics

We evaluated communication experiences and voice-related quality of life outcomes in 35 patients (n = 18, preintervention; n = 17, postintervention). Demographic data are presented in **Table 1**. All patients underwent laryngectomy or tracheostomy during their operative procedure, which rendered them acutely aphonic postoperatively. Additional details of the operative procedures are noted in the table. The majority of patients had medical comorbidities that affected their ability to communicate (76% in the preintervention group and 53% in the postintervention group). These medical comorbidities included vision loss, hearing loss, surgical site

morbidity affecting upper extremity mobility, and tremor. There were no statistically significant differences between the pre- and postintervention groups in the demographic data collected.

### Evolution of the Intervention

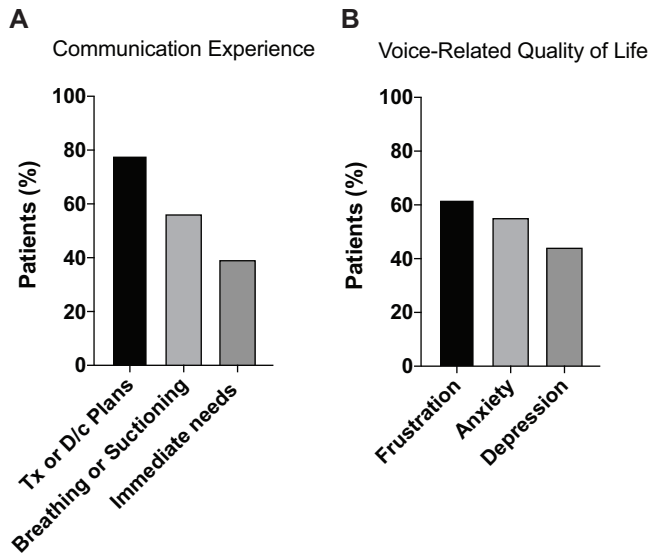
At the outset of this initiative, not all patients who underwent total laryngectomy or tracheostomy received the iPad with the electronic communication application. Suboptimal adoption was related to the limited quantity of devices available for patient use, the reluctance by some nursing staff to use the device, and the lack of patient experience with the technology.

To address these challenges, we received additional donated electronic devices for patient use. Meetings were held with nursing staff to discuss barriers to use of the device. These meetings revealed a knowledge gap related to the need for AAC in this patient population. An educational session was held with nursing staff to present preliminary data and to review patient perceptions of difficulty with communication and interest in using AAC devices. Following this educational session, we had improved implementation of the intervention.

We also learned that patients with experience using technological devices may use this device more effectively. Routine preoperative planning at our institution involves a meeting with our speech-language pathologists to discuss language rehabilitation. To this discussion, we added a brief introduction and training on the electronic communication application. This approach ensured that patients were familiar with the device when they arrived to the unit postoperatively. For our analyses, we included all patients who were given the device, regardless of their experience with technology, to reduce the risk of selection bias.

### Preintervention Outcomes

Our preintervention data demonstrated that 89% (16/18) of patients reported trouble communicating postoperatively. Patients had varied responses regarding which members of the care team they had trouble communicating with, although 78% (14/18) indicated difficulty communicating with their physicians. Patients articulated difficulty communicating about treatment or discharge plans (78%, 14/18), breathing or suctioning (56%, 10/18), or immediate needs such as pain management and going to bathroom (39%, 7/18; **Figure 1A**).



**Figure 1.** Preintervention communication experience. (A) Patients reported difficulty communicating about treatment (Tx) or discharge (D/c) plans, breathing or suctioning, or immediate needs. (B) Communication difficulties caused frustration, anxiety, or depression.

These communication difficulties caused frustration (62%, 8/13), anxiety (55%, 10/18), or depression (44%, 8/18; **Figure 1B**). Ninety-two percent (11/12) of patients stated that they were interested in the use of an electronic communication application in the postoperative period.

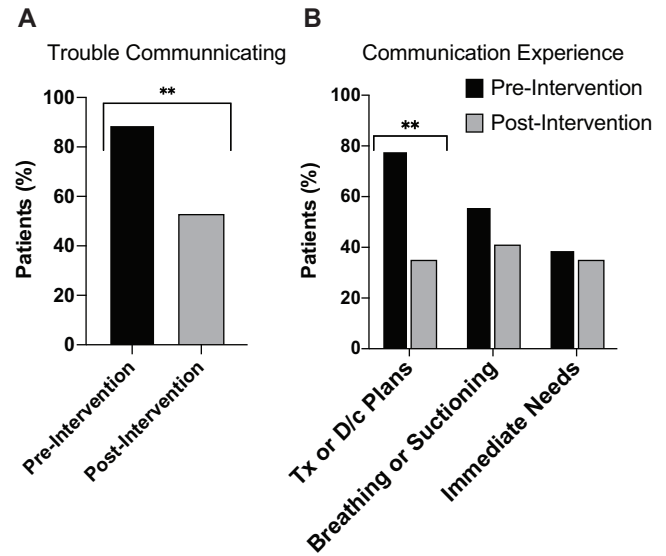
### Postintervention Outcomes

Patients who received the electronic communication intervention reported less trouble communicating. Self-reported rate of communication difficulties decreased from 89% (16/18) to 53% (9/17 [chi-square,  $P = .03$ ]; **Figure 2A**). Specifically, patients had less difficulty communicating about the treatment or discharge plans, decreasing from 78% (14/18) to 35% (6/17 [chi-square,  $P < .01$ ]; **Figure 2B**). This change was not captured in the limited subset of V-RQOL scores.

### Discussion

Our quality improvement study reveals that communication difficulties are a significant contributor to distress in patients following laryngectomy or tracheostomy for HNC. Communication difficulties cause anxiety, depression, and/or frustration in the majority of our patients. Patients are interested in augmentative and alternative interventions. Using an electronic communication application in the immediate postoperative period may mitigate communication difficulties in these patients.

Many otolaryngologic procedures lead to acute aphonia or voice changes. Few studies in this field cite communication or quality-of-life outcomes with the use of AAC interventions, although the small existing studies support findings presented here.<sup>22,23</sup> Allen et al performed a pilot study to implement the use of an electronic communication application on a tablet



**Figure 2.** Postintervention communication experience. (A) Patients who received the intervention reported less trouble communicating. (B) Specifically, patients had less difficulty communicating about the treatment (Tx) or discharge (D/c) plans.

device in patients who underwent microvascular reconstruction of the head and neck for oral cavity or oropharyngeal carcinoma. The majority of patients in their cohort described their feeling toward communicating with tracheostomy as “powerless or frustrating,” and all patients found an iPad device helpful for communicating.<sup>24</sup> Brunner et al investigated the feasibility of an iPad and communication application in the postanesthesia care unit in patients who underwent HNC surgery that resulted in impaired communication. Sixty-six percent of patients were able to use the customizable tablet, and at least 60% were satisfied with this intervention.<sup>25</sup> To our knowledge, our study is the first prospective quality improvement study to assess the impact of AAC on quality of life in patients who become aphonic due to HNC surgery.

Guidelines for survivorship care in HNC include recommendations to manage the physical and psychosocial effects of HNC and its treatment, such as communication disorders, anxiety, and depression.<sup>11</sup> The majority of academic HNC treatment centers employ a multidisciplinary approach to HNC care and survivorship, which includes voice rehabilitation with speech-language pathologists. Typically, this involves several preoperative visits to provide education, assess patient goals, and provide anticipatory guidance about what to expect after surgery.

Postoperative voice rehabilitation options after laryngectomy vary but include esophageal speech, external devices (electrolarynx), and most commonly tracheoesophageal voice prostheses (TEPs).<sup>29-31</sup> Studies have demonstrated superiority of TEP over other methods of voice restoration,<sup>32</sup> and successful rehabilitation with TEP leads to improvements in quality of life and self-reported anxiety and depression.<sup>33,34</sup>

In patients who undergo laryngectomy, there is often a period of aphonia before the TEP is functional due to wound-

healing issues and/or performing the TEP procedure in a delayed fashion.<sup>35</sup> Similarly, for patients with tracheostomy, there is a period of aphonia before the first tracheostomy tube change and placement of a speaking valve. During these periods of aphonia, AAC interventions such as this electronic communication application may be valuable. Implementing this intervention shows promise for improving communication difficulties, including patient understanding of treatment and discharge plans, which augments a patient-centered shared decision-making experience. A larger cohort of study is needed to confirm these pilot data and to determine if these interventions affect short- or long-term quality of life.

Future directions include development of an acute care communication instrument to quantify the extent of communication disorders and to objectively determine response to interventions. These data will allow us to target interventions to those most at risk. Additionally, data are needed to assess the impact of AAC interventions on caregivers such as family and medical providers. Finally, further studies are needed to determine the utility of enhanced education in preoperative counseling sessions to discuss expected postoperative communication challenges and potential interventions to mitigate these challenges.

There are several limitations of the present study. The sample size is small, which may over- or underestimate the intervention effect. There is a potential for selection bias as the device was not provided to all patients. Nursing may have been more inclined to give iPads to patients who they thought would succeed with a technological device, such as younger individuals with greater technological experience, which may have biased the results. There may have been variability in the way that nursing staff administered surveys to patients. A limitation for generalizability is the cost of the device and application, as well as the single-institution experience. Our study group was not affected by the cost, due to donation of the device and software used; however, if this is implemented in larger populations, cost analyses may be prudent.

## Implications for Practice

These data provide insight into the challenges that patients with HNC experience following laryngectomy or tracheostomy. Our results suggest that patients are interested in AAC interventions in the acute postoperative period while they are healing from surgery and awaiting definitive voice rehabilitation. AAC interventions may mitigate communication difficulties, although further studies are needed to determine what interventions can reliably improve quality of life.

## Author Contributions

**Catherine T. Haring**, design, data acquisition, analysis, writing of manuscript; **Janice L. Farlow**, design, data acquisition, analysis, critical review of manuscript; **Marie Leginza**, design, data acquisition, critical review of manuscript; **Kaitlin Vance**, design, data acquisition, critical review of manuscript; **Anna Blakely**, data acquisition, critical review of manuscript; **Teresa Lyden**, data

acquisition, critical review of manuscript; **Rebecca C. Hoesli**, design, data acquisition, critical review of manuscript; **Molly E. Heft Neal**, design, data acquisition, critical review of manuscript; **Michael J. Brenner**, design, analysis, critical review of manuscript; **Norman D. Hogikyan**, design, analysis, critical review of manuscript; **Robert J. Morrison**, design, analysis, critical review of manuscript; **Keith A. Casper**, design, data acquisition, analysis, critical review of manuscript.

## Disclosures

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## Supplemental Material

Additional supporting information is available in the online version of the article.

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