RADIATION THERAPY
(also known as “radiotherapy” and “irradiation therapy”, and includes “x-ray therapy” and “brachytherapy”)

Note: This fact sheet focuses on head and neck radiation for cancer treatment unless otherwise specified. Further information on myelosuppressive radiation therapy (specifically, “total body irradiation”) is found in the Bone Marrow Transplantation and Blood Stem Cell Transplantation Fact Sheet.

Is the initiation of non-invasive dental hygiene procedures* contra-indicated? Unlikely

- Is medical consult advised? Yes. The patient/client’s oncologist should be consulted regarding overall risk assessment and the safest time to schedule an appointment, and dental hygiene instrumentation may need to be altered to accommodate the patient/client’s physical condition. Consultation is also warranted pre-radiotherapy to learn anticipated radiation side effects, and the dental hygienist should ascertain if chemotherapy is also planned. Furthermore, the patient/client should be referred to a dentist pre-radiotherapy for consideration of selective teeth extraction (for poor lifelong prognosis teeth that will be in the field of radiation and/or for patient/client lack of interest in saving teeth). Additionally, advance consultation is prudent if dental radiographs are being considered during radiotherapy administration. Dental radiographs are not contraindicated if clinically indicated during radiotherapy; however, the decision to take routine oral radiographs while a patient/client is in the process of receiving radiation therapy should be carefully considered. Ideally, clinically indicated radiographs should be performed before radiotherapy commences.

Is the initiation of invasive dental hygiene procedures contra-indicated?** Yes. Active radiation therapy may affect appropriateness or safety, and scaling and root planing, including curetting of surrounding tissue, are contraindicated until the patient/client is medically cleared. In some cases, immunosuppression that warrants antibiotic prophylaxis and/or a bleeding disorder (thrombocytopenia) may be present.

- Is medical consult advised? As above. Additionally, post-radiotherapy referral to an oral surgeon or dental oncology specialist may be indicated for possible hyperbaric oxygen therapy and surgical management of necrotic tissue or bone.
- Is medical clearance required? Yes.
- Is antibiotic prophylaxis required? Possibly, but uncommonly unless total body irradiation is involved (e.g., for treatment of leukemia or for bone marrow/stem cell transplantation purposes). Prophylaxis indication is dependent on degree of suppression of white blood cell (WBC) count or neutrophil count. (See Chemotherapy Fact Sheet and Bone Marrow Transplantation and Blood Stem Cell Transplantation Fact Sheet for further information on use of prophylactic antibiotics.) Also, persons who have radiation to the left breast and chest are at increased risk of valvular heart disease, and may also be candidates for antibiotic prophylaxis.
- Is postponing treatment advised? Possibly. If dental hygiene procedures have not been accomplished before, they should be done within the first 2 weeks of head and neck radiotherapy, before the onset of mucositis; otherwise, postponement may be indicated. Similarly, postponement is advisable if the patient/client appears debilitated. In cancer patients/clients undergoing total body irradiation that results in:
  - thrombocytopenia, elective invasive procedures should be deferred until a platelet count of at least 50,000/μL has been achieved in order to reduce the risk of bleeding.
  - immunosuppression, elective invasive procedures should be deferred until after radiation-induced immunosuppression ceases. Specifically, treatment should be postponed until the patient/client’s absolute neutrophil count is >1000/μL to reduce risk of infection.

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Oral management implications

- Before, during, and after radiotherapy, the dental hygienist plays a key role in helping patients/clients with malignancy understand that optimal oral hygiene care prevents or reduces oral complications from irradiation. Such care improves patients’/clients’ quality of life and the likelihood they will be able to tolerate ideal doses of cancer treatment.

- The best time for dental hygiene assessment for a cancer patient/client is before cancer therapy begins — in most circumstances, ideally a month before radiotherapy begins. Particular emphasis should be placed on the identification and treatment of low-grade and acute intraoral infections. The dental hygienist should also ensure identification and elimination of sources of oral trauma and irritation, such as orthodontic bands, ill-fitting dentures, and other oral appliances, if they will be in the field of radiation. Following medical/dental clearance, tooth scaling and prophylaxis should be provided before initiation of radiotherapy. (In order to allow for healing, oral surgical/invasive procedures should ideally be performed at least 14 days before radiation therapy begins.)

- Teeth within the field of radiation that have a poor lifelong prognosis, acute infection, or severe periodontal disease that may predispose the patient/client to complications (e.g., sepsis or osteoradionecrosis) should be extracted 10 (in select circumstances in which healing will not be compromised) to 21 days before the initiation of radiotherapy.

- Throughout radiotherapy, the patient/client should be supported with suggestions to prevent and reduce side-effects/ complications. Post-therapy, frequent dental hygiene appointments (e.g., every 1 to 3 months) should be scheduled until the acute side-effects of radiotherapy have resolved and the patient/client demonstrates ability to care for his/her teeth (usually at least 6 months after radiotherapy ends).

- Dental hygiene provision should be coordinated with the patient/client’s oncology team. A radioprotectant (e.g., amifostine), may be administered to reduce xerostomia in head and neck cancer patients/clients. The dental hygienist should monitor mucosa and oral structures for bleeding and signs/symptoms of oral bacterial infection (e.g., swelling, erythema, and fever), and ensure dental/medical referral for definitive treatment.

- Tobacco and alcohol avoidance should be promoted. Dietary counselling should include emphasis on the need to avoid foods that irritate sore tissues or cause dental decay.

- Because radiation to the salivary glands causes permanent damage, lifelong management of xerostomia may be required, including daily applications of fluoride gel and frequent dental hygiene follow-up appointments for patients/clients who are severely xerostomic.

- Candidiasis should be managed by a physician/dentist with topical oral antifungal drugs, and severe cases may require systemic antifungals.

- Oral infections may be reduced by chlorhexidine gluconate mouth rinses, although its benefit is controversial. Preparations involving alcohol should ideally be avoided.

- Alteration of taste arising from tongue irradiation results in eating becoming a chore, because all food tastes like mush or straw. Therefore, the dental hygienist should provide a sympathetic ear, encourage eating to maintain optimal nutritional status, and indicate that taste will return several months after radiation therapy ceases. Nutritional liquid substitutes and/or referral to a registered dietitian for nutritional counselling may be indicated. In cases of chronic loss of taste, zinc supplementation may help some patients/clients improve taste perception.

- Mucositis management is very important, because mucositis is often a cause of dose interruption of radiotherapy. In addition to xerostomia management measures, mucositis can be addressed by extra soft, nonabrasive toothbrushes and avoidance of commercial toothpastes with strong flavouring agents (and possible substitution with baking soda paste). All mouthwashes with alcohol or phenol should be avoided due to their irritating and drying and effects. If toothbrushing becomes impossible due to painful tissues, the teeth, gingiva and tongue may be swabbed with gauze that has been moistened in warm water. Flossing should be continued as long as possible and recommenced as soon as the mucositis ends. Benzydamine rinses may reduce mucositis and pain. While topical anaesthetic agents (such as viscous lidocaine) may provide temporary relief from

1 Including highly mobile and exfoliating primary teeth in children, partially erupted third molars, fractured teeth, and restorations.
### Oral management implications * (con’t)

- Pain, patients/clients — particularly children and their parents — should be cautioned that there is a risk of food aspiration if the soft palate and epiglottis are anaesthetized; excessive use may actually increase mucositis symptoms. Some patients/clients may require mucosal coating agents (e.g., sucralfate rinse or milk of magnesia), systemic analgesics, or even narcotics to control their mucositis pain. Zinc supplements taken during radiotherapy may delay or decrease mucositis caused by radiation.

- Skin care around the mouth should be directed by the radiation oncologist during radiotherapy, with particular emphasis on avoidance of lip lubricants that exacerbate radiation dermatitis. Severe dermatitis may require topical and oral antibiotic therapy combined with topical corticosteroids to eradicate infection and help repair the skin’s barrier function.

- Patients/clients should avoid wearing their dentures (and other prostho-dontics) during the first 6 months after completion of head and neck radiotherapy, because even mild trauma can result in ulcerations to the altered mucosa as well as possible necrosis of underlying bone. Fabrication of new dental prostheses should be delayed until several months post-radiotherapy, when all acute side effects of radiation have resolved. Because radiation may alter oral tissues, dentures may need to be reconstructed after treatment is completed and the tissues have stabilized; some persons may never be able to wear dentures again.

- Rampant caries and tooth demineralization usually begin within the first year of radiation therapy, unless intensive oral hygiene and preventive measures have been implemented. All patients/clients receiving cancericidal doses of radiation to any of the salivary glands should have custom fluoride trays (with smooth, non-irritating edges) for daily application of sodium fluoride gel.

- Dietary habits should be discussed, with particular emphasis on reduction of sugar, acidic juice, and soft (including diet) drinks.

- Oral surgery on irradiated bone should be avoided if possible throughout the patient/client’s lifetime to reduce the risk of osteoradionecrosis (and hence consideration of “prophylactic” teeth removal pre-radiation). After radiation therapy, excellent oral hygiene and early intervention should be goals of regular dental hygiene care to minimize need for tooth extraction and risk of osteoradionecrosis and soft tissue necrosis. Hyperbaric oxygen therapy is an adjunctive therapy.

- The dental hygienist, in conjunction with the dentist, should monitor irradiated craniofacial and dental structures for abnormal growth and development in pediatric patients/clients.

- The dental hygienist should be sensitive to the evolving psychological state of the patient/client who is diagnosed with cancer (including oral cancer), about to undergo cancer treatment, or is recuperating from cancer treatment. Persons who have previously had a positive attitude about their teeth and oral hygiene may behave differently during times of stress. Additional time may be required during the dental hygiene appointment for the patient/client to express feelings, as well as for situational oral hygiene instruction.

- In cancer patients/clients undergoing total body irradiation that results in thrombocytopenia (abnormally low platelet count), vigorous teeth brushing should be avoided, along with dental floss, water-irrigating appliances, and toothpicks. Softer devices (e.g., gauze wrapped around a finger and dampened with warm water or an appropriate antimicrobial solution) are indicated.

- Dental diagnostic x-rays should generally be avoided during radiotherapy except in urgent situations and with prior consultation with the appropriate medical care provider. However, if they are required, the amount of radiation from dental radiography is tiny compared with radiotherapy to the head and neck, and unlikely to be of concern. Furthermore, patients/clients who have received radiation to the head and neck in the past can safely undergo dental radiography. In fact, head and neck radiation increases the risk of developing tooth decay, making radiographs all the more important for these patients/clients.

- Virtually all patients/clients receiving radiation for head and neck cancer develop oral side effects and complications, which vary depending on the field of treatment and the total dose of radiation required. Treatment-specific complications of radiotherapy, in contradistinction to chemotherapy, are radiation caries, trismus/tissue fibrosis, and osteonecrosis.
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Oral manifestations

- Radiation-induced damage is anatomically site-specific (unlike the case with chemotherapy); toxicity is localized to tissues in the direct field of radiation\(^2\). Radiation damage also differs from chemotherapy-induced changes in that irradiated tissue can manifest permanent damage that places the patient/client at continual risk for oral sequelae and increased susceptibility to subsequent toxic drug or radiation exposure.

- After the first week of radiation to the oral cavity or salivary glands, the patient/client typically experiences some of the acute side effects, whereas other complications may not manifest until later in the course of radiotherapy.

- Acute, temporary manifestations of radiotherapy of the head and neck include xerostomia, dysgeusia (altered taste, particularly changes in sweet, sour, bitter, and salty perceptions), hypogeusia (partial loss of taste), ageusia (complete loss of taste), mucositis, dysphagia, pain, secondary infection, muscle trismus, and dermatitis.

- Delayed, chronic side effects and sometimes permanent complications (occurring months or even years after the end of radiation) include xerostomia and salivary gland dysfunction; alterations in taste (compared with pre-radiation status); “burning” painful tongue; telangiectasias\(^3\); atrophic, fissured mucosa; focal hyperpigmentation; ongoing fungal infections (such as candidiasis — particularly the pseudomembranous and erythematous forms — and cheilitis caused by lack of saliva); osteoradionecrosis\(^4\) and/or soft tissue necrosis and/or pulp necrosis; tooth hypersensitivity; rampant caries (especially radiation-associated cervical caries) and tooth demineralization (related to salivary gland dysfunction); muscle and mucous membrane fibrosis, temporomandibular joint disorder, and trismus (related to direct effect of radiation on muscles of mastication or TMJ); and altered tooth and jaw development in children.

- Salivary gland dysfunction is noted by patients/clients after the first week of radiation to oral cavity and neck tumours. Saliva becomes thickened and ropy, and, as the treatment progresses, their mouths become drier. Xerostomia compromises speaking, chewing, and swallowing, as well as poses risk to nutritional status due to inability to eat some foods. Risk of dental caries and other oral infections (bacterial, fungal, and viral) is increased. Cracked lips are common.

- Dysgeusia, hypogeusia, and/or ageusia usually occur after the first few treatments when the tongue is irradiated. Taste returns a few months after cessation of radiotherapy, but it may be different than its pre-radiation status.

- Mucositis usually onsets by end of the second week of radiotherapy, with the patient/client experiencing mucosal inflammation and pain. It develops more often in nonkeratinized mucosa (i.e., ventral tongue and labial and buccal mucosa) and adjacent to metallic restorations. Ulcers begin as red, swollen tissue, and, as radiotherapy progresses, small ulcerations may enlarge to become confluent, yellowish, membrane-covered ulcerated tissue. Associated side effects and complications include pain, burning, mucosal bleeding, difficulty chewing, dysphagia (difficulty swallowing), nutritional compromise, difficulty talking, unpleasant odours, difficulty sleeping, and secondary mucosal infection (often candidiasis). In the absence of secondary infection, gradual resolution of mucositis occurs over 6-8 weeks post-radiotherapy. However, the epithelium undergoes permanent fibrosis, tissue may be thin and fragile, and telangiectasias may manifest.

- Oral mucosal toxicity may be worsened by the use of concurrent chemotherapy with head and neck radiation.

- Radiation dermatitis in the irradiated field usually manifests as morphologic changes of the skin that start halfway through irradiation and persist for some weeks afterwards. These changes include inflammation and erythema, followed by desquamation of the epidermis, and can lead to either the lesion healing or progression to radionecrosis. Scarring and atrophy of the epidermis increases tissue rigidity, and makes the skin less supple and less resistant to injury.

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2 The exception to this localization of radiotherapy is radioactive substances delivered orally or intravenously.

3 vascular lesions of dilated small blood vessels, typically appearing as red to purplish dots

4 Osteoradionecrosis is defined as radiotherapy-exposed bone that fails to heal over 6 months. Many cases result from damage to tissues overlying the bone, as opposed to direct bone damage.

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Oral manifestations (cont’)

- Trismus may result from high dose radiation to the masticatory muscles and/or the temporomandibular joint ligaments that decreases tissue elasticity and hence ability to open the mouth. It usually occurs within 3 months after radiotherapy (sometimes initially manifesting as pain or weakness), remains a lifelong problem, and can interfere with eating, talking, and post-treatment oral examination.

- Radiation-related caries usually appears within the first year after radiation therapy. Enamel demineralization and rapid decay (“rampant caries”) result from decreases in quantity and quality of saliva.  

- Altered tooth and jaw development occurs to varying degrees in children with oral cancer who receive radiotherapy. Older children who receive minimal doses may experience only altered root development, whereas younger children who are irradiated when their jaws and teeth are developing may experience gross malformation of dentition (such as microdontia, small crowns, incomplete calcification, enlarged pulp chambers, malocclusion, prematurity closure of apices, arrested tooth development, and significant skeletal deformities). Such changes in the primary teeth can cause significant malocclusion and may adversely affect facial development.

- Soft tissue necrosis and osteoradionecrosis (ORN) occur, because radiotherapy may irreversibly injure the vascularity of soft tissue and bone, as well as damage osteocytes, osteoclasts, and osteoblasts. This results in decreased ability to heal after trauma. Non-healing soft tissue and bone may become secondarily infected, leading to severe pain and even jaw fracture. Advanced presentations of ORN include pathologic fracture, fistula, and full-thickness devitalization of bone. Most cases of ORN occur in the mandible, with one-third of cases occurring spontaneously.

- Second malignancies later in life may result from head and neck radiation, including cancers of the oral cavity.

- Cancer patients/clients undergoing total body irradiation are susceptible to bone marrow suppression that can result in thrombocytopenia (abnormally low platelet count) and consequently bleeding problems. Gingival bleeding and submucosal hemorrhage can occur as a result of minor trauma (such as tongue biting or toothbrushing) when the platelet count falls below 50,000 cells/mm³, and spontaneous gingival bleeding may occur with a platelet count < 20,000/mm³. Palatal petechiae and purpura along the lateral margin of the tongue are other manifestations of thrombocytopenia.

Related signs and symptoms

- Radiotherapy uses ionizing radiation, from either external high-energy beams or internally implanted/administered sources (e.g., brachytherapy or radiopharmaceuticals), to slow or stop the growth of fast-growing cells such as cancer cells. It may be used by itself to treat oral squamous cell carcinoma and nasopharyngeal carcinoma or in combination with chemotherapy. It is also indicated in the treatment of other head and neck cancers (including salivary gland tumours and lymphomas, as well as retinoblastomas), as well as tumours of the prostate, breast, bladder, lung, etc. Palliative radiotherapy may offered to patients/clients who are not candidates for curative therapies.

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5 The reduced availability of calcium and phosphate in saliva leads to reduced remineralization of teeth, as well as reduced acid buffering.

6 The mandible (particularly posteriorly) is more susceptible than the maxilla, because of its dense bone structure and limited blood supply.

7 Petechiae and purpura are red or purple spots on the mucosa or skin, which do not blanch to applied pressure, caused by extravasation of blood (i.e., hemorrhages). Petechiae are pinpoint to pinhead in size (i.e., 1 to < 3 mm in diameter), whereas purpura lesions range from 3 to 10 mm in diameter.

8 Brachytherapy uses solid radiation sources, such as seeds, which are placed in the body in or near the cancer.

9 a form of eye (retinal) cancer, which rarely but typically occurs in young children
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Related signs and symptoms (cont’d)

- The degree of radiation damage depends on treatment regimen-related factors, including type of radiation utilized, total dose administered, and field size.
- Acute toxic reactions occur during and immediately after radiotherapy (with cells that undergo rapid turnover being most susceptible to damage), and delayed toxicity can occur several months to years after irradiation.
- Skin changes and focal hair loss (in the path of external beam radiation), fatigue, and altered sleep pattern are common during treatment. These side effects, and some others according to body site being irradiated, dissipate within two months of cessation of radiotherapy. Local, temporary skin changes include dryness, peeling, blistering, and itching.
- Constitutional complications such as dehydration (from being unable to drink), malnutrition (from being unable to eat), and systemic infections can result from radiotherapy to the head and neck.
- Partial or total hearing loss may occur on the side of the head being irradiated; hearing usually returns after radiotherapy is completed.
- Nausea and vomiting can result from head/neck irradiation, as well as from abdominal irradiation. Diarrhea is common with stomach and intestinal radiotherapy.
- Bloating, as well as rectal and bladder irritation, can result from radiation to the pelvis.
- Cough, shortness of breath, and increased mucus production may result from radiotherapy to the chest.
- Leukopenia (abnormally low white blood cell count, which may predispose to infection), anemia (abnormally low red blood cell count, which may contribute to fatigue), and thrombocytopenia (abnormally low platelet count, which may cause bleeding problems) can result from radiotherapy to the bone marrow.
- Late side effects may occur 6 or more months after radiotherapy is completed. Depending on body site subjected to radiation, such effects (which may be transient or permanent) include lymphedema, infertility, overactive bladder, urinary and/or fecal incontinence, joint problems, and secondary cancer.
- Nerve damage, delayed intellectual development in children, and, rarely, radiation-induced malignancy or brain hemorrhage are possible sequelae of radiotherapy to the head and neck.
- Anxiety and depression often occur in patients/clients undergoing radiotherapy to the head and neck for cancer, exacerbated by oral complications that affect eating and speaking. Social withdrawal may occur, and some drugs used to treat depression cannot be used, because they worsen oral side effects.

References and sources of more detailed information


10 localized fluid retention and tissue swelling caused by obstruction of the lymphatic system

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References and sources of more detailed information  


■ National Cancer Institute, National Institutes of Health: Oral Complications of Chemotherapy and Head/Neck Radiation (PDQ®)

■ National Institute of Dental and Craniofacial Research, National Institutes of Health

■ HealthLinkBC, citing National Cancer Institute, National Institutes of Health: Oral Complications of Chemotherapy and Head/Neck Radiation (PDQ®): Supportive Care – Health Professional Information http://www.healthlinkbc.ca/healthtopics/content.asp?hwid=ncicdr0000062870


* Includes oral hygiene instruction, fitting a mouth guard, taking an impression, etc.

** Ontario Regulation 501/07 made under the Dental Hygiene Act, 1991. Invasive dental hygiene procedures are scaling teeth and root planing, including curetting surrounding tissue.

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