Effects of Oral Cancer Treatment: Speech, Swallowing, and Quality of Life Outcomes

Les effets des traitements contre le cancer buccal au niveau de la parole, de la déglutition et de la qualité de vie

Julie A. Theurer and Ruth E. Martin

Abstract

The treatment of oral cancer typically has extremely adverse effects on speech and swallowing (Chen et al., 2001). Deficits in speech and swallowing are long-standing, often permanent, and significantly impact quality of life (Zelefsky et al., 1996). A critical review of the oral cancer literature highlights several themes. First, a variety of outcome measures have been used in evaluating the effects of oral cancer treatment, based on discrepant definitions of treatment 'success' (Konstantinovic, 1999). Secondly, although functional deficits occurring within the first year posttreatment are well documented, there is little information on residual effects beyond 12-months posttreatment. Lastly, data on the specifics of speech therapy protocols and their effectiveness are scarce. There is a need for future research that incorporates appropriate and comprehensive outcome measures, provides long-term data, and validates speech therapy techniques. An alternative approach to outcomes measurement using the World Health Organization's International Classification of Functioning, Disability, and Health (World Health Organization, 2001) is proposed.

Abrégé

Il est bien connu que les traitements contre le cancer buccal ont des effets très négatifs sur la parole et la déglutition (Chen et al., 2001). Les difficultés au niveau de la parole et de la déglutition durent longtemps, sont souvent permanentes et ont un impact significatif sur la qualité de vie (Zelefsky et al., 1996). Cet article fait état d'une revue critique de littérature sur le sujet et met en évidence ces différents effets. Premièrement, il y a une grande variété de mesures utilisées pour évaluer les effets des traitements contre le cancer buccal. Ces mesures sont souvent basées sur des définitions différentes du « succès » de traitement (Konstantinovic, 1999). Deuxièmement, même si les difficultés post-traitement sont bien documentées au cours des 12 premiers mois, il n'en est pas de même concernant les effets résiduels suivant cette période. Finalement, l'auteur rapporte le peu de données concernant les protocoles de thérapie de la parole ainsi que leur efficacité. L'auteur constate un besoin éminent de recherches qui permettraient d'établir des méthodes de mesure des résultats de traitement, qui seraient appropriées et détaillées. De même, il serait aussi nécessaire d'établir des méthodes de collecte de données à long terme et de validation des techniques de thérapie. En conclusion, une approche de mesure de résultats est suggérée utilisant la Classification internationale du fonctionnement, du handicap et de la santé proposée par l'Organisation mondiale de la Santé (World Health Organization, 2001).

Key words: oral cancer, speech-language pathology, speech, swallowing, quality of life, International Classification of Functioning, Disability, and Health (ICF).

Julie A. Theurer and Ruth E. Martin
University of Western Ontario
London, Ontario

An increasingly large body of literature addresses the treatment of patients with oral cancer. While the presence of an oral tumor adversely affects oral functioning, the ensuing medical treatment can have devastating effects on speech and swallowing (Chen et al., 2001). For this reason, the treatment of patients with oral cancer is of the utmost

concern for health-care providers who encounter the functional deficits associated with such treatment in their rehabilitation of this patient population.

As the title of this paper indicates, our interest is in quality of life (QOL), as well as speech and swallowing outcomes. Quality of life can best be defined as an overall state of well-being, encompassing physical, psychological, emotional, and social factors, which has the potential to influence an individual's ability to perform activities within his/her daily life (Epstein, Robertson, Emerton, Phillips, & Stevenson-Moore, 2001; Doyle, 1994). This focus on QOL is based on the following observation. Treatment for oral cancer typically involves surgical resection of the cancerous pathology with accompanying reconstruction, and/or radiotherapy to control the spread of disease (Pauloski & Logemann, 2000). Currently, multimodal therapy for treatment of oral cancer is regarded as optimal because of its "curative potential" (Zelefsky et al., 1996), or success in controlling the spread and evolution of the disease. However, patients undergoing multimodal therapy often incur functional impairments (Konstantinovic, 1999). The juxtaposition of control of disease and associated functional impairments points to a potential discrepancy between the definitions of "success" for health professionals and patients. An acceptable result for the medical community is typically the control of disease, whereas patients may find this outcome unsatisfactory if they suffer functional impairments. In order for treatment to be most successful, patients' functioning and QOL must be held paramount in the evaluation of treatment success (Konstantinovic, 1999).

The consideration of QOL as an important outcome measure necessitates that the rehabilitation model to which health professionals subscribe extends beyond a biomedical approach (Perry & Shaw, 2000). Although physical functioning is an important component of QOL, it is not sufficient to provide a complete picture of a patient's well-being (Doyle, 1994; List, Ritter-Sterr et al., 1996). One rehabilitation model that encompasses the impact of health (and disruptions in health) at the body level, individual activity level, and societal participation level, while incorporating environmental and personal factors, is the International Classification of Functioning, Disability and Health (ICF; World Health Organization [WHO], 2001). The ICF, which seeks to standardize language by which health and health-states are described, provides a framework for evaluating the determinants and outcomes of health (World Health Organization, 2001). In using this framework to provide direction for assessment and management of health conditions (e.g., oral cancer), rehabilitation professionals will be looking beyond impairments at the body level to view the patient within his/her environment. This directly allows for the components of QOL (physical, psychological, emotional, and social well-being) to be considered in a holistic rehabilitation approach, ensuring that the patient's QOL is incorporated in the evaluation of rehabilitation success (Doyle, 1994; List, Ritter-Sterr et al., 1996).

The purpose of this paper is to synthesize and comment on published literature that reports the outcomes of oral cancer treatment with respect to speech, swallowing, and related QOL. We first review the surgical and radiotherapy treatment literatures and show that a variety of different outcome measures have been employed in evaluating the success of oral cancer treatment. Furthermore, although long-term effects of oral cancer treatment are purported, we conclude that there is relatively little data on chronic deficits beyond 12 months posttreatment. We then review the literature regarding management provided by speech-language pathologists, and conclude that there is a significant lack of research documenting the details and effectiveness of behavioural therapy protocols.

Pretreatment Oral Function

Pretreatment measures of speech intelligibility, swallowing efficiency, and QOL are crucial as these serve as baseline measures for comparison with posttreatment outcomes (Wagner et al., 1998). Since oral cancer patients show wide intersubject variation in preoperative functional measures, preoperative baseline measures that allow each individual to serve as his/her own control in postoperative evaluations are optimal (Wagner et al., 1998). Pretreatment speech, swallowing, and QOL measures are also needed to compare oral cancer patients with healthy controls in attempts to identify selective pretreatment deficits. Although several studies have reported pretreatment measures of speech, swallowing, and QOL, this information has been used primarily as baseline performance data to document direction and magnitude of change following treatment; however, minimal attention has been given to the nature of these pretreatment deficits per se.

Pretreatment studies have shown that patients with oral cancer exhibit alterations in swallowing timing and overall swallowing efficiency prior to surgical intervention (Pauloski et al., 2000). Despite these demonstrable differences, pretreatment swallowing generally remains functional, with only half of the patient population complaining of swallowing difficulties (Pauloski et al., 2000). Self-reports of pretreatment swallowing difficulties appear to be proportionally greater than identification of dysphagic patients with videofluoroscopy (Colangelo, Logemann, & Rademaker, 2000). Factors affecting swallowing prior to treatment include tumor stage, tumor size and tumor location, swallowing function being worse in association with larger, later-stage, and oropharyngeal tumors (Pauloski et al., 2000; Colangelo et al., 2000).

While pretreatment speech data have been compared to posttreatment measures, (Pauloski et al., 1993; Pauloski et al., 1994; Schliephake, Schmelzeisen, Schonweiler, Schneller, & Altenbernd, 1998; Rogers, Lowe, Brown, & Vaughan, 1999), a single study has focused on identifying/quantifying speech deficiencies in the oral cancer population prior to treatment with respect to 'normal' performance (Colangelo et al., 2000). The results of this study indicate that a "substantial proportion" of individuals with oral cancer exhibit reduced articulatory precision, as well as decreased

intelligibility in conversational speech, in comparison to normative data (Colangelo et al., 2000). These changes in speech performance are related to tumor variables (i.e., stage, size, location; Colangelo et al., 2000).

QOL data prior to treatment for oral cancer have been reported in efforts to quantify changes following treatment (Schliephake, Ruffert, & Schneller, 1996; Gliklich, Goldsmith, & Funk, 1997; Schliephake et al., 1998; Rogers, Lowe, et al., 1999; de Graeff et al., 2000; Epstein et al., 2001; Rogers, Lowe, Fisher, Brown, & Vaughan, 2002). However, as pretreatment QOL measures have not been compared with those of healthy controls, or patients with other types of cancer, it is unknown whether these patients experience decreased QOL prior to receiving treatment. With information regarding pretreatment QOL, professionals may be able to intervene at an earlier stage in the treatment process, potentially minimizing the deleterious impact of treatment on an already diminished QOL.

Effects of Resection/Reconstruction on Oral Function

The main aims of surgical treatment for oral cancer are removal of diseased tissue, adequate closure of the defect, and restoration of function, while minimizing deficits. However, restoration of function often must be sacrificed to fulfill the first two objectives (Kwakman, Voorsmit, & Feihofer, 1997). Surgical treatment can be further decomposed into resection and reconstruction. Resection refers to the surgical removal of diseased oral tissue, whereas reconstruction refers to suturing and incorporation of donor tissue into the resection site.

Studies of the effects of surgical treatment for oral cancer on speech and swallowing have shown that speech and swallowing disturbances can result when the removal of diseased tissue impinges on oral structures such as the tongue. Patients are heterogeneous in terms of posttreatment speech and swallowing function, impairments varying with the location and amount of tissue resected, type of reconstruction (Pauloski et al., 1993; Lazarus, 2000), as well as residual oral mobility and the patient's ability to adapt to change following surgery (Furia et al., 2000). For example, Colangelo, Logemann, Pauloski, Pelzer, and Rademaker (1996), reported a "very general" relationship between clinical T-stage and swallowing and speech measures three months postsurgical healing. Surgical variables related to resection and reconstruction impact not only on speech and swallowing physiology, but also on patients' perceived QOL (Konstantinovic, 1999).

Resection

Surgical resection varies with respect to location in the oral cavity. Patients who undergo resections of similar locations tend to display similar functional speech and swallowing deficits (Langton & Bradley, 1992). Resections of the (i) anterior and lateral floor of the mouth, or (ii) mandible, sparing the tongue, do not appear to reduce swallowing efficiency (McConnel et al., 1994). Individuals with mandibular resections involving only the alveolar process report steady, significant increases in QOL measures, while such increases occur much later in patients with partial mandibulectomy resections (Schliephake et al., 1996). In contrast, anterior resections that include the tongue have been shown to result in speech and swallowing deficits, which are particularly severe at 3 months postsurgery, with no observable trend toward improvement (Pauloski et al., 1993). Pauloski and colleagues (1993) reported that patients with anterior tongue and lateral floor of the mouth involvement demonstrated greater oral stage than pharyngeal stage dysphagia, leading to increased risk of malnutrition/dehydration due to difficulties with bolus formation and oral transit. Although tongue base contact with the posterior pharyngeal wall decreased significantly following anterior resection, this contact has been shown to return to normal levels within three months (Pauloski, Logemann, Fox, & Colangelo, 1995).

Base of tongue resections result in greater reduction of tongue mobility than tongue tip and dorsum resections. This reduced tongue mobility is associated with decreased speech quality (i.e., intelligibility of single words), postoperative dysphagia and drooling (Schliephake et al., 1998; Logemann et al., 1993). Patients receiving posterior resections present with greater conversational understandability in comparison to patients with anterior resections, but decreased swallowing efficiency is comparable across these groups (Logemann et al., 1993). In terms of QOL, patients with base of tongue resections report decreased QOL compared to patients undergoing resections of 'other sites' in the oral cavity (Zelefsky et al., 1996; Hassanein, Musgrove, & Bradbury, 2001).

Bilateral tongue resections are associated with greater reductions in tongue mobility, and greater deficits in intelligibility than unilateral defects (Schliephake et al., 1998). Individuals with bilateral resection of the oral tongue report lower QOL values than patients with either medial or unilateral resections (Schliephake, Neukam, Schmelzeisen, Varoga, & Schneller, 1995), and these values remain low throughout a 12-month period following surgery (Schliephake et al., 1996). Medial resections are associated with greater impairment than unilateral resections (Schliephake et al., 1998).

Resections can also vary with respect to the volume of tissue removed. Because swallowing efficiency decreases as the volume of resected oral tongue and tongue base increases (McConnel et al., 1994), efforts are made to preserve as much residual tongue as possible, and maintain movement and sensation in the tongue remnant (Brown, 2001). The amount of tissue resected also interacts with the structure(s) excised. For example, larger resections of floor of the mouth, tonsilar tissue, and mandible may not impact on swallowing as much as smaller resections of areas integral to swallowing physiology, such as the base of tongue (McConnel et al., 1994). Partial glossectomies (i.e., less than 50% of the tongue removed) lead to difficulty with bolus formation and transport, while total/subtotal glossectomies (i.e., greater than 50% of the tongue removed) result in both oral and pharyngeal difficulties, including oral cavity, pharyngeal and upper

esophageal sphincter residue (Furia et al., 2000). The extent of tongue resection also appears to predict functional speech recovery (Wagner et al., 1998), larger resections being associated with poorer speech function (Pauloski et al., 1998). Quality of Life ratings tend to be worse for individuals with more advanced tumors (Schliephake et al., 1995; Hassanein et al., 2001). Patients with higher T-stages also report problems of increased severity (Rogers, Lowe, et al., 1999). However, Schliephake and colleagues (1996) reported gradual increases in posttreatment QOL scores over the long-term, regardless of the volume of tissue resection.

Reconstruction

Reconstruction techniques ranging from simple to complex procedures have been developed in an effort to decrease morbidity while maintaining function (i.e. mastication, swallowing, speech) and cosmesis (Altman, Avery, & Johnson, 1997). Even as reliable reconstruction techniques are now considered routine, functional recovery can remain incomplete for many patients (Wagner et al., 1998).

Primary or direct closure, in which the defect is closed without the addition of donor tissue, can be used for small lesions of the tongue or cheek. Primary closure may be favourable, as it does not introduce donor tissue into the oral cavity, thus retaining more normal sensation (Logemann, 1998). However, this type of reconstruction for large defects has often led to poor oral function and is now rarely used (Altman et al., 1997). The use of direct closure increases the risk of anterior tethering of the tongue, which affects the tongue's posterior movement, and ultimately impacts on bolus propulsion during swallowing, and articulation of posterior speech sounds (Pauloski & Logemann, 2000).

Local flaps, used for the reconstruction of smaller defects, involve the use of adjacent mucosa (e.g., buccal) to fill the defect (Schliephake et al., 1998). Schliephake and colleagues found that, although local flaps had a negative effect on tongue mobility, particularly of the tongue base, speech intelligibility was rated best in patients with local flaps compared to other reconstructions. When looking at the combined effects of location of resection and type of reconstruction, local flaps in medial and bilateral locations are associated with decreased speech intelligibility (Schliephake et al., 1998). Patients receiving local flaps report higher QOL ratings compared to patients receiving distal flaps (Schliephake et al., 1996).

Distal flaps involve integration of tissue from donor sites outside the oro-facial complex (Altman et al., 1997). Distal flaps are typically used in the reconstruction of large defects. They tend to be bulky, interfering with movement of the tongue (Kwakman et al., 1997). Distal flaps are either pedicled or free. Pedicled flaps remain attached to the donor site whereas free flaps do not maintain a connection to the donor area, allowing for more distant donor sites to be utilized (Altman et al., 1997). Examples of pedicled flaps include the *pectoralis major myocutaneous flap* and the *latissimus dorsi myocutaneous flap*; free flaps include the *free radial forearm flap* and the *iliac crest flap* (Altman et al., 1997). The use of free flaps is generally preferred to pedicled flaps as the former are more pliable than the latter, allowing for increased tongue mobility (Langton & Bradley, 1992). Another important variable in tissue reconstruction is the integration of a flap of sufficient volume to fill the entire resection defect. Adequate volume is crucial for contact between the tongue remnant and the hard palate for both swallowing and speech (Brown, 2001), and in decreasing the probability of a depression forming in the floor of the mouth (Langton & Bradley, 1992).

The ability to maintain oral intake is significantly reduced following distal flap construction (Wagner et al., 1998). Many patients require diet modifications to maintain safe and efficient swallowing, or require non-oral feeding (Bodin, Lind, & Arnander, 1994). Not surprisingly then, overall swallowing efficiency is also decreased following reconstruction with a distal flap (Wagner et al., 1998), with no improvement noted in the first three months postoperatively (Pauloski et al., 1993). Improved swallowing can be expected if the skin flap contacts the hard palate superiorly and the pharyngeal wall posteriorly (Bodin et al., 1994), as these contacts allow for increased bolus control and increased bolus propulsion through the pharynx.

The use of distal flaps to repair anterior tongue and floor of the mouth resections leads to decreased articulatory precision (Wagner et al., 1998), and speech intelligibility, with no improvement in intelligibility noted during the three-month postoperative period (Pauloski et al., 1993). Distal flaps are associated with greater reduction of tongue mobility and less effective speech production relative to local flap reconstructions (Schliephake et al., 1998). However, the speech intelligibility of a small group of oral cancer patients with free radial forearm flaps was rated at the higher end of the intelligibility continuum, with no significant differences between their scores and those of healthy controls (Ferri, 1998). When asked to rate their own speech intelligibility, most individuals who classified their speech as unintelligible were those with larger defects and reconstruction using a pectoralis major myocutaneous flap (Perry & Shaw, 2000).

Distal flaps have been reported to result in decreased QOL ratings at one year posttreatment, compared to local tissue reconstruction. However, it is noteworthy that the patients requiring distal flap reconstruction often reported lower QOL ratings pretreatment, perhaps related to their larger areas of diseased tissue (Schliephake et al., 1996; Konstantinovic, 1999). Patients who received pectoralis major myocutaneous flaps for larger surgical defects have reported particularly low QOL scores (Konstantinovic, 1999).

Because normal sensation is critical for speech and swallowing, reinnervation of skin flaps has been undertaken in an attempt to increase sensation in the resected region (Konstantinovic, 1999). One study that compared reinnervated distal flaps with nonreinnervated flaps found no significant differences in terms of swallowing physiology, speech intelligibility or QOL ratings (Mah et al., 1996). However, since most patients in this study had floor of mouth resections, with some limited anterior tongue involvement, few inherent difficulties would be expected (Mah et al., 1996).

Evaluation of the effects of reinnervation in patients with more extensive surgical procedures is needed in future studies.

Cricopharyngeal Myotomy

Cricopharyngeal myotomy is a treatment technique that is believed to facilitate bolus flow during swallowing by altering the cricopharyngeal segment to decrease resistance to bolus flow into the esophagus (Ali et al., 1997). The procedure involves severing fibres of the cricopharyngeus muscle, and can be performed at the time of surgical resection (Langton & Bradley, 1992). Since patients receiving treatment for oral cancer often exhibit pharyngeal swallowing difficulties, the use of cricopharyngeal myotomy has been advocated in this patient population.

Ali and colleagues (1997) found that individuals for whom cricopharyngeal myotomy was most beneficial were those with intact tongue and pharyngeal musculature. However, they also concluded that indicators for the use of myotomy, as well as predictors of its success, are not clear. Considering that most oral cancer patients experience some disruption of tongue and/or pharyngeal musculature, they may not be ideal candidates for cricopharyngeal myotomy. Jacobs and colleagues (1999) found no differences in swallowing efficiency between patients with and without myotomy. Moreover, patients undergoing supraglottic laryngectomy with concurrent cricopharyngeal myotomy have been reported to resume an oral diet 2 to 12 months postoperatively, while nonmyotomized individuals resumed a full oral diet within two to four weeks (Sasaki, Joe, & Albert, 2001). Taken together, these findings fail to provide evidence of a rehabilitative advantage among patients with myotomy and, indeed, suggest that myotomy may result in increased posttreatment swallowing deficits. Therefore, the routine use of cricopharyngeal myotomy in surgery for oral cancer currently is not supported. In addition, the effects of cricopharygneal myotomy on QOL have not been examined. One could speculate that, in patients whose swallowing is improved, QOL would increase accordingly, while patients with persistent dysphagia would report decreased QOL scores.

Effects of Radiation on Oral Function

Not all patients who receive surgical treatment for oral cancer receive postoperative radiotherapy; however, for patients who do receive radiotherapy, a different course of recovery can be expected (Pauloski et al., 1994). Radiation causes xerostomia and tissue fibrosis (Brown, 2001), both of which can affect swallowing. Xerostomia, or dry mouth, affects sensory perception during swallowing, as patients report changes in taste, sensations of food getting stuck, and the need for increased amounts of water while eating (Logemann et al., 2001). Fibrosis, characterized as the stiffening or constriction of local tissues, impairs chewing and swallowing by limiting muscle contractions. During swallowing, fibrosis is associated with reduced tongue base retraction, laryngeal closure, and hyolaryngeal anterior excursion (List, D'Antonio et al., 1996; Kendall, Leonard, McKenzie, & Jones, 2000). Even in instances where surgical intervention is limited to an anterior location, all head and neck musculature exposed to radiation may be affected by xerostomia and/or fibrosis (Pauloski & Logemann, 2000).

Swallowing difficulties can occur during the course of radiation treatment, as well as following radiotherapy. Bodin and colleagues (1994) reported anecdotal evidence of patients losing weight during radiotherapy because of swallowing difficulties stemming from swollen oral and pharyngeal mucosa. While pretreatment difficulties in swallowing are related to tumor bulk, pain and soreness, deficits following the introduction of radiation are due to mucosal changes (Lazarus et al., 2000).

Individuals receiving single modality treatment of radiotherapy display poorer functional outcomes than those receiving surgical treatment alone, but individuals receiving a combination of both surgery and radiotherapy tend to demonstrate the poorest functional outcomes (Finlay, Dawson, Robertson, & Soutar, 1992; Hassanein et al., 2001). Decreased function at one month postsurgery is primarily due to surgical effects (radiation treatment is not implemented immediately following surgery and is therefore generally not completed by this evaluation point), while the combined effects of surgery and radiotherapy affect performance approximately three months posttreatment (Pauloski & Logemann, 2000). Pauloski and colleagues (1994) reported significant effects of radiotherapy on both speech intelligibility and swallowing efficiency. Decreases in swallowing efficiency were greater for patients receiving radiotherapy than for patients receiving surgical treatment alone (Pauloski & Logemann, 2000; McConnel et al., 1994). When examined across a 12-month period following treatment, patients who received radiation did not demonstrate any significant gains, while patients not exposed to radiotherapy improved significantly on measures of speech intelligibility and swallowing efficiency by 12 months (Pauloski et al., 1994). For patients receiving radiotherapy, speech and swallowing fail to improve progressively throughout the first year following treatment, with measures decreasing maximally around six months posttreatment, followed by modest improvement at 12 months (Pauloski et al., 1994; Pauloski & Logemann, 2000). These improvements one year posttreatment have been attributed to the resolution of treatment effects (i.e., tissue fibrosis, xerostomia, fatigue, pain), as well as functional compensations produced by the patient, as evidenced by increased muscular effort within the oral cavity (Pauloski & Logemann, 2000; Schilephake & Jamil, 2002)

Attempts to develop organ-preservation treatment techniques have led to treatment regimens utilizing higher dose radiation and chemotherapy (Newman et al., 2002; Magné et al., 2001). For example, Magné and colleagues (2001) evaluated a treatment regime aimed at increasing the total radiotherapy dose, thus improving regional control of the disease, without increasing later-occurring negative effects. These treatments have been shown to be more effective than conservative treatments in controlling the disease itself. In terms of their effects on speech and swallowing, increased concentration (i.e., supradose intraarterial cisplatin and external-beam irradiation; Newman et al., 2002) within the

head and neck tissues did not reduce swallowing efficiency more than conventional treatment, and produced only mildly decreased speech articulation of few sounds (Newman et al., 2002). These promising results suggest that increased chemoradiation dosages may be used without increased short-term effects on speech and swallowing. Combined interstitial irradiation and hyperthermia has been reported to result in oropharyngeal dysphagia, particularly at six months posttreatment (Lazarus, Logemann, Kahrilas, & Mittal, 1994). Long-term outcome data are needed to determine whether organ-preservation treatments result in late effects on speech and swallowing. Such effects should be examined to ensure that disease control is not impinging negatively on patient functioning (Newman et al., 2002).

QOL ratings are reduced immediately following cessation of radiation treatment (Epstein et al., 2001). While individuals report a moderate increase in life satisfaction approximately 6 months posttreatment, these measures do not reach pretreatment levels (Epstein et al., 2001), and much variability exists in the extent to which QOL measures approach pretreatment scores across individuals (Schliephake & Jamil, 2002). Reductions in QOL are associated with chewing and swallowing difficulties, oral pain, and altered speech (Epstein et al., 2001). Specific patterns in QOL outcomes have not been related to different tumor sites, most likely as wide-field radiotherapy used in treating oral cancer affects tissues beyond the tumor site (Pauloski & Logemann, 2000). In patients who receive aggressive treatment (i.e., twice-a-day radiotherapy with concomitant chemotherapy), acute toxicities are accompanied by severe, short-term decreases in overall QOL, but significant long-term improvements, indicating positive change (Magné et al., 2001).

Two features are particularly apparent in the preceding review of the resection/reconstruction and radiation treatment literatures. First, a variety of outcome measures have been employed. In terms of speech outcomes, some investigators have used subjective measures of conversational speech intelligibility to delineate changes following treatment (Schliephake et al., 1998; Perry & Shaw, 2000), while others have employed standardized intelligibility and articulation tests (Pauloski et al., 1993; Pauloski et al., 1994; Wagner et al., 1998). Videofluoroscopy has been used to examine treatment-related changes in swallowing physiology (Lazarus, Logemann, & Gibbons, 1993; Logemann, Pauloski, Rademaker, & Colangelo, 1997a; Furia et al., 2000; Veis, Logemann, & Colangelo, 2000). While videofluoroscopy is considered the gold standard in evaluating swallowing physiology, it does not provide information on the functional consequences of dysphagia (Furia et al., 2000). Thus, other authors have reported patients' postoperative diets (i.e., solid, semi-solid, or liquid diet) as an indication of treatment-related changes in swallowing (Finlay et al., 1992).

A recent study of laryngectomy patients by Ward, Bishop, Frisby, and Stevens (2002) reported a wide variety of swallowing outcome measures including resumption of oral intake, type of diet, swallowing complications, disability, handicap and distress related to swallowing. This type of comprehensive, functional swallowing outcome measure has not yet appeared in the oral cancer literature, but reflects an initial attempt at incorporating components of the ICF framework in outcomes assessment with head and neck cancer patients. In spite of the importance of QOL information in assessing treatment outcome, its inclusion has been inconsistent, with very little information appearing in the oral cancer literature until recently by a small number of investigators.

A second feature of the literature on surgical and radiation treatment for oral cancer is that long-term data regarding speech, swallowing and QOL is in short supply, with a particular paucity of data on the impact of radiotherapy on QOL. Although there is ample evidence of treatment-related effects on speech and swallowing at one year posttreatment, there is very little longer-term data on changes following the initial 12-month period. Long-term follow-up is inherently difficult due to the high morbidity rate of this patient population. The five year survival rate for oral cancer patients is 51.3%; this statistic has not changed significantly in the last two decades (German-Austrian-Swiss Cooperative Group on Tumors of the Maxillofacial Region; Gellrich, Schramm, Bockmann, & Kugler, 2002). Additionally, factors including higher cancer stage, larger resection volumes, flap reconstruction, as well as patient-specific factors, have been identified as increasing the likelihood of dropout prior to the 12-month evaluation (Colangelo et al., 1999a). With respect to speech and swallowing function following treatment for oral cancer, poorer speech outcomes have been reported to increase the risk of dropout (Colangelo et al., 1999b). Given these methodological challenges, only a handful of studies have reported data beyond six months posttreatment, leaving clinicians lacking evidence on changes that may be expected over longer periods of time.

Rehabilitation is a long-term process, and speech and swallowing function often do not return to pretreatment levels (Wagner et al., 1998). Long-term follow-up is of particular importance for patients receiving radiotherapy, as treatment effects can continue to develop during the first three years following the cessation of treatment (Magné et al., 2001), with functional effects being documented up to 10 years following the end of treatment (Lazarus, 1993). Patients would benefit from long-term follow-up for the identification of residual treatment effects and any disease recurrences (as most occur within first 24 months), and for education regarding signs and symptoms of recurrence, thereby promoting self-advocacy (Carlson, 2002). It is difficult to determine what type of long-term rehabilitation is being provided as current practices are not readily found in the literature. It is important to ensure that these individuals are not being lost to follow-up or experiencing a lack service provision. As with many populations for whom speech-language pathologists provide service, the psychological impact of disease diagnosis, particularly that of cancer, should be attended to early in the rehabilitation process (Doyle, 1994). Speech-language pathologists have an opportunity to commence a comprehensive program of rehabilitation with preoperative counseling (Doyle, 1994;

Lazarus, 2000; Logemann, 1989, 1998). Pretreatment counseling may prove to be invaluable in helping to shape patients' perceptions and expectations of the treatment process and ensuing changes in function, and may serve to moderate posttreatment QOL scores.

Treatment Specific to Speech and Swallowing Deficits

Ongoing functional impairments in speech and swallowing following oral cancer treatment necessitate the direct involvement of speech-language pathologists in rehabilitation. Therapy focused at reducing functional deficits generally involves the utilization of prosthetics and behavioural techniques. However, a review of the current literature reveals a significant lack of information regarding behavioural speech therapy techniques. Although treatment protocols have been suggested, including the use of manoeuvres, postural adjustments, and exercises (Logemann, 1998; Lazarus, 2000), the scarcity of data on the details and outcomes of therapy leads one to question their appropriateness for this patient population, and renders the implementation of evidence-based practice impossible. This lack of research is particularly critical for speech-language pathologists who bear responsibility for providing appropriate and beneficial therapy for speech and swallowing deficits following treatment for oral cancer.

Prosthetics

An oral prosthesis may be utilized following ablative surgery to improve oral cavity continuity, thereby enhancing swallowing and speech. The main purposes of prostheses are to (a) reshape the oral cavity, (b) direct food safely into the esophagus, (c) protect exposed underlying tissue, (d) create a surface for tongue contact, and (e) allow for improvements in the appearance of the patient's oro-facial complex (Aramany, Downs, Beery, & Aslan, 1982; Leonard & Gillis, 1990). Prostheses may be maxillary or mandibular. Maxillary prostheses provide continuity of the palatal arch and lower the hard palate in specific locations for tongue contact during speech and swallowing. Mandibular prostheses provide continuity of the mandible and allow for a prosthetic tongue (Leonard & Gillis, 1990). Patients undergoing partial glossectomy benefit from maxillary/palatal prostheses, while individuals undergoing total glossectomy benefit more from a mandibular prosthesis (Aramany et al., 1982; Leonard & Gillis, 1990).

A wide variety of approaches have been used in measuring the outcomes of prosthesis use. Subjective ratings of improvements in speech quality and swallowing (Lauciello, Vergo, Schaaf, & Zimmerman, 1980; Gillis & Leonard, 1983; Kaplan, 1993), as well as standardized intelligibility tests and instrumental swallowing assessments have been reported in the literature (Ballard, Kerner, Tyson, Ashford, & Rees, 1986; Robbins, Bowman, & Jacob, 1987; Leonard & Gillis, 1990; Shimodaira, Yoshida, Yusa, & Kanazawa, 1998).

The purpose of the palatal augmentation prosthesis is to lower the palate to a position where the tongue can articulate with the palate for both swallowing and speech. Construction of the palatal prosthesis is guided by knowledge of the residual capabilities of the remaining lingual tissue (Knowles, Chalian, & Shanks, 1984). For example, patients receiving anterior tongue resections require palatal prostheses that are built up anteriorly to facilitate articulation of anterior consonants, particularly fricatives and affricates (Lauciello et al., 1980). Prosthetic development is thus a process that requires attention to individual variability in the remaining oral structures (Leonard & Gillis, 1990). The use of a palatal augmentation (i.e. palatal drop) prosthesis has been shown to improve the oral preparatory and oral stages of the swallow, as well as overall swallowing efficiency, immediately following placement of the prosthesis, and following long-term use (Robbins et al., 1987). Anterior anchoring of the tongue is increased, enhancing bolus propulsion through the oral cavity and pharynx (Logemann, Kahrilas, Hurst, Davis, & Krugler, 1989). Oral transit times for all boluses, and particularly thicker consistencies (e.g., paste, solids,) are decreased with a palatal augmentation device (Logemann et al., 1989; Shimodaira et al., 1998).

The use of prostheses appears to improve overall speech intelligibility by increasing the accuracy of vowel production and decreasing the number of consonant production errors, although benefits derived from prostheses vary across individuals (Leonard & Gillis, 1990). Robbins and colleagues (1987) reported enhanced articulation following placement of a palatal augmentation device. With the use of a prosthesis that provides a lowered palatal vault appropriate for tongue-to-palate contacts, patients' speech intelligibility improved both on articulation tasks and in conversational speech (Shimodaira et al., 1998). Even with the use of a prosthesis, acceptable articulation of all phonemes may not be possible. Hence, patients should be encouraged to use consistent compensatory articulations to code sounds/sound classes that are difficult to produce (Casper & Colton, 1998; Skelly, 1973).

Shimodaira and colleagues (1998) proposed the use of different palatal vault shapes for speech and swallowing based on their finding that a bulky prosthesis designed for swallowing lowered the palate beyond the level optimal for intelligible speech, resulting in restricted tongue movement. A palatal prosthesis for speech should allow for tongue-to-palate contact at anterior and posterior points (Leonard & Gillis, 1990), while a swallowing prosthesis must allow for sufficient tongue-to-palate contact at all points along the hard palate.

Construction of prosthetics has been revolutionized by techniques that allow for adjustments to be made instantaneously, with the patient present, in an effort to achieve the best fit possible while providing maximum benefit for speech intelligibility and swallowing efficiency (Meyer, Knudson, & Myers, 1990). It is also possible to modify palatal prostheses to mimic the anatomy of the natural palate, for example, by adding palatal rugae or incisive papilla, thus increasing sensory feedback. It has been suggested that such feedback may aid articulation (Gitto, Esposito, & Draper, 1999).

Mandibular prostheses generally involve the creation of a prosthetic tongue appropriate for speech and swallowing. The mandibular prosthesis must provide a sufficiently stable base for the prosthetic tongue. Stability may be achieved through the use of dental implants providing the patient has suitable bone segments for implantation (Kwakman et al., 1997). For swallowing purposes, a dorsal groove in the synthetic tongue may aid in channeling food through oral cavity to the pharynx (Ballard et al., 1986; Gillis & Leonard, 1983). A similar type of construction aimed at improving swallowing of liquids involves constructing a cup and funnel in the floor of mouth. Liquids pool in the cup and then flow through the funnel into the pharynx, allowing for controlled bolus flow (Kaplan, 1993). The implementation of some type of food guidance system should improve the patient's ability to maintain normal head posture during meals, allow for nourishment to be taken orally (as opposed to tube feeds), and ultimately increase swallowing safety (Çötert & Aras, 1999; Lauciello et al., 1980). Another adjustment that can be made with a mandibular prosthesis is to lower the occlusal plane, thereby allowing the tongue remnant to place food on the occlusal plane for mastication (Lauciello et al., 1980). Success with mandibular prostheses has been variable, however it appears that any stabilization of the mandible provided by the prosthesis is important for success in swallowing (Ballard et al., 1986).

In creating a prosthetic tongue to improve speech intelligibility, Leonard and Gillis (1990) noted that the prosthesis must allow for closure or constriction at various points within the oral cavity (i.e. alveolar ridge, hard palate), as well as some anterior protrusion of the tongue for interdental sounds. If the prosthetic tongue has been created with grooves to augment swallowing, it will be difficult for the patient to achieve lingual-palatal approximation for certain speech sounds (e.g., fricatives, affricates; Çötert & Aras, 1999). Aramany and colleagues (1982) suggested that the optimal prosthetic tongue for speech purposes does not fill the entire palatal vault but has a flatter contour allowing for residual movement to specific areas of the palate during consonant articulation.

QOL data pertaining to the use of prosthetics are generally anecdotal, with improvements in speech and perceived appearance associated with prosthetic placement (Gillis & Leonard, 1983). In a group of patients with maxillary prostheses, improved QOL was related to the performance of the prosthesis in restoring speaking and eating capabilities (Kornblith et al., 1996). Moroi, Okimoto, and Terada (1999) evaluated QOL in patients using dental prostheses following treatment for oral cancer and found that satisfaction with one's dentures correlated with parameters of eating, esthetics, pain, health, and well being beyond that demonstrated for 'normal' denture wearers.

In patients receiving dental prostheses, long-term follow-up is essential for monitoring patients' levels of satisfaction with this type of management (Leeper & Gratton, 1999), as well as evaluating continuation of benefits. Speech-language pathologists should be involved in counseling before, during, and following prosthetic fitting to facilitate patients' adjustments to the prosthesis (Leeper & Gratton, 1999). Since recovery of some function may occur in the residual oral cavity musculature (e.g., tongue strength and range of motion), prostheses may no longer be necessary, or may need to be altered. Conversely, late-effects of radiation therapy may necessitate that a prosthesis be enhanced to allow for continuation of function at an acceptable level.

Manoeuvres

Rehabilitation may involve the use of voluntary manoeuvres or postural adjustments in attempts to ensure safe swallowing (Lazarus et al., 1993). Logemann, Rademaker, Pauloski, and Kahrilas (1994) note that it is important that manoeuvres and postural adjustments be introduced on a patient-by-patient basis, as no single technique benefits all patients, even those receiving similar surgical/radiation treatments. Oral cancer patients experiencing incomplete closure of the airway during swallowing may benefit from manoeuvres aimed at reducing risk of aspiration (e.g., supraglottic and super-supraglottic manoeuvres), while individuals with decreased opening of the cricopharyngeal sphincter may benefit from manoeuvres that allow for increased duration of cricopharyngeal opening (e.g., Mendelsohn manoeuvre; Lazarus et al., 1993). In order to achieve a good fit between an individual's swallowing difficulties and an effective manoeuvre, the impact of different manoeuvres on swallowing efficiency should be assessed objectively with videofluoroscopy (Logemann et al., 1994).

Lazarus and colleagues (1993) reported the effects of manoeuvres in a single patient with oral cancer. The super-supraglottic swallow and Mendelsohn manoeuvre increased tongue base retraction and laryngeal elevation, and decreased pharyngeal residue. The Mendelsohn manoeuvre also eliminated aspiration in this patient (Lazarus et al., 1993). These manoeuvres have been reported to make oral feeding possible for other patients by increasing swallowing safety. The maintenance of oral intake with a safe swallow, in contrast to implementation of non-oral feeding, is in the interest of QOL for the patient (Bulow, Olsson, & Ekberg, 2001). Bulow and colleagues (2001) suggested that the supraglottic swallow improved laryngeal elevation and cricopharyngeal opening in dysphagic patients (not all oral cancer patients), however these improvements were not significant in comparison to control swallows. Following radiotherapy, the super-supraglottic swallow has been shown to increase airway closure, hyoid elevation (with accompanying elevation of larynx), and base of tongue retraction (Logemann, Rademaker, Pauloski, & Kahrilas, 1997a; but see Chaudhuri et al., 2002). Tucking one's chin during a swallow has been shown to decrease the depth of penetration of material into the opening of the airway, thus decreasing the risk of aspiration (Bulow et al., 2001). Similarly, the use of an effortful swallow (i.e., conscious muscular effort exerted during swallow) has also been shown to significantly decrease the depth of laryngeal penetration (Bulow et al., 2001). While these short-term effects have been reported, long-term outcome data on the use of manoeuvres in patients with oral cancer is lacking. Long-term studies are needed to

document change associated with repeated use of compensatory manoeuvres.

It appears that some patients who have not received formal training in the use of manoeuvres or postural adjustments spontaneously develop such strategies. Individuals have demonstrated increased use of buccal, mandibular, pharyngeal and laryngeal musculature, multiple swallows, increased suction, and mandibular movements to decrease intraoral space in reaction to swallowing difficulties following treatment for oral cancer (Furia et al., 2000). No studies reporting QOL data in relation to the use of swallowing manoeuvres in patients with oral cancer were found. One can speculate that the use of certain manoeuvres may impact on QOL, dependent upon the perspective of each patient regarding the use and effectiveness of the behaviours.

Exercises

The rehabilitation of individuals following treatment for oral cancer is influenced by the mobility of the remaining oral structures and muscle coordination (Lauciello et al., 1980). Rehabilitation provided by speech-language pathologists should begin with pretreatment counseling, to share information regarding potential effects of treatment on speech and swallowing, helping patients prepare for what may lay ahead (Doyle, 1994; Logemann, 1998). Following surgical/radiation treatment, speech and swallowing evaluation should determine the need for therapy, and its directions. Logemann (1998) suggests that patients receive weekly therapy for several months following the cessation of treatment, with the introduction of oral exercises after the excision site has healed. Few researchers have described specific therapies aimed at increasing mobility and coordination. Most reports have been anecdotal in nature, perhaps in part because the protocols differ depending on individual patients' needs and residual anatomy and physiology. Within these anecdotal reports, details of therapy protocols are incomplete at best. In one of the few studies to document therapy effects, Logemann, Pauloski, Rademaker and Colangelo (1997b) showed that patients who regularly performed oral range-of-motion exercises in the first three months following oral and oropharyngeal surgery exhibited significantly greater improvement in global speech and swallowing measures compared to patients who did not do such exercises. Given the relative lack of research evidence, it is difficult for clinicians to ensure they are providing the best treatment for each patient. Long-term therapy data, with accompanying detailed reports of the therapy protocols to allow for clinical replication, are needed to identify functional changes that can be attributed to behavioural therapy in order to validate the use of specific techniques.

Pauloski and colleagues (1993) noted that therapy to improve speech intelligibility (e.g., oral motor exercises and articulation drills) generally was provided at the discretion of the treating clinician. Therapy may include oral motor exercises aimed at improving tongue to palate contact (e.g., tongue tip to hard palate, back of tongue to soft palate), as well as articulation strategies used to compensate for anatomical and physiological deficits (Pauloski et al., 1993), and strengthening and range of motion exercises of lip, jaw, and tongue (Lazarus, 2000). Videofluoroscopy can be useful in determining which exercises lead to enhanced swallowing safety and efficiency. When videofluoroscopy is not available, a variety of exercises should be implemented to maximize rehabilitation potential (Veis et al., 2000).

Several studies have evaluated outcomes of exercises, but these reports have not been specific to the oral cancer population. Veis and colleagues (2000) reported that the tongue base moved further during voluntary yawning, gargling, and backward tongue pulling compared to that during swallowing in a group of dysphagic clients, including patients with head and neck cancer, progressive and sudden neurologic insults, and general medical problems. The gargle technique produced the most retracted tongue position in the majority of subjects (Veis et al., 2000). These techniques may prove to be useful as exercises for individuals with decreased base of tongue retraction following oral cancer treatment.

Perlman, Luschei, and Du Mond (1989) reported that swallowing itself evokes more activity in the pharyngeal constrictors than that created by any non-swallowing activities. This suggests that swallowing may ultimately be the best treatment for dysphagia associated with weak pharyngeal musculature (Perlman et al., 1989). This highlights the importance of therapy aimed at resuming an oral diet, albeit within the constraints of safely and nutrition. It has been suggested that goals, such as increasing mobility and aspiration prevention, can be addressed through the use of jaw and tongue range of motion exercises, bolus manipulation exercises, and thermal tactile stimulation to aid in triggering a delayed swallow (Lazarus, 2000; Pauloski et al., 1993).

The paucity of information presented regarding clinical treatment protocols being used by speech-language pathologists is of great concern. Without clear descriptions of the therapy protocols being implemented, outcome data are not clinically useful. Limited positive gains from behavioural therapy have been attributed to a low rate of therapy implementation with this population (Pauloski et al., 1994). Rigorous research studies, including case series designs, are needed to document the effectiveness of exercises to provide support for the use of such techniques in rehabilitation. Although the afore-mentioned exercises seem intuitive to use with this patient population, research data are not available to support the use of these behavioural therapy protocols.

Quality of Life

The importance of QOL has been recognized in the laryngeal cancer literature for some time (Doyle, 1994; List, Ritter-Sterr et al., 1996). Presumably the diagnosis of cancer impacts patients' QOL, regardless of the location of the disease (Doyle). Until recently, little information has appeared regarding the effects of treatment for oral cancer on QOL. Nevertheless, both speech and eating have been shown

to strongly predict QOL ratings following treatment for head and neck cancer (Karnell, Funk, & Hoffman, 2000). Information on the impact of speech and swallowing therapy on QOL appears to be completely lacking. The information that is available suggests that QOL is influenced by many of the same factors that affect function, such as extent and location of resection, type of reconstruction and the use of radiotherapy (Rogers, Lowe et al., 1999). Subjective QOL ratings decrease in the first six months following treatment, with modest improvements noted at one year posttreatment (de Graeff et al., 2000). Deficits in QOL several years following treatment tend to be similar to those observed at the end of the first year posttreatment (Rogers et al., 2002). Thus, evaluation of QOL at one year may be a useful indicator of long-term outcome (Rogers et al.).

In future studies, QOL measures should be obtained prior to, and at the cessation of, clinical treatment protocols to determine treatment success, or the need for further intervention (Magné et al., 2001). Quality of Life evaluation needs to be multidimensional, encompassing all variables that impact QOL, and assessed through objective measures and reported self-perceptions of oral cancer patients, in order to obtain a true evaluation of their perceptions of treatment, as patients are the final arbiters of treatment success (Lauciello et al., 1980; Stoeckli, Guidicelli, Schneider, Huber, & Schmid, 2001; Tiwari et al., 2000). Oral cancer patients have specific deficits that are not adequately addressed through the use of general QOL assessment tools, even those specific to cancer patients (Chen et al., 2001; Gliklich et al., 1997). Patients experiencing functional oral limitations have rated their general health as essentially normal on general QOL measures (Hammerlid & Taft, 2001), while disease-specific measurement tools more adeptly measure changes in function following treatment for specific diseases/deficits (Chen et al.). Thus, general and disease-specific assessment tools provide complementary information in the assessment of patients' QOL following treatment of oral cancer (Gliklich et al.).

Although a plethora of general and disease-specific QOL measurement tools are available, they are not used consistently in the oral cancer literature, with continued use of idiosyncratic questionnaires (Tiwari et al., 2000) making integration of outcome data difficult. One QOL measurement tool specific to swallowing is the SWAL-QOL, a psychometrically validated QOL tool for use with patients with dysphagia (McHorney et al., 2002). Use of the SWAL-QOL with the oral cancer population has not been reported to date. Even more specific is a recently developed tool for assessing the impact of dysphagia on QOL of head and neck cancer patients, the M. D. Anderson Dysphagia Inventory (MDADI; Chen et al., 2001). Rogers, Fisher, and Woolgar (1999) have provided a comprehensive review of many of the validated QOL measurement tools.

As an increasing number of valid, reliable, sensitive, and specific tools for collecting information regarding patients' QOL become available, it is important to ask how QOL information should be used. The literature suggests that QOL information may be used to (a) monitor long-term outcomes (Chen et al., 2001), providing data regarding the progression/resolution of treatment effects, (b) provide patients with education as to the treatment process and its associated morbidities (List, D'Antonio et al., 1996), or (c) continually evaluate the impact of treatment upon the individual in order to shape future health care practices (Chen et al.). The QOL of cancer survivors should be considered the final appraisal point in the course of treatment (Stoeckli et al., 2001).

Conclusions and Future Directions

Understanding treatment outcomes in relation to speech, swallowing, and QOL for patients with oral cancer is inherently difficult due to the heterogeneity of the population, and the challenge of maintaining large subject samples for long-term follow-up. A broad range of research methods have been employed across studies, particularly with respect to measures of outcome. Implicit in the choice of an outcome measure is one's definition of "successful treatment" since it may be regarded as the end point of the treatment process. While survival and control of malignancy are of paramount concern for healthcare professionals (Perry & Shaw, 2000; Stoeckli et al., 2001), patients may be equally concerned with the functional consequences of surgical or radiation treatment (Perry & Shaw), but the effects of these treatments on patients' overall function has received much less attention (Chen et al., 2001). For example, the impact of swallowing deficits on posttreatment pneumonia and nutrition, and the impact of speech difficulties on social relationships have not been explored.

In this vein, outcomes research with respect to speech and swallowing for patients with oral cancer could benefit from implementing the ICF (World Health Organization, 2001). This framework classifies the consequences of disease and the effects of those consequences on the individual experiencing the disease (Eadie, 2001). In regards to treatment for oral cancer, the effects of surgery/radiation on oral anatomy and physiology have been reported. However, attention must also be given to any associated limitations in activity (e.g., swallowing) and restrictions in participation (e.g., eating in social situations) to ensure the patient's QOL is being considered. Integrating the ICF framework into outcomes measure-ment following oral cancer treatment would serve to ensure that outcome variables are universal, and that areas of impairment, activity limitation and participation restriction are included systematically in future research. Incorporating these classifications into outcomes measurement ensures a holistic approach to rehabilitation (Eadie, 2001) and incorporates the interests of all persons involved in the treatment of oral cancer.

Summary

This paper has drawn together the results of various research studies to provide a picture of the functional difficulties experienced by individuals receiving treatment for oral cancer. To better serve patients following treatment of oral cancer, suggestions for future research include utilizing

outcome measures that focus beyond the level of impairment, and collection of long-term data on treatment effects. The absence of research data on speech-language pathology treatment protocols is particularly critical for those clinicians who bear responsibility for providing appropriate and beneficial therapy for speech and swallowing deficits following treatment for oral cancer. Future efforts aimed at describing and evaluating speech therapy protocols will serve to inform clinical practice, thereby improving the quality and universality of therapy.

Acknowledgments

This work was supported by an Ontario Ministry of Health Career Scientist Award to Ruth E. Martin, a Natural Sciences and Engineering Research Council of Canada grant OGPO1712208 to Ruth E. Martin, and a Premier's Research Excellence Award to Ruth E. Martin.

Author Notes

Please address all correspondence to Julie A. Theurer, PhD Program in Rehabilitation Sciences, Elborn College, University of Western Ontario, London, Ontario, N6G 1H1.

The first author would like to dedicate this paper to the memory of Dr. H. A. Leeper, whose mentorship revealed the gratification of working with the oral cancer population.

References

Ali, G. N., Wallace, K. L., Laundl, T. M., Hunt, D. R., deCarle, D. J., & Cook, I. J. (1997). Predictors of outcome following cricopharyngeal disruption for pharyngeal dysphagia. *Dysphagia, 12,* 133-139.

Altman, K., Avery, C. M. E., & Johnson, P. A. (1997). Reconstruction techniques in oral carcinoma. *Dental Update, 24,* 50-52.

Aramany, M. A., Downs, J. A., Beery, Q. C., Aslan, Y. (1982). Prosthodontic rehabilitation for glossectomy patients. *The Journal of Prosthetic Dentistry, 48*(1), 78-81.

Ballard, J. L., Kerner, E., Tyson, J., Ashford, J., & Rees, R. (1986). Adenocarcinoma of the tongue complicated by a hemimandibulectomy: Soft tissue support for a tongue prosthesis in an edentulous glossectomy patient. *The Journal of Prosthetic Dentistry, 56*(4), 470-473.

Bodin, I. K. H., Lind, M. G., & Arnander, C. (1994). Free radial forearm flap reconstruction in surgery of the oral cavity and pharynx: Surgical complications, impairment of speech and swallowing. *Clinical Otolaryngology, 19,* 28-34.

Brown, A. E. (2001). Functional reconstruction of the tongue: Can we do better? *British Journal of Oral and Maxillofacial Surgery, 39,* 256-259.

Bulow, M., Olsson, R., & Ekberg, O. (2001). Videomanometric analysis of supraglottic swallow, effortful swallow, and chin tuck in patients with pharyngeal dysfunction. *Dysphagia, 16,* 190-195.

Carlson, E. (2002). Follow-up in patients with oral cancer. *Journal of Oral and Maxillofacial Surgery, 60,* 387-388.

Casper, J. K., & Colton, R. H. (1998). *Clinical manual for laryngectomy and head/neck cancer rehabilitation* (2nd ed.). San Diego, CA: Singular.

Chaudhuri, G., Hildner, C. D., Brady, S., Hutchins, B., Aliga, N., & Abadilla, E. (2002). Cardiovascular effects of the supraglottic and super-supraglottic swallowing maneuvers in stroke patients with dysphagia. *Dysphagia, 17,* 19-23.

Chen, A. Y., Frankowski, R., Bishop-Leone, J., Hebert, T., Leyk, S., Lewin, J., et al. (2001). The development and validation of a dysphagia-specific quality-of-life questionnaire for patients with head and neck cancer. *Archives of Otolaryngology Head and Neck Surgery, 127,* 870-876.

Colangelo, L. A., Logemann, J. A., Pauloski, B. R., Pelzer, J. R., & Rademaker, A. W. (1996). T stage and functional outcome in oral and oropharyngeal cancer patients. *Head & Neck, 18,* 259-268.

Colangelo, L. A., Logemann, J. A., & Rademaker, A. W. (2000). Tumor size and pretreatment speech and swallowing in patients with resectable tumors. *Otolaryngology-Head and Neck Surgery, 122,* 653-661.

Colangelo, L. A., Logemann, J. A., Rademaker, A. W., Pauloski, B. R., Smith, C. H., McConnel, F. M. S., et al. (1999a). Factors related to dropout in a study of head and neck cancer patients after surgery. *Otolaryngology-Head and Neck Surgery, 120,* 368-374.

Colangelo, L. A., Logemann, J. A., Rademaker, A. W., Pauloski, B. R., Smith, C. H., McConnel, F. M. S., et al. (1999b). Relating speech and swallow function to dropout in a longitudinal study of head and neck cancer. *Otolaryngology-Head and Neck Surgery, 121,* 713-719.

Çötert, H. S., & Aras, E. (1999). Mastication, deglutition and speech considerations in prosthodontic rehabilitation of a total glossectomy patient. *Journal of Oral Rehabilitation, 26,* 75-79.

de Graeff, A., de Leeuw, J. R. J., Ros, W. J. G., Hordijk, G.-J., Blijham, G. H., & Winnubst, J. A. M. (2000). Long-term quality of life of patients with head and neck cancer. *Laryngoscope, 110,* 98-106.

Doyle, P. C. (1994). *Foundations of voice and speech rehabilitation following laryngeal cancer.* San Diego, CA: Singular.

Eadie, T. L. (2001). The ICIDH-2: Theoretical and clinical implications for Speech-Language Pathology. *Journal of Speech-Language Pathology and Audiology, 25,* 181-200.

Epstein, J. B., Robertson, M., Emerton, S., Phillips, N., & Stevenson-Moore, P. (2001). Quality of life and oral function in patients treated with radiation therapy for head and neck cancer. *Head & Neck, 23,* 389-398.

Finlay, P. M., Dawson, F., Robertson, A. G., & Soutar, D. S. (1992). An evaluation of functional outcome after surgery and radiotherapy for intraoral cancer. *British Journal of Oral and Maxillofacial Surgery, 30,* 14-17.

Ferri, C. L. (1998). *Alteration in vowel production following surgery for oral cancer.* Unpublished master's thesis, University of Western Ontario, London, Ontario.

Furia, C. L. B., Carrara-de Angelis, E., Martins, N. M. S., Barros, A. P. B., Carnerio, B., & Kowalski, L. P. (2000). Video fluoroscopic evaluation after glossectomy. *Archives of Otolaryngology Head and Neck Surgery, 126,* 378-383.

Gellrich, N. C., Schramm, A., Bockmann, R., & Kugler, J. (2002). Follow-up in patients with oral cancer. *Journal of Oral and Maxillofacial Surgery, 60,* 380-386.

Gillis, R. E., & Leonard, R. J. (1983). Prosthetic treatment for speech and swallowing in patients with total glossectomy. *The Journal of Prosthetic Dentistry, 50(6),* 808-814.

Gitto, C. A., Esposito, S. J., & Draper, J. M. (1999). A simple method of adding palatal rugae to a complete denture. *The Journal of Prosthetic Dentistry, 81*(2), 237-239.

Gliklich, R. E., Goldsmith, T. A., & Funk, G. F. (1997). Are head and neck specific quality of life measures necessary? *Head & Neck, 19,* 474-480.

Hammerlid, E., & Taft, C. (2001). Health-related quality of life in long-term head and neck cancer survivors: A comparison with general population norms. *British Journal of Cancer, 84(2),* 149-156.

Hassanein, K. A.-A. M., Musgrove, B. T., & Bradbury, E. (2001). Functional status of patients with oral cancer and its relation to style of coping, social support and psychological status. *British Journal of Oral and Maxillofacial Surgery, 39,* 340-345.

Jacobs, J. R., Logemann, J., Pajak, T. F., Pauloski, B. R., Collins, S., Casiano, R. R., et al. (1999). Failure of cricopharyngeal myotomy to improve dysphagia following head and neck cancer surgery. *Archives of Otolaryngology Head and Neck Surgery, 125,* 943-946.

Kaplan, P. (1993). Immediate rehabilitation after glossectomy: A clinical report. *The Journal of Prosthetic Dentistry, 69(5),* 462-463.

Karnell, L. H., Funk, G. F., & Hoffman, H. T. (2000). Assessing head and neck cancer patient outcome domains. *Head & Neck, 22,* 6-11.

Kendall, K. A., Leonard, R. J., McKenzie, S. W., & Jones, S. U. (2000). Timing of swallowing events after single-modality treatment of head and neck carcinomas with radiotherapy. *Annals of Otology, Rhinology, Laryngology, 109,* 767-775.

Knowles, J. C., Chalian, V. A., & Shanks, J. C. (1984). A functional speech impression used to fabricate a maxillary speech prosthesis for a partial glossectomy patient. *The Journal of Prosthetic Dentistry, 51(2),* 232-237.

Konstantinovic, A. S. (1999). Quality of life after surgical excision followed by radiotherapy for cancer of the tongue and floor of the mouth: Evaluation of 78 patients. *Journal of Cranio-Maxillofacial Surgery, 27,* 192-197.

Kornblith, A. B., Zlotolow, I. M., Gooen, J., Huryn, J. M., Lerner, T., Strong, E. et al. (1996). Quality of life of maxillectomy patients using an obturator prosthesis. *Head & Neck, 18,* 323-334.

Kwakman, J. M., Voorsmit, R. A. C. A., & Feihofer, H. P. M. (1997). Improvement in oral function following tumour surgery by a combination of tongue plasty by the Steinhauser technique and osseointegrated implants. *Journal of Cranio-Maxillofacial Surgery, 25,* 15-18.

Langton, S. G., & Bradley, P. F. (1992). The management of dysphagia after surgery for oral malignancy. *British Journal of Oral and Maxillofacial Surgery, 30(1),* 8-13.

Lauciello, F. R., Vergo, T., Schaaf, N. G., & Zimmerman, R. (1980). Prosthodontic and speech rehabilitation after partial and complete glossectomy. *The Journal of Prosthetic Dentistry, 43(2),* 204-211.

Lazarus, C. L. (1993). Effects of radiation therapy and voluntary maneuvers on swallow functioning in head and neck cancer patients. *Clinics in Communication Disorders, 3(4),* 11-20.

Lazarus, C. L. (2000). Management of swallowing disorders in head and neck cancer patients: Optimal patterns of care. *Seminars in Speech and Language, 21(4),* 293-309.

Lazarus, C., Logemann, J. A., & Gibbons, P. (1993). Effects of maneuvers on swallowing function in a dysphagic oral cancer patient. *Head & Neck, 15,* 419-424.

Lazarus, C., Logemann, J. A., Kahrilas, P. J., & Mittal, B. B. (1994). Swallow recovery in an oral cancer patient following surgery, radiotherapy, and hyperthermia. *Head & Neck, 16,* 259-265.

Lazarus, C., Logemann, J. A., Pauloski, B. R., Rademaker, A. W., Larson, C. R., Mittal., B. B., et al. (2000). Swallowing and tongue function following treatment for oral and oropharyngeal cancer. *Journal of Speech and Hearing Research, 43,* 1011-1023.

Leeper, H. A. & Gratton, D. G. (1999). Oral prosthetic rehabilitation of individuals with head and neck cancer: A review of current practice. *Journal of Speech-Language Pathology and Audiology, 23*(3), 117-133.

Leonard, R. J., & Gillis, R. (1990). Differential effects of speech prostheses in glossectomized patients. *The Journal of Prosthetic Dentistry, 64(6),* 701-708.

List, M. A., D'Antonio, L. L., Cella, D. F., Siston, A., Mumby, P., Haraf, D., et al. (1996). The performance status scale for head and neck cancer patients and the functional assessment of cancer therapy-head and neck scale: A study of utility and validity. *Cancer, 77(11),* 2294-2301.

List, M. A., Ritter-Sterr, C. A., Baker, T. M., Colangelo, L. A., Matz, G., Pauloski, B. R., et al. (1996). Longitudinal assessment of quality of life in laryngeal cancer patients. *Head & Neck, 18,* 1-10.

Logemann, J. A. (1989). Speech and swallowing rehabilitation for head and neck tumor patients. In E. N. Myers & J. Y. Suen (Eds.), *Cancer of the head and neck* (2nd ed.) [pp. 1021-1043]. New York: Churchill-Livingstone.

Logemann, J. A. (1998). *Evaluation and Treatment of Swallowing Disorders* (2nd ed.). Austin: Pro-Ed.

Logemann, J. A., Kahrilas, P., Hurst, P., Davis, J., & Krugler, C. (1989). Effects of intraoral prosthetics on swallowing in oral cancer patients. *Dysphagia, 4,* 118-120.

Logemann, J. A., Pauloski, B. R., Rademaker, A. W., & Colangelo, L. A. (1997a). Super-supraglottic swallow in irradiated head and neck cancer patients. *Head and Neck, 19,* 535-540.

Logemann, J. A., Pauloski, B. R., Rademaker, A. W., & Colangelo, L. A. (1997b). Speech and swallowing rehabilitation for head and neck cancer patients. *Oncology (Huntingt)., 11,* 651-659.

Logemann, J. A., Pauloski, B. R., Rademaker, A. W., McConnel, F. M., Heiser, M. A., Cardinale, S., et al. (1993). Speech and swallow function after tonsil/base of tongue resection with primary closure. *Journal of Speech and Hearing Research, 36,* 918-926.

Logemann, J. A., Rademaker, A. W., Pauloski, B. R., & Kahrilas, P. J. (1994). Effects of postural change on aspiration in head and neck surgical patients. *Otolaryngology – Head and Neck Surgery, 110,* 222-227.

Logemann, J. A., Smith, C. H., Pauloski, B. R., Rademaker, A. W., Lazarus, C. L., Colangelo, L. A., et al. (2001). Effects of xerostomia on perception and performance of swallow function. *Head & Neck, 23,* 317-321.

Magné, N., Marcy, P. Y., Chamorey, E., Guardiola, E., Pivot, X., Schneider, M., et al. (2001). Concomitant twice-a-day radiotherapy and chemotherapy in unresectable head and neck cancer patients: A long-term quality of life analysis. *Head & Neck, 23,* 678-682.

Mah, S. M., Durham, J. S., Anderson, D. W., Irvine, R. A., Chow, C., Fache, J. S., et al. (1996). Functional results in oral cavity reconstruction using reinnervated versus nonreinnervated free fasciocutaneous grafts. *The Journal of Otolaryngology, 25(2),* 75-81.

McConnel, F. M. S., Logemann, J. A., Rademaker, A. W., Pauloski, B. R., Baker, S. R., Lewin, J., et al. (1994). Surgical variables affecting postoperative swallowing efficiency in oral cancer patients: A pilot study. *Laryngoscope, 104,* 87-90.

McHorney, C. A., Robbins, J., Lomax, K., Rosenbek, J. C., Chignell, K., Kramer, A. E., & Bricker, D. E. (2002). The SWAL-QOL and SWAL-CARE outcomes tool for oropharyngeal dysphagia in adults: III. Documentation of reliability and validity. *Dysphagia, 17,* 97-114.

Meyer, J. B., Knudson, R. C., & Myers, K. M. (1990). Light-cured interim palatal augmentation prosthesis: A clinical report. *The Journal of Prosthetic Dentistry, 63(1),* 1-3.

Moroi, H. H., Okimoto, K., & Terada, Y. (1999). The effect of an oral prosthesis on the quality of life for head and neck cancer patients. *Journal of Oral Rehabilitation, 26,* 265-273.

Newman, L. A., Robbins, K. T., Logemann, J. A., Rademaker, A. W., Lazarus, C. L., Hamner, A., et al. (2002). Swallowing and speech ability after treatment for head and neck cancer with targeted intraarterial versus intravenous chemoradiation. *Head & Neck, 24,* 68-77.

Pauloski, B. R., & Logemann, J. A. (2000). Impact of tongue base and posterior pharyngeal wall biomechanics on pharyngeal clearance in irradiated postsurgical oral and oropharyngeal cancer patients. *Head & Neck, 22,* 120-131.

Pauloski, B. R., Logemann, J. A., Colangelo, L. A., Rademaker, A. W., McConnel, F. M. S., Heiser, M. A., et al. (1998). Surgical variables affecting speech in treated oral/oropharyngeal cancer patients. *Laryngoscope, 108,* 908-916.

Pauloski, B. R., Logemann, J. A., Fox, J. C., & Colangelo, L. A. (1995). Biomechanical analysis of the pharyngeal swallow in postsurgical patients with anterior tongue and floor of the mouth resection and distal flap reconstruction. *Journal of Speech and Hearing Research, 38,* 110-123.

Pauloski, B. R., Logemann, J. A., Rademaker, A. W., McConnel, F. M. S., Heiser, M. A., Cardinale, S., et al. (1993). Speech and swallowing function after anterior tongue and floor of mouth resection with distal flap reconstruction. *Journal of Speech and Hearing Research, 36,* 267-276.

Pauloski, B. R., Logemann, J. A., Rademaker, A. W., McConnel, F. M. S., Stein, D., Beery, Q., et al. (1994). Speech and swallowing function after oral and oropharyngeal resections: One-year follow-up. *Head & Neck, 16,* 313-322.

Pauloski, B. R., Rademaker, A. W., Logemann, J. A., Stein, D., Beery, Q., Newman, L., et al. (2000). Pretreatment swallowing function in patients with head and neck cancer. *Head & Neck, 22,* 474-482.

Perlman, A. J., Luschei, E. S., & Du Mond, C. E. (1989). Electrical activity from the superior pharyngeal constrictor during reflexive and nonreflexive tasks. *Journal of Speech and Hearing Research, 32,* 749-754.

Perry, A. R., & Shaw, M. A. (2000). Evaluation of functional outcomes (speech, swallowing and voice) in patients attending speech pathology after head and neck cancer treatment(s): Development of a multi-centre database. *The Journal of Laryngology and Otology, 114,* 605-615.

Robbins, K. T., Bowman, J. B., & Jacob, R. F. (1987). Postglossectomy deglutitory and articulatory rehabilitation with palatal augmentation prostheses. *Archives of Otolaryngology Head and Neck Surgery, 113,* 1214-1218.

Rogers, S. N., Fisher, S. E., & Woolgar, J. A. (1999). A review of quality of life assessment in oral cancer. *International Journal of Oral and Maxillofacial Surgery, 28,* 99-117.

Rogers, S. N., Lowe, D., Brown, J. S., & Vaughan, E. D. (1999). The University of Washington head and neck cancer measurement as a predictor of outcome following primary surgery for oral cancer. *Head and Neck, 21,* 394-401.

Rogers, S. N., Lowe, D., Fisher, S. E., Brown, J. S., & Vaughan, E. D. (2002). Health-related quality of life and clinical function after primary surgery for oral cancer. *British Journal of Oral and Maxillofacial Surgery, 40,* 11-18.

Sasaki, C. T., Joe, J. K., & Albert, S. (2001). Efficacy of adjunctive cricopharyngeus myotomy in supraglottic laryngectomy. *Dysphagia, 16,* 19-22.

Schliephake, H. & Jamil, M. U. (2002). Prospective evaluation of quality of life after oncologic surgery for oral cancer. *International Journal of Oral and Maxillofacial Surgery, 31,* 427-433.

Schliephake, H., Neukam, F. W., Schmelzeisen, R., Varoga, B., & Schneller, H. (1995). Long-term quality of life after ablative intraoral tumour surgery. *Journal of Cranio-Maxillo-Facial Surgery, 23,* 243-249.

Schliephake, H., Ruffert, K., & Schneller, T. (1996). Prospective study of the quality of life of cancer patients after intraoral tumor surgery. *Journal of Oral and Maxillofacial Surgery, 54,* 664-669.

Schliephake, H., Schmelzeisen, R., Schonweiler, R., Schneller, T., & Altenbernd, C. (1998). Speech, deglutition, and life quality after intraoral tumor resection: A prospective study. *International Journal of Oral and Maxillofacial Surgery, 27,* 99-105.

Shimodaira, K., Yoshida, H., Yusa, H., & Kanazawa, T. (1998). Palatal augmentation prosthesis with alternative palatal vaults for speech and swallowing: A clinical report. *The Journal of Prosthetic Dentistry, 80(1),* 1-3.

Skelly, M. (1973). *Glossectomee speech rehabilitation.* Springfield, Ill: Thomas.

Stoeckli, S. J., Guidicelli, M., Schneider, A., Huber, A., & Schmid, S. (2001). Quality of life after treatment for early laryngeal carcinoma. *European Archives of Otorhinolaryngology, 258,* 96-99.

Tiwari, R. M., van Ardenne, A., Leemans, C. R., Quak, J. J., Tobi, H., Mehta, D. M., et al. (2000). Advanced squamous cell carcinoma of the base of the tongue treated with surgery and postoperative radiotherapy. *European Journal of Surgical Oncology, 26,* 556-560.

Veis, S., Logemann, J. A., & Colangelo, L. (2000). Effects of three techniques on maximum posterior movement of the tongue base. *Dysphagia, 15,* 142-145.

Wagner, J. D., Coleman, J. J., Weisberger, E., Righi, P. D., Radpour, S., McGarvey, S., et al. (1998). Predictive factors for functional recovery after free tissue transfer oromandibular reconstruction. *The American Journal of Surgery, 176,* 430-435.

Ward, E. C., Bishop, B., Frisby, J., & Stevens, M. (2002). Swallowing outcomes following laryngectomy and pharyngolaryngectomy. *Archives of Otolaryngology – Head and Neck Surgery, 128*(2), 181-186.

World Health Organization. (2001). ICIDH-2: International Classification of Functioning, Disability, and Health. Geneva: Author.

Zelefsky, M. J., Gaynor, J., Kraus, D., Strong, E. W., Shah, J. P., & Harrison, L. B. (1996). Long-term subjective functional outcome of surgery plus postoperative radiotherapy for advanced stage of oral cavity and oropharyngeal carcinoma. *The American Journal of Surgery, 171,* 258-262.

Manuscript received: *January 23, 2003*
Accepted: *September 12, 2003*