Radiation-Induced Xerostomia: How Dry Is Your Patient?

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Head and neck cancers represent about 5% of the cancers diagnosed annually (Schwartz, Patrick, & Yueh, 2001) and include cancers of the oral cavity, oropharynx, nasopharynx, larynx, hypopharynx, and salivary glands. In 2003, approximately 27,000 people were diagnosed with cancers of the head and neck, and 7,200 deaths were expected to occur as a result of these diseases (Jemal et al., 2003).

Surgery and radiation therapy are the primary modalities of treatment. Most patients with head and neck cancer receive a course of radiation therapy as a component of treatment. Chemotherapy is added for advanced disease or used as a radiosensitizer.

The management of patients with head and neck cancer undergoing radiation therapy can be a unique challenge for oncology nurses, whether they work in radiation therapy or medical oncology settings. Patients with head and neck cancer often present with many symptoms, such as dysphasia, pain, and weight loss. When treatment is initiated, particularly with radiation therapy and concurrent chemotherapy, these symptoms often are magnified because of the side effects related to treatment. Oncology nurses can have a significant impact on patient outcomes through diligent assessment and ongoing education regarding symptom management.

Xerostomia

Most patients receiving radiation therapy to the head and neck region will experience some type of oral complication. Xerostomia is one of the most severe symptoms that patients experience and may become a lifelong problem. This article reviews normal salivary function, effects of radiation therapy on oral mucosa, impact of xerostomia on quality of life, and current treatment strategies used to manage this debilitating side effect. Oncology nurses can have a significant impact on patient outcomes through diligent assessment and ongoing education regarding symptom management.

Key Words: radiotherapy, xerostomia

Most patients receiving radiation therapy to the head and neck region will experience some type of oral complication. Xerostomia is one of the most severe symptoms that patients experience and may become a lifelong problem. This article reviews normal salivary function, effects of radiation therapy on oral mucosa, impact of xerostomia on quality of life, and current treatment strategies used to manage this debilitating side effect.

Normal Salivary Function

The salivary glands are regulated by the nervous system. The glands respond within two to three seconds after stimulation by the sight, smell, or taste of food as the result of a conditioned reflex. About 80% of all major salivary gland tumors occur in the parotid gland (Million & Cassisi, 1984). The major salivary glands account for 70%–80% of salivary flow. The remaining flow comes from the 600–1,000 minor salivary glands that are located throughout the mouth. Large and small glands open into the oral cavity. Two parotid glands, the largest salivary glands, are located below and in front of each ear. The two submandibular glands are located in the lower jaw, and several sublingual glands are located beneath the tongue. The parotid glands are responsible for secreting saliva into the mouth through openings in the cheeks on each side opposite the upper teeth. The submandibular and sublingual glands discharge saliva upward through the openings into the floor of the mouth. Under resting conditions, the flow from the submandibular glands is at least as great as that from the parotid glands or possibly greater. The sublingual glands contribute only 2%–5% of the flow rate. Once

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Lack of moisture can cause redness, swelling, and pain in the mucous membranes. Saliva contains water, mucous, 40 essential proteins, 13 electrolytes and minerals, and 7 small organic molecules. These components of saliva balance the mouth’s chemical makeup, especially when eating. Lack of saliva can lead to a lower pH level in the mouth (the normal pH of saliva is mildly alkaline at 6.5–7), which, in turn, increases the mouth’s acidity (Huether, 2000).

Radiation Therapy

The goal of treatment with radiation therapy is to control the primary tumor and adjacent lymph nodes while maintaining the structure and function of the area being irradiated. This often requires up to 7,000 cGy for curative intent. Xerostomia has been reported after one week or approximately 1,000 cGy of radiation. If the salivary tissue receives less than 3,000–3,500 cGy, some return of function can occur as early as six months following treatment. Marks, Davis, Gottsman, Purdy, and Lee (1981) noted that only one-fifth of 44 patients who received 4,000–6,000 cGy had any measurable salivary flow after salivary stimulation.

The best method for sparing salivary function is to avoid irradiating as much of the salivary tissue as possible, which can be done during the treatment-planning process. The goal of treatment planning is to limit the volume of salivary tissue irradiated and the dose delivered whenever possible without compromising optimal treatment outcomes for patients. Radiation doses and exposed fields are dependent on the disease site and extent as well as the goals of therapy. As dose and percentage of irradiated tissue increase, damage to the tissues increases. Researchers have found that three-dimensional treatment planning and conformal dose-delivery techniques can minimize radiation damage while providing therapeutic doses to the tumor and regional lymph nodes (Henson, Inglehardt, Eisbruch, & Shep, 2001).

Intensity-modulated radiotherapy (IMRT) is a newer form of radiation therapy that uses computer-generated images to plan and then deliver more tightly focused radiation beams to cancerous tumors than when conventional radiation therapy is used. A precise radiation dose that conforms to the tumor is delivered, which reduces the amount of radiation to the surrounding healthy tissues. The technique can be used to treat any type of cancer but is thought to be particularly beneficial in head and neck cancers when surgery is not an option. For example, in the treatment of head and neck tumors, IMRT enables the radiation to be delivered in a way that minimizes exposure to the spinal cord, optic nerves, eyes, salivary glands, and other important structures (Chao & Ozyigit, 2003; Dogan, Leybovich, King, Sethi, & Emami, 2002; Lee et al., 2003).

Radiation changes can be acute or late. Acute effects generally are self-limited and present during the treatment course or in the immediate postirradiation period (up to three months). Late effects are acute effects that have persisted for more than three months following radiation therapy and may be permanent. Late complications are dependent on the total dose and volume of tissue irradiated.

The salivary glands that are most radiosensitive are the parotid glands because they produce serous secretions. Changes in these salivary glands often result in thicker, more ropey, and tenacious saliva. Researchers hypothesized that radiation exposure does not damage the glands themselves but rather the blood vessels or nerves supplying the glands (Logemann et al., 2001). Within 12 hours of the first treatment, about 5% of patients develop parotiditis, a transient, usually painless enlargement of one or more of the salivary glands in the treatment portal (Million & Cassisi, 1984). The swelling usually disappears within one to two days despite continued treatment. An anti-inflammatory agent, such as ibuprofen, or a mild analgesic will alleviate the discomfort should it occur. As the saliva becomes thick and ropey, patients may have difficulty handling these tenacious secretions with their dry oral mucosa.

Mucositis is an inflammation of the mucous membranes that line the mouth and throat. Radiation injures the normal epithelial cells while killing the cancer cells. Mucositis can occur after the first few treatments but is seen more commonly two to three weeks after the start of radiation therapy and can make xerostomia worse. Patients may experience redness of the oral mucosa to ulcerations of the mucosal lining that result in pain during swallowing.
the oral cavity particularly is vulnerable to mucosal damage from radiation therapy and/or chemotherapy. In severe cases, damage to the oral mucosa can be dose limiting or require a break from treatment to allow for healing of the damaged mucosa.

Oral assessment and mouth care are important components of nursing care for patients with cancer. They become essential for patients with head and neck cancers who are undergoing radiation therapy because these patients will become xerostomic and be at high risk for oral complications. The primary goal of mouth care during radiation therapy is to minimize oral complications related to therapy.

Each patient should have a comprehensive dental evaluation prior to beginning radiation therapy to identify any teeth in poor repair or any preexisting gum disease. Any restorative work should be done as well as a routine cleaning. If extraction of teeth is necessary, it must be completed 10–14 days prior to the start of treatment to allow for adequate healing time. Patients requiring extractions after radiation therapy may face serious healing problems. Once treatment has started, patients’ oral cavities must be assessed at regular intervals, which can be incorporated into the weekly treatment check with a radiation oncologist. Patients may need to be assessed more frequently if problems arise. Patients should be instructed about self-assessment of the oral cavity and signs and symptoms to report to the healthcare team. Patients should report any pain, tenderness, or burning sensations in the oral cavity that warrant further examination. Upon completion of therapy, patients will need to have dental follow-ups every three to four months to monitor for oral complications because oral conditions can deteriorate rapidly in irradiated patients with head and neck cancer. The development of dental caries may begin as soon as three to six months after completion of therapy.

Assessment of the oral cavity requires that nurses have knowledge of the anatomy of the oral cavity. Nurses need to be knowledgeable about the effects that radiation therapy has on oral mucosa, with or without the addition of chemotherapy to the treatment plan. To assess the oral cavity adequately, good lighting is essential. Patients should remove any dentures or prostheses to allow for optimal inspection. A tongue blade is necessary to move the tongue out of the way so that nurses can thoroughly examine the oral cavity and mucosa. A gloved finger allows for palpation of the oral mucosa. Nurses should inspect the entire oral cavity, paying particular attention to signs of mucositis, ulcerations, degree of oral dryness, and presence of candidiasis. After inspection of the oral cavity, patients with xerostomia will have mucosa that appears dry and dull, and pallor or increased erythema of the mucous membranes may exist. The amount of saliva may be scant, and any secretions may be thick and ropelike. Oral candidiasis infection may be present and appear as soft, white- or cream-colored patches covering parts or all of the tongue, lips, gums, or buccal mucosa. Candida usually can be scraped off the tongue and mucosal surface areas. It may be discolored by food or tobacco. Patients may report a burning sensation, metallic taste, or difficulty swallowing when candida is present. Candida responds well to appropriate treatment with a systemic agent such as Diflucan® (Pfizer Inc., New York, NY). Avoid using oral troches in patients with xerostomia because they have too little saliva to dissolve the troche. Reinfestation may occur and should be identified early.

Patients usually will find that dry mouth is worse at night or when arising in the morning. The salivary glands produce the least amount of saliva at these times. Patients may keep water at the bedside to drink after waking or try using a humidifier to keep moisture in the air. With a decrease in saliva production, patients also may experience difficulty with communicating. This can have a profound psychosocial impact on patients.

In addition to oral inspection, a review of patients’ current medications is essential to identify the ones that may be contributing to xerostomia. Patients should be encouraged to keep up-to-date medication logs so that periodic reviews of their medications can be facilitated. About 1,800 drugs in 80 drug classes have the capacity to induce xerostomia (Wrigley Company, 2001). The most commonly implicated drug classes are antidepressants, anxiolytics, antipsychotics, antihistamines, antihypertensives, diuretics, anticholinergic compounds, and analgesics. Strategies for patients receiving xerogenic medications include elimination of the drug, if possible; substitution of a medication with fewer xerogenic properties; or a change in the dosing schedule. The Web site www.drymouth.org contains a practitioner portal that assists healthcare providers in the identification of drugs that induce oral dryness.

**Oral Care**

Good oral hygiene is the cornerstone of oral health. Diligent oral care during and following therapy can contribute significantly to the success of cancer treatment. Oral care is an essential part of patient care and can be complex for patients with xerostomia. Permanent xerostomia causes discomfort, alters taste acuity, promotes poor oral hygiene, and accelerates dental decay (Armstrong, 1998).

Oral care procedures are not standardized and vary in clinical practice. Institutions differ in the routines that they recommend to patients for oral care (Ganley, 1996). Since the 1970s, attempts to investigate and evaluate the efficacy of numerous cleaning agents and oral hygiene protocols have resulted in confusing and contradictory results (Miller & Kearney, 2001). Although a systematic, evidence-based approach to oral care is recommended frequently in the literature, the clinical reality may be somewhat different (Miller & Kearney). The goal of oral care is to keep treatment-induced side effects to a minimum while promoting comfort and a sense of well-being in patients. Major changes in oral mucosa can have a significant impact on patients’ QOL. Patients’ level of oral hygiene is the major factor in determining the ultimate condition of the teeth after radiation therapy (Million & Cassisi, 1984).

A strict oral care program needs to be taught to patients and their families. Postradiation oral care becomes a lifelong necessity for these patients. Patients need to be made aware that noncompliance can result in serious complications, such as sepsis or inadequate nutrition, which may necessitate delaying treatment for a period of time. Patients should be taught the importance of removing daily plaque buildup. This can be achieved by brushing three to four times daily using nonabrasive fluoride toothpaste and flossing daily with unwaxed, nonshredding dental floss. Oral care should be done before and after meals, at bedtime, and as needed to cleanse and enhance the moisture content of the oral mucosa. Patients should be taught to perform oral assessments and make them a part of their daily oral care program. Mouthwashes can be soothing and are used to loosen debris and moisten the mouth. Most commercial mouthwashes contain alcohol and should be avoided because of their drying nature. Biotene® mouthwash (Laclede, Inc., Rancho Dominguez, CA) does not contain alcohol and can be recommended to patients.

Fluoride treatments are another essential component of oral care for patients with xerostomia. Many methods of fluoride application have been used, but the method of preference is a daily, five-minute, self-application of fluoride gel using a tray that is custom-made by patients’ dentists (Million & Cassisi, 1984). Fluoride treatments should be practiced during radiation therapy and usually are continued for the remainder of patients’ lives. If patients do not tolerate fluoride treatments during therapy because of mucositis, the treatments can be resumed.
after the oral mucosa heals. Healing may take a minimum of four to six weeks. Fluoride treatments are done at night, after the teeth have been brushed and flossed. Daily application is necessary because most of the fluoride is lost from the teeth within 24 hours. Patients should be instructed not to rinse, eat, or drink for at least 30 minutes after treatments. The importance of daily fluoride treatments must be reinforced with patients so that they understand the implications of noncompliance.

Treatment

The goal of treatment for xerostomia is to provide symptomatic relief from mucosal dryness with moistening agents and/or agents that increase the flow of saliva. The discomfort of dry mouth that patients with xerostomia experience can be alleviated in many ways. Treatments mainly are palliative and can be local or systemic. One of the main disadvantages of most local treatment strategies is that the effect is short-lived and requires frequent use or application, thus making them cumbersome for patients who already are experiencing many issues related to treatment effects.

Patients may start out with sucking on sugar-free candy (lemon or sour flavors) or chewing sugar-free gum to help stimulate saliva production. Xylitol-sweetened gum has antiangiogenic properties (Mautner, Maher, & Zampini, 2003). Several gums on the market contain xylitol, including Biotene gum, Orbit® (Wrigley Company, Chicago, IL), and Xylifresh® (Bio-Science, Port Orchard, WA). Encouraging patients to increase fluid intake of nonacidic juices or water will promote comfort as well as add calories and hydration. Patients should avoid eating any dry foods that require large amounts of saliva to chew and swallow. Sauces and gravies can be added to these foods to moisten or thin them for easier swallowing. Other dietary modifications, such as eating soft foods or liquids, may be required. Patients need to be instructed to avoid things that will irritate and dry the mucous membranes. These include tobacco, alcohol, carbonated beverages, caffeine, and spicy or acidic foods. Mouthwashes such as Biotene mouthwash that do not contain alcohol can be used to rinse and refresh the mouth.

Some patients find artificial saliva or saliva substitutes beneficial. These agents are appropriate for the management of xerostomia and assist in lubricating the oral mucosa. They are available over the counter. Artificial saliva is a solution composed of carboxymethylcellulose, glycerin or sorbitol, normal saline, and a flavoring agent; it has a pH of about 7 and a consistency similar to that of saliva. Saliva substitutes often are used prior to meals, at bedtime, and as needed to promote oral lubrication and comfort. Although saliva substitutes can be effective in maintaining oral comfort, they fail to provide the antibacterial and immunologic properties of saliva (Miller & Kearney, 2001). More than a dozen artificial saliva preparations, some available in spray bottles, can be purchased over the counter and have no known side effects. Some patients report an unpleasant taste associated with the saliva substitutes and may be reluctant to use them.

Saliva Stimulants

Saliva stimulants can be helpful in reducing the discomfort of xerostomia and also stimulate salivary production. One of the most common saliva stimulants is pilocarpine, marketed as Salagen® (MGI Pharma, Inc., Hopkins, MN). Pilocarpine is a systemic treatment that is classified as a cholinergic parasympathomimetic agonist. It works through the cholinergic nervous system to stimulate any residual functioning salivary gland tissue. Pilocarpine is indicated for the treatment of inadequate salivary flow that occurs as a result of radiation therapy for cancers of the head and neck. The recommended dose is one 5 mg tablet three to four times a day. The usual dose range is 15–30 mg per day, with no more than two tablets taken per dose. The effects of pilocarpine usually last two to four hours. Pilocarpine is titrated according to the therapeutic response and tolerance. Patients must be instructed that noticeable results may take up to 90 days or longer. The lowest dose that is effective and tolerated should be used for maintenance. Pilocarpine usually is used after radiation therapy has been completed. When compared with artificial saliva, pilocarpine is more effective in patients with radiation-induced xerostomia (Davies & Singer, 1994).

Pilocarpine is contraindicated in patients with uncontrollable asthma, known hypersensitivity to pilocarpine, acute iritis, or narrow-angle glaucoma. Side effects associated with pilocarpine include excessive sweating, nausea, diarrhea, chills, flushing, increased urination, dizziness, and rhinitis. Taking pilocarpine with food can minimize some of the side effects. The most commonly reported reason for discontinuing the medication is excessive sweating and runny nose. Prior to starting patients on pilocarpine, nurses should perform a baseline oral assessment documenting the grade of xerostomia according to the National Cancer Institute Common Toxicity Criteria Scale, version 3.0 (Trotti et al., 2000) (see Table 1) or their institution’s grading standard. Patients should be assessed for dry mouth symptoms, such as severity of dry mouth, mouth discomfort, ability to sleep without drinking, and use of saliva substitutes. Patients’ current oral intake and ability to maintain adequate hydration during treatment with pilocarpine also must be assessed. Because excessive sweating is a common side effect of pilocarpine, patients should be instructed to drink fluids (at least two to three liters per day) to avoid becoming dehydrated. Signs and symptoms of dehydration need to be reviewed with patients and their families.

Another possible side effect associated with pilocarpine is visual disturbance (blurring) and impairment of depth perception, especially at night. Pilocarpine also may cause dizziness or light-headedness. Patients should be cautioned against driving at night, operating equipment, or participating in any activity that could be dangerous if they are not alert or able to see well. As with any other treatment or medication, patients should be instructed about signs and symptoms to report to the healthcare team. Any symptoms of overdose (e.g., chest pain, confusion, irregular heartbeat, headache, stomach cramps, severe weakness or tiredness, severe trembling or shaking) should be reported immediately.

Cytoprotection Agents

Cytoprotection is a new and supportive approach to cancer care. These agents can be given prior to cytotoxic therapy with radiation therapy and/or chemotherapy. Amifostine, marketed as Ethyol® (MedImmune Oncology, Inc., Gaithersburg, MD) is an organic thio phosphate cytoprotective agent that can protect normal cells from the damaging effects of radiation therapy and certain chemotherapy drugs (MedImmune Oncology, Inc., 2001). The active metabolite of amifostine is free thiol. Free thiol scavenges free radicals, preventing damage to cell membranes.

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Note: Based on information from National Cancer Institute, 2003.
Amifostine is indicated for use in patients undergoing postoperative radiation therapy for squamous cell cancer of the head and neck. The drug is indicated to protect against xerostomia and mucositis in patients with head and neck cancer receiving radiotherapy. Amifostine significantly reduced the overall incidence of grade II or higher acute xerostomia from 78% to 51% (p < 0.0001) (Brizel et al., 2000). Likewise, one year after the completion of treatment, grade II or greater chronic xerostomia was significantly less in patients who received amifostine compared with those who did not (34% and 57%, respectively, p < 0.002) (Brizel et al.). Researchers also found that patients who received amifostine produced significantly more saliva than patients treated with radiotherapy alone.

Amifostine is administered via IV 15–30 minutes before each radiation treatment. The dosage is calculated on patients’ body surface area and is given at a dose of 200 mg/m². Amifostine is taken up by the normal cells in the salivary glands and helps to protect them from the effects of radiation. Use of amifostine does not change the effectiveness of the radiation. Common side effects of amifostine are nausea, vomiting, and hypotension. When receiving amifostine, patients are instructed to take an antidiemetic (such as prochlorperazine or ondansetron hydrochloride) one to two hours before their scheduled treatment time. Patients also should drink two 8-ounce glasses of water prior to the administration of amifostine. Patients must be able to maintain adequate hydration of at least six to eight glasses of water a day while being treated with amifostine. This can be a particular challenge for patients experiencing pain, dysphasia, and loss of taste and appetite related to treatment effects. Patients who cannot drink enough fluids may need to receive supplemental IV fluids prior to the administration of amifostine. If a patient has a gastrostomy tube, extra hydration can be given by this method, thus eliminating the need for IV administration. Patients’ current medications should be reviewed carefully. Because hypotension is a common side effect, anti-hypertensives and diuretics that patients are taking are of particular concern.

Amifostine is given via an IV push for no longer than three minutes. Longer administration times have been associated with a higher incidence of adverse reactions. Careful monitoring of patients’ blood pressure is required before, during, and after administration of the drug. Patients should remain in a supine position. Episodes of hypotension respond to changes in position (placing patients in the Trendelenburg position) and/or resuscitation with IV fluids. Nausea and vomiting, if experienced, usually occur shortly after administration of the drug and subside within one to two hours of treatment. Other side effects that occur less commonly include dizziness, sleepiness, hiccups, chills, skin rash, sneezing, and flushing (MedImmune Oncology, Inc., 2001).

In a phase II randomized trial, subcutaneous administration of amifostine was well tolerated, effectively reduced radiotherapy’s early toxicity, and prevented delays in radiation therapy (Koukourakis et al., 2000). The subcutaneous route is much easier and saves time when compared to IV administration and can be given safely and effectively in a busy radiation therapy practice. Therefore, amifostine is given subcutaneously in many radiation practices, even though the U.S. Food and Drug Administration has not approved it for this route of administration.

Nurses play a pivotal role in caring for patients receiving amifostine. They must be knowledgeable about the drug, method of administration, and side effects. The administration and timing of treatment requires effective collaboration with radiation therapists. Diligent assessment and observation of patients will assist in early identification and intervention when side effects develop. Patient and family teaching is key to helping them understand the potential side effects and their role in administration of the drug. A drug assistance program is available to help defray the cost of amifostine. More information about this assistance program is available at www.medimmune.com or by calling 877-633-4411.

**Acupuncture**

Recent data revealed that 34%–40% of patients seek nontraditional medical treatment (Johnstone, Nientzw, & Riffenburgh, 2002). An uncommon and not well-known treatment for xerostomia is acupuncture. Treatment of xerostomia with acupuncture has been reported in Western medical literature since 1981. Acupuncture is based on optimally restoring the balance and flow of qi (pronounced “chee”). The body’s symptoms are distress signals that warn about a problem in the balance and flow of qi. Traditional acupuncture treats the underlying imbalances that can result in various symptoms. Traditional acupuncture works well to complement conventional Western medical care. The mechanism of action for acupuncture is not clearly understood in patients with xerostomia. Acupuncture appears to be a more sensitive initiator of salivation than pilocarpine (Blom & Lundeberg, 2000). Autonomic stimulation by the needles is presumed to be at least partially responsible for the effect. Acupuncture has been theorized to help regulate fluid distribution in the body, whether too little is flowing or too much is accumulating. Eastern philosophy claims that the relief of xerostomia is achieved by removing a blockage of qi.

Acupuncture originally was designed as a two-step process but has been refined. A single treatment with eight needles is used currently. Special acupuncture needles are placed in three points in the bilateral ears and a single point in the distal radial aspect of the index finger. Patients are provided with a piece of sugar-free candy or lozenge to further stimulate or “milk” the salivary glands. Although this is a known salivary stimulant, most patients with severe xerostomia are refractory to this intervention in the absence of acupuncture (Johnstone et al., 2002). Frothy salivation has been reported in as early as 15–20 minutes. Each visit lasts about 30–60 minutes, and the average charge per visit is approximately $65. Most insurance companies do not cover the cost of acupuncture. Some plans will cover it only if a licensed physician performs the treatment. Initially, visits are scheduled weekly for four to six weeks or until a response is reported. The interval of sessions then is extended. Monthly to bi-monthly visits are encouraged for those who continue to achieve benefit from them. No adverse events related to the use of acupuncture for xerostomia have been noted. Potential side effects of acupuncture are hematoma at the acupuncture point and fatigue following the first few treatments. The Xerostomia Inventory (XI) is used for documenting response outcomes of acupuncture for patients with xerostomia. XI is an 11-item, 5-point rating scale on which higher numbers represent worsening toxicity. The items include location of dryness (e.g., skin, eyes, nose, lips, mouth) and behaviors to manage xerostomia (e.g., sipping liquids, getting up at night to drink liquids, sucking on hard candy). XI was selected for its ease of use and because salivary flow rates do not correlate well with patients’ subjective feelings of oral dryness (Johnstone et al.). Acupuncture can be performed during or after radiation treatments. Preliminary data reveal that many patients achieve relief, even those who have become refractory to pilocarpine therapy. Earlier studies have shown that acupuncture can
improve salivary secretion in patients with xerostomia (Blom & Lundeberg, 2000). In a study by Johnstone et al. (2002), 50 patients underwent 318 treatments and the number of acupuncture visits was highly significant ($p = 0.006$). The number of visits varied from patient to patient. Responders exhibited almost twice the visits. Blom and Lundeberg found that 24 acupuncture treatments resulted in statistically significant improvement in the salivary flow rate (SFR) in patients with xerostomia in the long-term up to six months and noted that additional acupuncture treatments can maintain this improvement in SFR for up to three years.

### Cevimeline Hydrochloride

Cevimeline hydrochloride, marketed by Daiichi Pharmaceuticals Co., Ltd. (Montvale, NJ), as Evoxac®, was approved by the U.S. Food and Drug Administration in January 2000 for the treatment of dry mouth in people with Sjögren’s syndrome (an autoimmune disorder that causes salivary dysfunction and dry mouth). Evoxac is being evaluated in phase III clinical trials to determine its efficacy in the treatment of radiation-induced xerostomia. The phase III study is a multicenter, randomized, double-blind, placebo-controlled design in which approximately 30 investigative sites in the United States are participating. The study was initiated in January 2001 and is ongoing. Eligible subjects must have had external beam radiation therapy to the head and neck region and completed therapy more than four months prior to enrollment in the study. All subjects have clinically significant xerostomia with grade II or III xerostomia (see Table 1). Subjects must have received more than 4,000 cGy of radiation and must have at least one anatomically intact parotid gland. The study will examine the efficacy of cevimeline at a possible dose escalation to 45 mg three times daily compared with no drug (placebo) treatment (SnowBrand Pharmaceuticals, 2000).

Cevimeline hydrochloride is pharmacologically similar to pilocarpine hydrochloride because both drugs stimulate residual salivary gland tissues that still are functioning despite damage induced by radiation. Cevimeline hydrochloride is a cholinergic agonist that binds to muscarinic receptors. In sufficient doses, muscarinic agonists can increase the secretion of exocrine glands, such as the salivary glands (Daiichi Pharmaceuticals Co., Ltd., 2002). Currently, no published clinical studies have compared the safety and efficacy of oral cevimeline with oral pilocarpine.

### Quality of Life

QOL is receiving considerable attention in the literature, especially as it relates to the treatment of cancer. Since 1989, more than 300 articles in the head and neck cancer literature have referred specifically to QOL (Schwartz et al., 2001). QOL can be defined as a state of well-being in which an individual is able to perform everyday activities related to physical, psychological, and social well-being as well as satisfaction with function and control of disease and treatment-related symptoms (Epstein et al., 2001). QOL also can be thought of as the gap existing between a person's actual status and ideal standard (Long, D’Antonio, Robinson, Zimmerman, & Petti, 1996).

Chronic side effects of radiation treatment, such as xerostomia, may have a greater impact on QOL than the actual cancer diagnosis. The impact of chronic xerostomia is illustrated in Figure 2. The sequelae of chronic xerostomia can become a vicious cycle for patients and present many challenges in the management of this multifaceted symptom. The following quotes by Leo Streebny, DDS, professor of dentistry at the State University of New York at Stony Brook, puts perspective on a patient’s battle with chronic xerostomia. “A world without saliva is a world without pleasure...like living with a drought... There is dryness of the mouth; viscous, sticky saliva; altered taste; a defiant sense of smell; failed speech; lackluster singing; trouble with chewing; increased disfiguring dental caries with wedge-shaped erosion; bad breath; heartburn and esophagitis; changed diet; burning tongue; cracked lips; dry kisses; festering and pestering yeast infections. Yet despite all this, saliva is largely an unheralded, unsung, and ignored secretion” (Streebny, 2000, p. 141).

Even with the knowledge of the treatment-induced side effects for patients with head and neck cancer, only a limited number of studies address QOL after treatment for these cancers. Even less is known about the impact of oral complications on the oral function of these patients. More research is needed into the acute and late xerostomia effects of radiation treatment. The outcome measures of the studies will influence and guide the direction of management strategies to assist patients in coping with this life-altering problem. Measuring QOL outcomes is beneficial when deciding among treatments when no survival advantage is afforded by one modality over another (Schwartz et al., 2001).

### Implications for Practice

The impact of xerostomia on patients can be devastating and debilitating. Xerostomia affects multiple domains of patients’ lives and has serious implications for patients’ QOL. Patients may never be able to resume normal eating habits or continue jobs that require direct verbal communication. The problems faced by these patients are complex and have no easy solutions. Challenges with current care strategies for xerostomia are temporary, cumbersome to patients, costly, ineffective, or prohibited because of side effects.

“The challenge for oncology clinicians is to help patients return to satisfying and productive lives while managing the impact of chronic xerostomia” (Mautner, Maher, & Zampini, 2003). To facilitate this, patients with xerostomia require a multidisciplinary approach to their care to ensure that the best supportive care is provided to them. Nurses play a pivotal role in the coordination of care of these patients. Education of patients and their families cannot be stressed enough. Patients need to be encouraged to actively participate in their own care.

Further investigation of new drugs and/or techniques, such as salivary gland transplantation (Spiegel, Zhang, Levin, Singer, & Buncke, 2000), for the prevention or reduction of xerostomia needs to continue. Nurses need to use the best evidence available to guide the care of patients with xerostomia. More QOL research is needed in this patient population with longer follow-up of patients.

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**FIGURE 2. CYCLICAL IMPACT OF CHRONIC XEROSTOMIA**

*Note. Used with permission from Karen E. Maher, ANP, MS, AOCN®.*
Xerostomia is one of the most severe symptoms patients experience after ionizing radiation to the oral cavity and neck. Many symptoms related to radiation therapy are acute and resolve with time, but xerostomia is one that can become a lifelong problem and significantly impacts patients’ quality of life. Patients with xerostomia are at increased risk of oral infection, dental caries, and loss of teeth, and often experience difficulty with chewing, swallowing, and speaking. Current treatment of xerostomia mainly is palliative, offers short-lived relief, is cumbersome, and can be costly. Oncology nurses can have a significant impact on patient outcomes through diligent assessment and ongoing patient education. More research is needed in the areas of quality of life and alternatives for xerostomia symptom management.

Rapid Recap

Radiation-Induced Xerostomia: How Dry Is Your Patient?

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