Chapter

Oral and Dental Care for Patients on Palliative Care

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Abstract

Therapeutic improvements and epidemiologic changes over the last three decades have led to increased numbers of survivors and aged population, resulting in greater need for continuing management of oral and dental health in this population. Generally, the palliative care patient oral health needs are complex, requiring multidisciplinary collaboration among medical and dental professionals with special knowledge and training in the field of oral medicine and oncology. This chapter offers clinical protocols and information for medical providers to assist in understanding oral complications and their management in these patients and survivors, and their oral and dental health care needs. Oral and dental care is impacted by the patient's initial oral and dental status, as well as the specific disorder for cancer location, type, and its treatment; thus, close communication between the dental professional and the medical team is required for appropriate therapy. Patients undergoing palliative care are at high risk of oral complications with the potential of causing significant morbidity and mortality. Dental professionals should play a fundamental role in the prevention and treatment of oral sequelae in thesis patients. However, the dental and medical community is not well informed/experienced in managing the oral complications of these vulnerable group.

Keywords: oral and dental health, oral manifestations, oral mucositis, oral infections, temporomandibular disorders

1. Introduction

Palliative care dentistry can be described as the examination and treatment of individuals who are suffering from advanced, progressive diseases, where the oral cavity has been compromised either due to the disease itself or its treatment. The primary focus of this form of care is to enhance the patient's quality of life. It encompasses not only addressing the patient's physical requirements but also providing support for their spiritual well-being and that of their family. This chapter aims to highlight common challenges encountered in palliative care dentistry, specifically in relation to adults with terminal cancer and proposes appropriate solutions for these issues. To better illustrate the oral problems associated with palliative care, we have summarized the most common one in **Figure 1**.

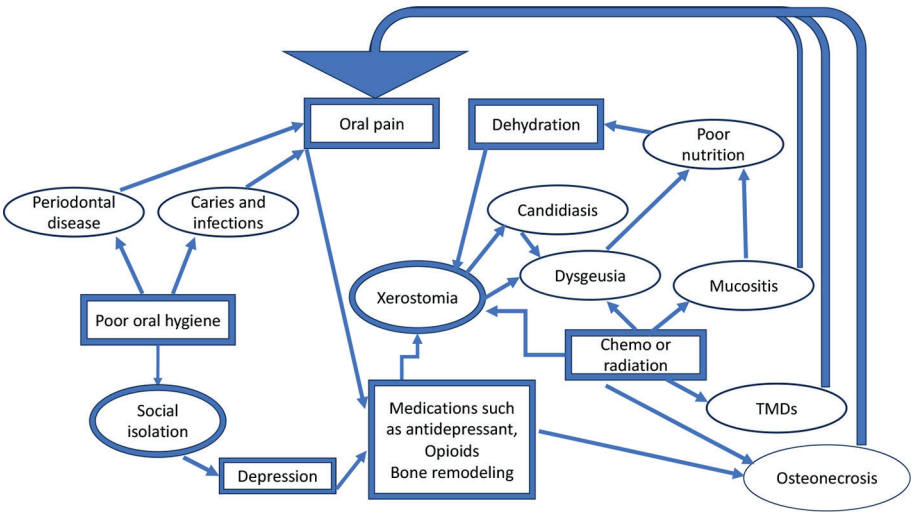

Figure 1.
Most common oral complications and its relations in patient in palliative care.

2. Oral pain in the cancer patient

Patients with cancer frequently experience orofacial and oropharyngeal pain, which can have underlying nociceptive, neuropathic, and psychosocial components. Oral pain in patients with advanced stages of cancer and other life-threating conditions in palliative care can be multifactorial, resulting from primary tumor or tumor-related pathology, mucositis, oral infections, TMJ problem and limitation in the mouth opening, xerostomia, dysgeusia and dysphagia, dental caries, periodontitis, and treatment-induced, complications such as ORN and MRONJ [1]. The impact of the oral pain can be profound, affecting essential functions such as eating, drinking, swallowing, and speaking and can lead to significant distress and diminish quality of life and patient overall well-being [2].

2.1 Oral mucositis

Oral mucositis is a common and distressing condition experienced by many palliative care patients and characterized by inflammation or/and ulceration of the oral mucosa, including buccal mucosa, tongue, and gingiva. Chemotherapy primarily affects rapidly dividing tissues, often impacting the oral cavity. It is estimated that approximately 40% of chemotherapy patients experience mucositis [3]. Diminished cell division leads to tissue atrophy, resulting in the formation of ulcers. This condition can be further complicated by microbial invasion [4]. Mucositis typically manifests within 5–7 days following chemotherapy administration which are known to have strong mucositis-inducing properties. In cases, where radiotherapy is employed to treat head and neck cancers, xerostomia (dry mouth) occurs due to the destruction of salivary tissues within the treatment area. The decrease in saliva's lubricating and protective properties renders the tissues more vulnerable to trauma and pathogenic invasion. Consequently, ulceration and erythema are observed in the affected tissues [5]. This condition can cause severe pain, difficulty in eating and swallowing, and increased

risk of infections. In severe cases, intravenous or even total parenteral nutrition may be necessary to maintain adequate hydration and nutrition [6].

Several factors play a significant role in determining the extent and severity of mucositis. These factors encompass the particular drug used, dosage, method and frequency of administration, individual patient tolerance, genetic variations in drug-metabolizing pathways, immune signaling and cellular injury/repair mechanisms, and smoking history [7]. The following table (**Table 1**) provides a comprehensive list of cancer treatment drugs that have the potential to cause oral mucositis and summarizes the risk factors.

In palliative care, where the focus is on improving the quality of life for patients with advanced illness, effective management of oral mucositis is crucial. The management of these patients focuses on addressing symptoms and providing supportive care to ensure patient comfort and education. The goals include maintaining proper nutrition and oral hygiene while preventing opportunistic infections. It is crucial to closely monitor the patients and collaborate closely with their physicians. To prevent any potential sources of infection, all patients should undergo a thorough oral evaluation before undergoing radiation therapy. Whenever feasible, it is recommended to allow a healing period of 14 days after oral surgical procedures before initiating chemo or radiation therapy. Emphasizing oral hygiene is crucial both before, during, and after cancer therapy. To alleviate oral discomfort, topical anesthetics such as viscous lidocaine HCl (Xylocaine), diphenhydramine elixir (Benadryl), and throat lozenges containing dyclonine HCl can be used. Artificial saliva products such as Sage Moist Plus, Moi-Stir, and salivary can help reduce oral dryness. Laclede oral balance gel is a useful mouth moisturizing gel. Fungal overgrowth can be controlled with Nystatin and clotrimazole preparations. Chlorhexidine rinses are effective in managing plaque and candidiasis. Additionally, fluoride products, such as dentifrices, gels, and rinses, are applied to control dental caries. In **Table 2**, the recommendations and suggestions have been summarized:

2.2 Oral infection

During palliative care, patients often face the risk of acquiring secondary infections as a result of weakened immune systems and dysfunction in their salivary glands. One prevalent oral infection is candidiasis, which is primarily caused by *Candida albicans*. This opportunistic infection develops due to the combined effects of immunosuppression (common in chemotherapy, certain targeted therapies, and the use of intraoral topical steroids) and reduced salivary gland activity. Symptoms may vary and include pain, a burning sensation, changes in taste perception, and difficulties in consuming food and beverages [18]. The most typical manifestation is pseudomembranous candidiasis, characterized by easily removable white plaques that may leave behind small petechial hemorrhages.

The erythematous or atrophic form of candidiasis can present subtly with red patches and a burning sensation. To effectively manage candidiasis and prevent its recurrence during or after cancer therapy, antifungal treatment (both topical and systemic) is recommended, especially for individuals undergoing highly immunosuppressive chemotherapy regimens, such as allogeneic hematopoietic cell transplantation.

During palliative care or chemotherapy and other cancer therapies, herpes simplex virus infections can reoccur due to immunosuppression and stress. These irregular and painful ulcerations commonly affect the lips and tongue but can occur in any

Potential risk factors			
Specific anticancer agents			
Alkylating agents:	Busulfan, carboplatin, cisplatin, cyclophosphamide, and melphalan procarbazine	Prevent cell division primarily by cross-linking strands of DNA	Mild to moderate mucositis
Cytotoxic chemotherapy agents	Bleomycin, fluorouracil [FU], and methotrexate	Specific DNA cell cycle	Associated with higher rate of oral mucositis
	NOTE: Methotrexate, etoposide	Excreted through saliva	More damaging
Molecularly targeted agents: The occurrence of stomatitis varies across different molecularly targeted agents and depends on their class	Sunitinib, sorafenib, lenvatinib, and regorafenib	Tyrosine kinase inhibitors and vascular endothelial growth factor receptors	In 30–40% of patients
	Afatinib	Blocks signaling from the EGFR1 (erbB1), EGFR2 (HER2/erbB2), and erbB4	72%
	Erdafitinib and infigratinib	Oral fibroblast growth factor receptor inhibitors	56%
	Palbociclib	Cyclin-dependent kinase 4/6 inhibitor	25%
	Niraparib	Poly (ADP-ribose) polymerase (PARP) inhibitor	20%
	Cetuximab, erlotinib, dacomitinib, and mobocertinib	Epidermal growth factor receptor (EGFR)	10–46%
	Temsirolimus and everolimus	Target of rapamycin (mTOR) inhibitors	Aphthous like lesion in up to 75% of patient
	Note: A review found that mTOR inhibitor-associated stomatitis was the most frequent adverse event overall associated with these drugs (73%) and accounted for almost 30% of dose reductions, making it the most common dose-limiting toxicity (53%) [11]		
Immune checkpoint inhibitors	Mucosal toxicities related to immune checkpoint inhibitors include periodontal disease, stomatitis, oral lichen planus, xerostomia, and, rarely, a condition resembling Sjögren's disease that affects the salivary glands, as well as mucous membrane pemphigoid-like lesions [12, 13]		
Preexisting oral disease [14]	Chronic periodontal disease: Dental caries, poor oral hygiene, and periapical pathology		

Potential risk factors		
Age of patient	Younger patient at higher risk	Due to a faster epithelial mitotic rate
Additional factors	Nutritional status, the specific treatment protocol, the quality of oral care during treatment, pre-treatment neutrophil counts, the use of hematopoietic growth factor support during therapy, and variations in the oral microbiome [15, 16]	
	Genetic susceptibility [17]	Inherited variations in drug-metabolizing enzymes and proinflammatory cytokines

Table 1.
Factors associated with the development of oral mucositis [8–10].

intraoral site. They tend to be more extensive and take longer to heal compared to non-immunocompromised patients. Confirming the diagnosis can be done through PCR, direct fluorescent antibody test, culture, and cytology. Antiviral resistance and drug susceptibility can only be evaluated through culture. The management involves systemic antiviral therapy with medications, such as acyclovir or valacyclovir. For patients with unresolved infections despite antiviral therapy, considering antiviral susceptibility testing is recommended [19].

In immunosuppressed cancer patients, odontogenic infections may not present with typical signs such as swelling, erythema, and purulence. Fever or pain may be the only symptoms. It is crucial to promptly manage odontogenic infections in these cases by administering antibiotics and providing definitive care, such as tooth extraction. Patients with jaw osteonecrosis may also experience bacterial infections characterized by a mixture of oral flora [20]. The management of the oral infections has been summarized in **Table 3**.

2.3 Temporomandibular joint disorders (TMDS)

Palliative care is a specialized medical approach that focuses on providing relief and support to individuals facing serious illnesses, aiming to improve their quality of life. It is typically provided to patients with life-limiting conditions such as cancer, advanced heart disease, or neurodegenerative disorders. While palliative care primarily addresses pain management, symptom control, and emotional well-being, it also encompasses a holistic approach that considers the patient's overall health, including the management of specific conditions, such as temporomandibular dysfunction (TMD).

Temporomandibular dysfunction, also known as temporomandibular joint disorder (TMJ), refers to a group of conditions affecting the jaw joint and the surrounding muscles. It can cause pain, discomfort, restricted jaw movement, clicking or popping sounds, and even difficulties in eating or speaking. TMD can be caused by various factors, including jaw injuries, bruxism (teeth grinding or clenching), arthritis, or stress or cancer treatment [21].

When patients on palliative care experience TMD, managing their symptoms becomes an essential aspect of their overall care plan. Here are some considerations in addressing TMD in palliative care patients:

1. Pain management: TMD often causes significant pain and discomfort. Palliative care teams work closely with healthcare professionals, such as dentists, oral

General dental care	• Make available resources and support for individuals who wish to quit smoking. • Conduct an initial assessment of new patients to establish a baseline. • Instruct nurses or caregivers to actively screen for potential oral complications. • Provide both verbal and written guidance on maintaining oral hygiene from the beginning of the treatment. • Emphasize the importance of maintaining oral health throughout the treatment phase for the following reasons. a. Ensuring sufficient hydration and nutrition. b. Decreasing the occurrence, severity, and duration of oral mucositis. c. Preventing or minimizing the impact of oral complications. • It is recommended that a dental examination and any necessary interventions be carried out by a dentist or an oral oncology specialist prior to initiating radiation or chemotherapy • Emphasize and provide resources for smoking cessation.
Oral hygiene	• Floss at least once daily. • Brush 2–4 times daily within 30 minutes of eating and for at least 2 minutes with a small, extra soft nylon bristled manual toothbrush. • Use nonabrasive, fluoride toothpaste with a neutral taste. • Rinse toothbrush well with hot water after each use, allow to air dry. • Replace toothbrush when bristles are no longer standing up straight. • If unable to brush, clean teeth with clean, moist gauze or foam swab accompanied with vigorous rinsing using recommended oral rinse solution or use lollipop cleaning sponge. • If there has been an oral infection, use a new toothbrush after infection has resolved. • Patients should be assessed for the use of daily fluoride tray. • Use oral rinses to keep your mouth moist and clean. • After brushing, rinse mouth with the below recopies for minimum of four times daily or after each brushing. • Recipe #1: Normal saline (NS)—1/2 teaspoon (2.5 ml) of salt in 8 oz. (240 ml) of water • Recipe #2: NS/sodium bicarbonate mixture —– 1/4 teaspoon (1.25 ml) of salt and 1/4 teaspoon (1.25 ml) baking soda in 8 oz. (240 ml) of water • Recipe #3: Sodium bicarbonate—1/4 to 1/2 teaspoon (1.25–2.5 ml) baking soda in 8 oz. (240 ml) of water • Multi-agent rinses—“Magic Mouthwash” (may include a topical analgesic, a steroid, an antifungal agent, an antibacterial agent and/ or a mucosal coating agent) may be prescribed to help palliate pain, discuss with your dentist or health care provider. • Benzydamine Hydrochloride 0.15% (Tantum®) is an anti-inflammatory mouth rinse that is recommended for use to prevent and/or relieve the pain and inflammation associated with oral mucositis. • Increase frequency as needed for symptom severity increases. • AVOID using commercial mouthwashes, which contain alcohol as well as povidone-iodine, hydrogen peroxide, sucralfate, or lemon glycerin swabs.
Lip care	• Use water-soluble, lanolin, or oil-based lubricants to protect the lips and keep moist. • Use after oral care, at bedtime, or as often as required. NOTE: Oil-based lubricants (e.g., petroleum jelly) are generally not recommended due to increased risk of aspiration and occlusive nature may increase the growth of pathogens.

Dentures	• All dentures, plates, and/or prostheses should be removed before oral hygiene is performed. • Brush and rinse dentures after every meal and at bedtime. • Soak dentures in oral rinse solution, rinse before placing in mouth. • Avoid wearing tight- or loose-fitting dentures. • Give your oral cavity enough resting time without wearing dentures, at least 8 hours daily (e.g., overnight). • Ear the denture only during mealtime if mouth sensitive or in case of pain or oral mucositis.
Cryotherapy	• Patients should be instructed to hold ice chips in mouth five minutes prior, during, and for 30 minutes after the chemotherapy, such as bolus infusion of fluorouracil (5FU) to reduce the risk and severity of oral mucositis. • It is contraindicated if regimens includes oxaliplatin due to potential exacerbation of cold-induced. Pharyngolaryngeal dysesthesia
Dietary management	• Recommendation 1. Daily fluid intake of 8–12 cups (2–3 liters), unless contraindicated, to help keep oral mucosa moist (e.g., water, sugar-free popsicles, nonacidic juices, ice cubes, sports drinks, and broth). 2. Well-balanced diet high in protein, vitamins B and C. 3. The use of soft, moist, and bland foods as symptoms develop or progress. 4. Add nonacidic sauces, gravy, salad dressings, butter/margarine, broth, or another liquid to help moisten and thin foods. • Avoid 1. Dry or coarse foods (e.g., toast, crackers, and chips). 2. Spicy or hot temperature foods. 3. Highly acidic fluids and foods (e.g., lemon glycerin swabs, vitamin C lozenges). 4. Fluid or foods high in sugar (e.g., pop, some fruit juices). 5. Caffeine, alcohol, and tobacco.
Patient education and follow-up	It is important to discuss oral care and hygiene recommendations with the patient and their family. This includes explaining how to perform a daily oral assessment at home. It is crucial to provide both verbal and written information on how to maintain oral hygiene during the treatment. Additionally, it is essential to provide contact information and emphasize to the patient and their family when to seek immediate medical attention in case of certain emergent conditions, such as: • Fever with a temperature equal to or greater than 38°C, presence of white patches, redness, or foul odor, which may indicate a possible infection. • Difficulty breathing, which could be a sign of respiratory distress. • Bleeding that lasts longer than 2 minutes, which may indicate thrombocytopenia. • Inability to eat or drink fluids for more than 24 hours, putting the patient at risk of dehydration. • Difficulty swallowing, which reflects the severity of symptoms. • Uncontrolled pain, indicating a deteriorating patient status and severity of symptoms. Furthermore, it is important to instruct the patient and their family to reach out if mucositis worsens, does not improve, or if any other complications develop.

Table 2.
General recommendation for prevention and treatment of oral mucositis in palliative care patients.

Fungal	Oral candidiasis	• The goal is to reestablish a normal balance of oral flora and improve oral hygiene. • The disinfection of all removable oral prostheses with antifungal denture-soaking solutions and the application of antifungal agents on the tissue-contacting surfaces is necessary to remove a potential source of fungal reinfection.
	Topical antifungal agents Note: Creams and ointments are ideal for treating patients wearing complete or partial dentures	• Clotrimazole (Mycelex) troches 10 mg. • Mycostatin pastilles 200,000 U. • Nystatin vaginal suppositories 100,000 U. • Nystatin ointment. • Ketoconazole (Nizoral) cream 2%. • Clotrimazole (Gyne-Lotrimin, Mycelex-G vaginal cream 1% [OTC]). • Miconazole (Monistat 7) nitrate vaginal cream 2% (OTC). • Nystatin (Mycostatin, Nilstat) oral suspension 100,000 U/mL.
	Systemic antifungal agents	• Fluconazole (Diflucan) tablets 100 mg. • Note: It should be used with caution in patients with impaired liver function (a history of alcoholism or hepatitis).
	Angular cheilitis and cheilosis	• Nystatin-triamcinolone acetonide (Mycolog II, Mytrex) ointment. • Polymyxin B/Bacitracin (Polysporin) ointment (OTC). • Clotrimazole-betamethasone dipropionate (Lotrisone) cream • Hydrocortisone-iodoquinol (Vytone) cream 1%. • Ketoconazole (Nizoral) cream 2%. • Clotrimazole (Gyne-Lotrimin, Mycelex-G) vaginal cream 1% (OTC). • Miconazole (Monistat 7) nitrate vaginal cream 2% (OTC).
Viral	HSV	• Reactivation of herpes virus might cause intraoral or extraoral lesions. • The current recommendation from the food and drug Administration is using systemic acyclovir to treat oral herpes only for immunocompromised patients. • Valacyclovir has been approved for the prevention and management of oral recurrent herpes simplex infections.
	Varicella zoster (Shingles):	• Precipitating factors include thermal, inflammatory, radiologic, and mechanical trauma, stress, as well as immunosuppression, promptly initiate antiviral therapy to reduce the duration and symptoms of the lesions. Patients over 60 years of age are particularly prone to postherpetic neuralgia (PHN).
	Topical antiviral agents	• Penciclovir (Denavir) cream 1%. • Docosanol (Abreva) cream (OTC).Acyclovir and hydrocortisone cream (Xerese).
	Systemic antiviral agents	• Valacyclovir (Valtrex) caplets 500 mg. • Acyclovir (Zovirax) capsules 800 mg.

Table 3.
Management of oral infections in patients on palliative care.

medicine, and pain specialists, to develop individualized pain management strategies. This may involve a combination of medications, physical therapy, heat or cold therapy, and relaxation techniques [22].

2. Oral health assessment: It is crucial to assess the patient's oral health status regularly. Dental professionals can examine the jaw joint, teeth, and surrounding tissues to identify any oral issues contributing to TMD symptoms. They may also provide recommendations for dental appliances, such as splints or mouthguards to alleviate jaw pressure and facilitate proper jaw alignment [23].

3. Patient education: Palliative care teams and dental professionals play a vital role in educating patients and their caregivers about TMD. They can explain the condition, its causes, and potential triggers to help patients understand and manage their symptoms effectively. Patient education may include guidance on stress reduction techniques, relaxation exercises, and lifestyle modifications to minimize TMD-related discomfort [24].

4. Nutritional support: TMD can affect a patient's ability to eat and speak, potentially impacting their nutrition and overall well-being. Palliative care teams collaborate with dieticians or nutritionists to ensure patients receive adequate nutrition while considering their specific TMD-related limitations. Soft food options or modifications to food textures may be recommended to accommodate their needs [25].

5. Emotional support: Palliative care recognizes the importance of addressing patients' emotional and psychological well-being. Living with a life-limiting illness and experiencing chronic pain can be emotionally challenging. Supportive services, such as counseling, support groups, or complementary therapies, such as music or art therapy, can help patients cope with the emotional impact of TMD and the overall palliative care journey [26].

6. Collaborative care: Palliative care involves a multidisciplinary approach, where different healthcare professionals work together to provide comprehensive support. In the case of TMD, this may involve collaboration between palliative care specialists, dentists, oral surgeons, physical therapists, and pain management experts. Regular communication and coordination among the care team ensure that all aspects of the patient's care, including TMD management, are addressed effectively.

It is important to note that the management of TMD in palliative care patients should be individualized and consider the patient's specific condition, overall health status, and personal goals of care. Open communication and collaboration among the patient, their caregivers, and the healthcare team are essential for providing optimal palliative care and addressing the challenges posed by TMD.

2.4 Xerostomia

Saliva plays a crucial role in various oral functions, including taste perception, swallowing, and speech. It also acts as a protective mechanism against infection and tooth decay by effectively cleansing the teeth and gums and maintaining an optimal oral pH level. However, patients with cancer particularly head and neck cancer (HNC) who undergo cytotoxic chemotherapy and radiotherapy often experience persistent dry mouth or xerostomia due to reduced saliva production (hyposalivation). This reduction is a result of radiation-induced damage to the salivary glands or effects

of chemotherapy [27, 28]. It is worth noting that a significant proportion of patients (up to 64%) who undergo conventional radiotherapy continue to suffer from moderate to severe permanent xerostomia, with some cases persisting for as long as 22 years after treatment. Xerostomia manifests with symptoms such as thick and stringy saliva, increased thirst, changes in taste perception, difficulties in swallowing or speaking, a sore or burning sensation, and the occurrence of cuts or cracks in the lips or corners of the mouth. Additionally, changes in the texture of the tongue's surface may also be observed [27, 29, 30]. The alterations in salivary composition, characterized by increased viscosity and lower pH levels, can have a detrimental impact on oral health. They can lead to a reduction in tooth remineralization, increased tooth sensitivity, and an elevated risk of dental caries. Moreover, these changes can also contribute to the development of candidiasis and lead to psychological complications associated with challenges in nutrition and social interaction [31, 32]. Therefore, the compromised saliva quality associated with xerostomia further contributes to the oral health challenges faced by patients.

2.4.1 Prevention & treatment

The management of hyposalivation involves a comprehensive approach that assesses saliva production and employs various treatment strategies to stimulate residual salivary function. One effective approach is to stimulate chewing and taste, along with the use of systemic sialagogues such as pilocarpine (Salagen), cevimeline (Evoxac), or bethanechol (Urecholine). These systemic sialagogues have demonstrated their potential in enhancing saliva production from functioning salivary glands. However, it is important to acknowledge that when acinar of the salivary glands is destroyed, the medical approach is ineffective [27, 28, 31]. To alleviate the symptoms associated with hyposalivation, patients should be advised to adopt certain practices. These include regularly sipping water, chewing sugar-free gum or candies, and avoiding substances such as caffeine, tobacco, alcohol, and hard or dry foods. Increasing fluid intake is also crucial to prevent dehydration [30]. Creams and ointments containing wax or lanolin have demonstrated effectiveness in moisturizing and safeguarding the lips. However, it is advisable to avoid products based on petrolatum [33]. Additionally, maintaining a cool and moist mouth can be achieved by using sugar-free popsicles, plain ice cubes, or ice water. It is important to note that individuals with teeth should avoid consuming foods high in acidity as this can further irritate oral tissues and contribute to tooth demineralization [27, 28]. In conjunction with these self-care measures, promoting regular oral hygiene practices and scheduling frequent dental visits are essential. Fluoride toothpaste or rinse and remineralization supplementation should also be considered to counteract the effects of insufficient saliva. For patients experiencing persistent hyposalivation, additional interventions such as moistening oral surfaces, enhancing saliva substitutes with inorganic substances such as calcium and phosphate, and utilizing antimicrobial mouth rinses have proven to be safe and effective in relieving dry mouth symptoms and reducing the risk of infections [6, 30, 34]. By adopting a comprehensive approach to manage hyposalivation, individuals can significantly improve their oral health and overall well-being (**Table 4**).

2.5 Dental caries

Various factors contribute to an increased risk of dental caries. These include a shift in the oral microflora toward a cariogenic flora, a decrease in the concentration

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Management strategies	Description
Saliva substitutes	• Glandosane: A saliva substitute that contains carboxymethylcellulose as a thickening agent. It is designed to provide moistening and lubricating properties to alleviate xerostomia symptoms. • Orthana: A saliva substitute that incorporates natural mucins, specifically porcine gastric mucin and bovine submandibular mucin. These natural mucins aim to replicate the viscoelastic properties of human saliva, providing enhanced moistening and lubrication for xerostomia patients. • Xialine: A saliva substitute based on the natural biopolymer xanthan gum. It can Improve speech and sense perception.
Systemic sialogogues	• pilocarpine (Salagen) 5 mg: 3–6 tabs daily. Note: Contradiction with asthma, glaucoma, and liver dysfunction. • Cevimeline (Evoxac) 30 mg: 1 table 3 times daily Note: Contradiction with asthma, glaucoma, liver dysfunction, and cardiovascular disease. • Bethanechol (Urecholine) 25 mg: 1 table 3 times daily. Note: Contradiction with asthma, peptic ulcer, and bladder inflammation.
Mouthwash	• Home-made mouthwashes: Saline solution (0.9% NaCl), bicarbonate solution. • Commercial mouthwashes: Biotène, oral balance, and Zendium. They contain antimicrobial proteins, have a gentle flavor, and are free from detergents, such as sodium lauryl sulfate (SLS).
Oral hygiene	• Emphasize meticulous oral hygiene practices, including regular brushing and flossing, to prevent oral infections. • Provide proper education on denture cleaning for denture patients, particularly emphasizing the importance of removing the appliance before going to sleep.
Dietary modifications	• Maintain regular water intake, chew sugar-free gum, consume sugar-free candy, avoid caffeine, tobacco, alcohol, and hard, dry, spicy, or acidic foods, and increase their fluid intake.
Moisture retention	• Suggest the application of creams and ointments containing wax or lanolin for moisturizing and protecting the lips. Caution against using products based on petrolatum due to an increased risk of aspiration and the potential for promoting pathogen growth due to their occlusive nature.
Humidifiers	• Recommend the use of humidifiers in the bedroom or throughout the home to increase moisture in the air.

Table 4.
Management of xerostomia associated with head and neck radiotherapy in palliative care patients.

of salivary antimicrobial proteins, and the loss of mineralizing components. In the case of conventional radiotherapy, significant changes occur in the oral microflora, leading to dominance of acidogenic bacteria, notably Streptococcus mutans and Lactobacilli [27, 34]. Unlike typical caries, radiation-associated caries can progress rapidly, and become evident as early as 3 months after treatment completion. They tend to affect nontraditional tooth surfaces, such as cusp tips and cavities at the gum line. Furthermore, radiation-associated caries have a higher recurrence rate and pose an increased risk of treatment failure, often requiring additional dental procedures. This condition can cause pain, infections, and functional impairments within the oral cavity. Additionally, the extraction of affected teeth after radiation therapy increases the risk of osteoradionecrosis (ORN), which is a complex complication that often requires extensive surgical intervention [34, 35].

2.5.1 Prevention & treatment

Radiation caries, a common complication of radiotherapy, can be prevented through proactive oral health management strategies. To address this issue, it is recommended that patients undergoing or planning to undergo radiotherapy or chemotherapy adopt a comprehensive approach to oral care. This involves thorough dental examinations, diagnoses, and necessary treatments, such as restorations and extractions, prior to starting cancer treatment. Additionally, scheduling regular dental check-ups is crucial for early detection of demineralization and carious lesions, enabling timely intervention [35]. To prevent severe dental demineralization and cavities, it is advised to apply 1.1% neutral sodium fluoride gel daily for at least 5 minutes. Ideally, a custom-fitted vinyl tray should be made for this purpose, starting from the first day of radiation therapy and continuing throughout the period of reduced salivary flow and dry mouth. In cases where fluoride trays are not feasible or preferred, high-potency fluoride brush-on gels and dentifrices can serve as suitable alternatives [28, 34]. For patients exhibiting signs of tooth demineralization and reduced saliva production, the use of remineralizing products containing calcium and phosphate is essential. These products provide the necessary building blocks for teeth and should be used in conjunction with topical fluoride treatments [35]. In addition to these preventive measures, dietary guidance and oral hygiene counseling play a crucial role in managing patients undergoing cancer therapy particularly radiotherapy for head and neck cancer. By implementing the proactive dental management plan outlined above and focusing on preserving salivary function and stimulating residual gland function, it is possible to enhance caries control and achieve improved overall oral health outcomes. Regular follow-up appointments and adherence to these recommendations will contribute to the success of the oral health management plan [32, 34].

2.6 Periodontitis

Periodontitis, a chronic disease characterized by the loss of tooth-supporting tissue, presents significant risks for patients with head and neck cancer (HNC) or patients on bone remodeling medications such as bisphosphonate or denosumab as part of their cancer treatment, including the development of osteoradionecrosis (ORN) and other complications. Cancer patients undergoing radiation therapy particularly to the head and neck area are more susceptible to periodontal disease due to factors such as hyposalivation, changes in the bone turnover, osteoporosis, and

alterations in the oral microbiome. Research has shown substantial loss of periodontal attachment and gingival recession following radiation therapy. The severity of these effects depends on the location and radiation dose as well as type of the chemotherapy, and preexisting periodontal disease can worsen with cancer treatment. This is concerning because periodontal disease has been linked to an increased risk of ORN and oral mucositis. Accurate diagnosis and effectively management of periodontitis in cancer patients are crucial to mitigate its adverse impact on oral health and treatment outcomes as well as patient general well-being [28, 34–36].

2.6.1 Prevention & treatment

Comprehensive dental examination and treatment are crucial before, during, and after cancer therapy, with a specific focus on periodontal disease. Prior to cancer treatment, a thorough evaluation of oral health, including clinical and radiographic assessments should be done to address any preexisting conditions. Patients should be educated about oral hygiene, nutrition, and the risks associated with smoking and alcohol consumption. They should also receive instructions on effective oral care techniques. Treatment for periodontal diseases prior to cancer therapy may involve scaling, root planning, extractions, and antimicrobial therapy. It is important to schedule tooth extractions at least 14 days before cancer treatment to prevent osteoradionecrosis or delayed wound healing. During cancer therapy or palliative care, emphasize should be placed on oral hygiene and preventive measures such as using chlorhexidine and fluoride mouthwashes. Urgent dental procedures can be performed based on blood counts and patient overall health and minimize long-term complications Mechanical plaque control and chemical plaque control through mouthwashes are essential. Conservative approaches are recommended for periodontal care, and tooth extractions should be carefully planned. In certain cases, Periodontal surgery may be considered as an alternative to extraction, with decisions made in consultation with the medical team [35, 36].

2.7 Apical lesions

The high prevalence and rapid development of caries following radiotherapy based on the region suggest increased pulpal involvement in the caries process and the subsequent bacterial intrusion into the pulpal space. Moreover, radiation-exposed pulp experiences a decrease in cellularity, rendering it more susceptible to necrosis triggered by uncontrolled caries. Consequently, an increase in the occurrence of apical periodontitis is expected among patients who have undergone radiation therapy [6, 36]. In a study, apical periodontitis was observed in 7.8% of teeth among patients who received radiation therapy in the head and neck area [37].

2.7.1 Prevention & treatment

A comprehensive radiographic assessment is essential in conjunction with clinical evaluation to identify periapical abnormalities, assess periodontal health, detect dental conditions, and determine tumor invasion in the bone. Prior to cancer treatment, dental assessments should encompass panoramic radiographs in addition to selective periapical or bitewing films to ensure a thorough evaluation [27, 34]. Focal infections, such as periapical or periodontal pathologies, and mucosal trauma from ill-fitting dentures, significantly increase the risk of osteonecrosis in individuals who have

undergone cancer therapy. Therefore, an interdisciplinary approach involving a comprehensive dental examination before cancer therapy, coupled with ongoing monitoring during the palliative care by a specialized dental team, is crucial. It is important to pay close attention to the periodontal condition throughout and after cancer therapy while strictly adhering to mechanical oral hygiene practices. Maintaining optimal oral and periodontal hygiene, including personalized fluoride carriers, is essential for long-term care due to the compromised healing ability of the periodontium following cancer therapy [34].

2.8 Jaw osteonecrosis

Osteonecrosis of the jaw (ONJ) is a debilitating condition and can develop after radiation therapy to the head and neck (osteoradionecrosis) or after treatment with antiresorptive therapies, or rarely antiangiogenic targeted therapies called medication-related osteonecrosis of the jaw or (MRONJ); Osteoradionecrosis results from radiation-induced changes due to hypocellularity, hypovascularity, and ischemia in the jaws. MRONJ results from an imbalance in bone homeostasis due to osteoclast inhibition. Osteonecrosis of the jaw is defined as the presence of exposed dental bone for longer than 8 weeks, which can be probed through an intraoral or extraoral fistula. While dental surgery, including tooth extraction, in setting of chronic dental infections for example periodontal disorders, or following any trauma such as trauma from ill-fitting denture, are common trigger for ONJ, this condition can also develop spontaneously. Secondary soft tissue infection is a prevalent occurrence and represents the leading cause of symptoms in this context. In more severe cases, advanced infection can result in the formation of an extraoral fistula. Additionally, symptoms may arise due to the compression of the inferior alveolar nerve or as a consequence of pathologic fractures.

The risk of developing these complications is particularly high in posterior mandibular areas. Moreover, patients who have received radiation doses exceeding 6500 cGy to the jaw, individuals with higher cumulative doses of antiresorptive therapy, smokers, and those who have undergone traumatic procedures, such as extractions with the use of local anesthetics containing epinephrine are also at an increased risk [38].

2.8.1 Prevention & treatment

The prevention of osteonecrosis of the jaw (ONJ) is a crucial concept that highlights the importance of dental stabilization before cancer therapy and maintaining good oral and dental health in survivors. Therefore, it is vital for palliative care patient who are scheduled to receive bone-modifying agents or radiation to head and neck area to undergo a comprehensive oral care assessment and necessary dental procedures before starting these medications. It is recommended to avoid elective invasive dental procedures that involve manipulation of the alveolar bone in patients using these medications or have history of head and neck radiation.

Protocols to reduce the risk of jaw osteonecrosis include selecting endodontic therapy over extraction, employing an atraumatic surgical technique if surgery is necessary. Additionally, prophylactic antibiotics should be initiated on the day of surgery and continued during the week of healing, typically penicillin VK for 7 days. While there is limited evidence supporting the use of local anesthetic

without epinephrine or hyperbaric oxygen therapy as preventive measures for patients at risk of osteoradionecrosis (ORN), these approaches may be considered. It is important to note that hyperbaric oxygen therapy involves daily "dives" in a chamber under two atmospheres of oxygen pressure and carries certain risks such as middle ear injury, myopia, and seizures. When jaw osteonecrosis does occur, conservative management is generally effective in controlling symptoms and stabilizing the condition [39, 40].

To promote healing, it is important to brush the exposed bone thoroughly, and patients should rinse their mouths with chlorhexidine twice a day. If there is a bony sequestrum present, it should be removed to facilitate epithelialization. Debridement procedures can help reduce the risk of secondary infection and improve symptoms. In cases, where there is swelling and suppuration, broad-spectrum antibiotics are recommended.

Pathologic fractures should be managed by a surgeon, although not all fractures require surgery. If conservative measures fail to produce the desired outcome, surgical resection of the affected bone may be necessary. In the specific management of ORN, there is limited evidence supporting the use of hyperbaric oxygen treatment, involving 60- to 90-minute dives, 5 days per week, for a total of 20–30 dives. Additionally, the combination of pentoxifylline and tocopherol has shown some potential in the treatment of ORN [41].

Currently, there is insufficient evidence to support the temporary discontinuation of antiangiogenic or antiresorptive drugs (drug holiday) before dentoalveolar surgery in patients receiving an oncologic dose of these medications. Limited literature suggests that some adjunctive therapies, such as pentoxifylline and alpha-tocopherol (Pent-E) and photobiomodulation (PBM) with or without photodynamic therapy (PDT), have shown promising results in managing MRONJ. However, recent guidelines from the International Association of Oral and Maxillofacial Surgeons (IAOMS), as well as guidelines from the Multinational Association of Supportive Care in Cancer/International Society of Oral Oncology (MASCC/ISOO) and the American Society of Clinical Oncology (ASCO), only recommend topical antimicrobial rinses, antibiotics, effective oral hygiene, and surgical interventions [39, 42]. Insufficient evidence exists to support the discontinuation of antiangiogenic or antiresorptive drugs after the diagnosis of MRONJ.

2.9 Neuropathic pain and chemosensory changes such as taste change (dysgeusia)

Dysgeusia can refer to an abnormal or impaired sense of taste, where the ability to taste is affected. It can also describe an unpleasant alteration of taste sensation, where tastes may be distorted or altered in an unpleasant way. Additionally, dysgeusia can refer to a distortion or perversion of the sense of taste, where the perception of taste is not accurate or is perceived differently than normal [43].

Dysgeusia is closely linked to changes in olfaction as both taste and smell play a role in producing the sense of flavor. Taste and smell work together to create our perception of flavors, and alterations in either of these senses can affect the overall sensory experience of food or beverages. Therefore, when dysgeusia occurs, it is often accompanied by changes in the sense of smell, leading to a disruption in the overall perception of flavor. Several mechanisms contribute to taste alterations in patients on palliative care particularly cancer patients such as cancer-related inflammation, adverse effects of chemotherapy and other drugs used to treat complications, nutritional status, and the lifestyle habits of the patients. Chemotherapy is associated

with dysgeusia through multiple mechanisms, such as damage to taste buds and olfactory receptors, impairment to neurotransmission, and other physical (i.e., xerostomia) or psychological effects [44, 45].

Dysgeusia can become a chronic issue and negatively influence patients' quality of life, worsening their dysphagia and their nutritional status. The management of dysgeusia includes using zinc supplementation, self-care management of dry mouth, and dietary counseling [46].

Patient on palliative care, particularly cancer patients may also experience long-term persistent orofacial neuropathic pain. While symptoms may vary, the most frequently reported experience is a strong burning sensation, particularly aggravated by movement and activity. In rare instances, individuals with a history of severe and extensive ulcerations (such as mucositis), as well as those who have experienced shingles or severe herpes simplex virus reactivation, may develop post-inflammatory dysesthesias. These dysesthesias are typically characterized by a burning feeling, sometimes accompanied by reduced or altered taste perception. Addressing these symptoms poses a challenge, but patients can potentially benefit from the use of topical and systemic anticonvulsant medications [47].

2.10 Bleeding

Almost 6–10% of palliative care patients present with clinically significant bleeding [48]. It has been described that 74% of this population experienced bleeding during their final month of life in the head and neck region including the oral cavity [49].

The risk of oral bleeding is much higher in patient undergo high-dose chemotherapy or with end-stage renal and liver disease or any medications or treatment that affects bone marrow. Gingival bleeding and submucosal hemorrhage may arise due to minor incidents such as tongue biting, toothbrushing, or swallowing, particularly when the platelet count decreases to less than 50,000 (especially below 20,000) cells/mm3. Notable observations in clinical practice involve the presence of palatal petechiae, purpura along the sides of the tongue, and instances of gingival bleeding or seepage. Gingival bleeding can be worsened by inadequate oral hygiene. To address this issue, individuals experiencing easy gingival bleeding should consider using gentler cleaning tools like sponge Toothettes. If gingival bleeding cannot be controlled, certain local approaches can be employed. These may include applying pressure using a gelatin sponge infused with thrombin or microfibrillar collagen on the affected area. Another option is to use gauze soaked in an oral antifibrinolytic solution, such as aminocaproic acid [Amicar] syrup 250 mg/mL. If local measures prove ineffective, platelet transfusion might be necessary.

3. Systemic management of the oral pain

The primary objective of palliative care is to alleviate the suffering and burden of illness experienced by both patients and caregivers during the progression of a chronic condition. This approach aims to minimize the physical, emotional, and psychological distress from the moment of diagnosis until the end of life. A comprehensive palliative care approach recognizes the importance of supporting not only the patient but also their caregivers, treating them as a cohesive unit of care. Moreover, it acknowledges and attends to the grief process before death and during the subsequent bereavement period [50].

To decrease nociceptive pain, opioid analgesics are included in current pharmacologic treatment recommendations [1, 51]. In addition, intrathecal opioid delivery has been shown to provide effective pain relief with reduced adverse effects for chronic persistent/intractable cancer pain [52]. However, opioids are limited in efficacy in the treatment of neuropathic pain, use of anticonvulsant medications, centrally-acting antidepressants, and biopsychosocial treatments are often indicated in cancer patients [2].

Transnasal fentanyl (a rapidly acting opioid) may be used for the treatment of breakthrough pain in patients with head and neck cancer, especially because of increased likelihood of mucosal damage leading to difficulties with the administration of transoral or transmucosal preparations. In addition to baseline systemic analgesics, topical oropharyngeal preparations may be applied [53].

As for the management of mucositis-related pain, a study reviewed use of oral rinses and systemic analgesics that include opioids and introduced investigation of novel use of methylene blue oral rinse in management [54]. A systematic review of topical anesthetics and analgesics for oral mucositis pain in 2020, provided a suggestion for use of morphine 0.2% solution, other agents discussed included topical coating agents, topical anesthetics, and topical doxepin [55]. A randomized trial studied the difference between a single dose of doxepin rinse or diphenhydramine-lidocaine-antacid mouthwash versus placebo for oral mucositis-related pain. Pain reduction was similar for both, more drowsiness was observed with doxepin [56]. Pregabalin and doxepin rinse were found effective for neuropathic pain and pain associated with oral mucositis respectively in HNC patients [57]. Application of photobiomodulation (PBM) has been described for prevention of oral mucositis associated with radiotherapy to the head and neck and has been shown to provide pain reduction and reduced analgesic use during and following cancer therapy [58].

Relief of cancer pain has been reported with tetrahydrocannabinol (THC) and cannabidiol combination [59]. A study found a direct role of cannabinoid receptor agonists in the reduction of mechanical allodynia and discussed potential positive effects upon cancer cell viability, suggesting the potential of antitumor effect [60].

A literature review identified positioning stents during RT for HNC to avoid unwanted radiation to the jaw and salivary glands [61]. Chemical neurolysis was found to provide significant pain relief to patients with refractory cancer-related pain, with minimal risk of manageable adverse effects [62]. Spheno-palantine nerve block with bupivacaine for pain in the maxillary division of the trigeminal nerve and transcutaneous electrical nerve stimulation (TENS) during the last 2 weeks of RT caused a decrease in head and neck cancer-related neuropathic pain scores [63, 64].

4. Conclusions

Patients nearing the end of life often experience a range of oral complications that can significantly impact their quality of life. These complications include pain, dysfunction of the salivary glands, difficulty swallowing (dysphagia), and infections affecting the mouth and mucous membranes. These issues may arise either as a result of treatments administered during the terminal phase or due to the progressive nature of the underlying disease. The oral well-being plays a crucial role in various aspects of our lives, such as effective communication, proper eating, clear speech, and efficient swallowing. Any compromises in this area can significantly impact one's quality of life, potentially leading to functional decline and a failure to thrive. Therefore,

it becomes imperative to integrate oral health care as an essential component of palliative care. The primary objectives of such care include preventing oral complications, preserving optimal oral function, and enhancing overall quality of life and comfort. In the context of palliative care, it is recommended to uphold regular oral hygiene practices whenever feasible. Additionally, addressing the need for treating dental issues such as decay, fractures, or missing teeth should be considered if it aligns with the patient's desires and is in accordance with their care objectives.

The overall concerns include:

- Difficulties in eating can result in reduced food consumption, inadequate nutrition, weight loss, and changes in facial structure.
- Speech and communication challenges can cause significant stress and frustration for both patients and their caregivers/families.
- Patients' concerns about their facial and oral appearance may stem from their desire for dignity and respect at the end of life.
- Neglecting regular oral hygiene practices toward the end of life can contribute to problems such as gingivitis, periodontitis, tooth decay, tooth loss, and bad breath. These issues can impact self-esteem, and loved ones may avoid close contact due to halitosis, exacerbating the patient's feelings of isolation and depression.
- Decayed, broken, or missing teeth can impair chewing abilities and increase the risk of oral tissue injuries, leading to further disability.
- Dysfunction of salivary glands, primarily not only resulting in dry mouth (xerostomia) but also affecting taste (dysgeusia), can affect appetite, formation of food boluses, swallowing, and speech and communication.
- Oral pain and poorly fitting dentures can hinder oral intake and further limit a patient's ability to communicate, especially in cases where cachexia is associated with a terminal illness.

Maintaining optimal oral hygiene plays a crucial role in reducing the risk of various oral health issues such as gingivitis, periodontitis, oral infections, and caries. To ensure proper oral hygiene, the following practices should be performed at least twice a day:

1. Brushing: Utilize a soft-bristled toothbrush along with either an over-the-counter fluoride toothpaste or a prescription-strength fluoride toothpaste containing 1.1% sodium fluoride. Begin by placing the brush at the gum line and using a circular motion to cover all tooth surfaces. Patients with limited mobility, coordination, or dexterity may find electric toothbrushes more effective.
2. Rinsing: Thoroughly rinse your mouth with water or an alcohol-free mouthwash. This helps reduce bacterial load and improves halitosis (bad breath).
3. Denture care: If you wear dentures, remove them and meticulously brush them with a denture brush and warm water. In the case of candidiasis (oral fungal infection), dentures may require soaking in a prescribed solution.

4. Lip care: To address dry or chapped lips, consider using over-the-counter lip care moisturizers such as lanolin, oral balance, unflavored Chapstick, or cocoa butter.

5. Alternative options: For individuals who cannot rinse or spit due to physical limitations or swallowing difficulties, gently swab the mouth and teeth twice daily with a sponge Toothette soaked in alcohol-free 0.12% chlorhexidine gluconate.

6. High caries risk: Individuals with increased caries risk, particularly due to functional or cognitive impairment, may benefit from additional measures. These include applying fluoride gels (1.1% sodium fluoride gel) with a brush daily, using topical fluoride varnish (5% sodium fluoride varnish, 0.4 mL dose) at 3-month intervals, or applying silver diamine fluoride (38% silver diamine fluoride) at 3-month intervals.

By incorporating these practices into your daily routine, you can maintain excellent oral hygiene and reduce the likelihood of oral health problems.

Conflict of interest

The authors declare no conflict of interest.

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