Dental Considerations for Older Adult Patients

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- Read the enclosed course.
- Complete the questions at the end of the course.
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Faculty
Mark J. Szarejko, DDS, FAGD, received his dental degree from the State University of New York at Buffalo in 1985. He received fellowship from the Academy of General Dentistry in 1994.

Faculty Disclosure
Contributing faculty, Mark J. Szarejko, DDS, FAGD, has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Senior Director of Development and Academic Affairs
Sarah Campbell

Director Disclosure
The director has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Audience
This course is designed for dental professionals involved in the care of older adult patients.

Accreditations & Approvals
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This course meets the Dental Board of California's requirements for 5 units of continuing education.

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A complete Works Cited list begins on page 27.

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Course Objective

The purpose of this course is to provide dental professionals with information regarding oral manifestations of the aging process and their relationship with oral and systemic health to ensure the maintenance of optimum quality of life in older patients.

Learning Objectives

Upon completion of this course, you should be able to:

1. Discuss how the changing population demographics of the United States will feature a growing geriatric population.
2. Identify the correlation between oral health and systemic disease.
3. Describe common cardiovascular and cerebrovascular diseases in the geriatric population and their effects on oral health.
4. Outline the implications of common chronic diseases on geriatric oral health.
5. Discuss the impact of oral and systemic cancers and various treatment modalities on the provision of dental care.
6. List common physiologic changes that occur during the aging process and their influence upon oral hygiene and oral health.
7. Cite the issues associated with cognitive impairment and oral health.
8. Describe how various issues create problems for access to dental care for older Americans.

EVIDENCE-BASED PRACTICE RECOMMENDATION

Sections marked with this symbol include evidence-based practice recommendations. The level of evidence and/or strength of recommendation, as provided by the evidence-based source, are also included so you may determine the validity or relevance of the information. These sections may be used in conjunction with the course material for better application to your daily practice.

INTRODUCTION

The demographics of the United States reflect an increasing number of citizens that have attained the age of 65 years or older. There is no specific age assignment at which a person is categorized as "geriatric." Because most individuals qualify for Medicare at 65 years of age, it is this age or older that will be the defining age for older adult or geriatric classification for this course.

A significant factor that will increase the number of people within this group is the aging of 78 million "baby boomers," those Americans born between 1946 and 1964 [1]. The year 2011 marked the point at which the first wave of these citizens turned 65, and this will continue in succession through the year 2029. Thus, while approximately one out of every eight people was 65 years of age or older in 2001, by 2030 all baby boomers (approximately 72 million) will be older than 65 years of age [2; 3].

The aging process affects each person differently. Approximately 60% of individuals 65 years of age or older are afflicted with at least one chronic illness, while 25% have two or more chronic illnesses [4]. Chronic illnesses are those that last longer than six months and can be treated but not cured. Both the medications used in the treatment of these diseases and the disease process itself may have deleterious oral manifestations. When evaluating dental health, care should be taken to obtain a comprehensive medical history for each patient to determine if a given medical problem will allow dental treatment to be initiated and completed.

Some patients may require deferral of dental treatment if there is an acute exacerbation of an existing medical issue. Severe medical problems may require dental treatment to be performed in a hospital setting. Any medications used for dental concerns before, during, or after dental treatment should not interact negatively with those prescribed to treat any chronic disease(s).

Poor oral health, especially periodontal disease, may be a concern in the development of some of these chronic diseases, particularly cardiovascular disease. Because many patients within this group are retired and do not have dental insurance, the financing of even basic dental care to improve periodontal health and minimize it as a concern in the development of some chronic diseases can be a prohibitive issue.

This course will discuss some of the most common systemic diseases that afflict older adults and the manner by which they influence oral and overall health for these patients.

POPULATION TRENDS AND DEMOGRAPHICS

While the number of Americans who are 65 years of age or older will increase dramatically in the coming years, it is predicted that another age group will more than double. The number of Americans older than 85 years of age is expected to more than double from 6.5 million in 2018 to 14.4 million by the year 2040 [5].

At one time, advancing age was synonymous with complete edentulism and the placement of dentures. Based on studies by the U.S. Department of Health and Human Services, this trend is decreasing. The National Health and Nutrition Examination Survey (NHANES) 1 study (1971–1974) was followed by the NHANES 2 study conducted from 1988–1994. Statistics from the first study indicated 45.6% of Americans 65 to 74 years of age were completely edentulous. The second study indicated a decrease to 28.6% for those in the same age range [6]. According to the American Dental Association (ADA), an estimated 5% of adults 65 years of age and older were edentulous in 2023 [3]. Better awareness of oral hygiene and preventive dentistry have contributed to this encouraging trend.

Advances in medical science and in preventive dentistry have allowed patients to live longer and to retain their teeth while doing so. Therefore, more older adults will seek dental care to maintain and restore their teeth as part of a desire for a better quality of life. Many of these patients will contend with at least one chronic disease and will take the required medication(s). Dental treatment should only be undertaken for these patients when their medical conditions allow for a favorable outcome. Similarly, medications that are prescribed for any aspect of dental treatment should be in harmony with any medication that is prescribed for a chronic disease. Collaboration between the patient's medical and dental care providers should occur if there is any concern about the patient's ability to undertake dental treatment, especially that of a surgical nature.

EVIDENCE-BASED PRACTICE RECOMMENDATION

The National Institute for Health and Care Excellence recommends that the mouth-care needs of all residents should be assessed as soon as they start living in long-term care, regardless of the length or purpose of their stay.

(https://www.nice.org.uk/guidance/ng48. Last accessed May 31, 2024.)

Level of Evidence: Expert Opinion/Consensus Statement

THE ASSOCIATION BETWEEN ORAL HEALTH AND SYSTEMIC DISEASE

The dental profession has long advocated a preventive approach for the problems of dental caries and periodontal disease. If the preventive approach does not yield the desired results, an early and proactive stance should be used to restore carious teeth to their proper function and to correct periodontal defects to allow for the retention of teeth. The goals are to decrease the pain, morbidity, and potential for local or disseminated infections of dental origin.

These ideals for optimal dental health reflect the highest aspirations of the dental profession. However, research has discovered another benefit to oral health that is appropriately maintained; many studies have found strong correlations between patients with periodontal disease and some systemic diseases [7; 8; 9].

The suggestion of a correlation between the inflammatory nature of periodontal disease and systemic illness is not new. An 1891 publication, *The Human Mouth as a Focus of Infection*, advocated that adverse oral conditions could influence bodily functions in a negative fashion [10]. Some proponents advocated the extraction of all teeth as a means of preventing varied systemic illnesses. The theories presented in this publication found a new audience in the late 1980s, when a new group of researchers began to investigate the correlations between periodontitis and systemic conditions, particularly cardiovascular disease [11].

PERIODONTITIS AND CARDIOVASCULAR DISEASE

Classic risk factors for the development of cardiovascular disease include high levels of total cholesterol, high serum triglyceride levels, smoking, and a family history of cardiovascular disease. Historically, periodontitis has not been categorized among these risk factors. However, research has identified a strong correlation between this oral health problem and the development of cardiovascular disease. In particular, one study indicated that patients with periodontitis were 1.6 times more likely to experience stroke [12].

Periodontal disease is usually a slowly-progressing pathologic process in which the gingival tissues and the alveolar bone that support the teeth are infiltrated by oral bacterial pathogens. Loss of tissue attachment and irreversible destruction of the alveolar bone can proceed to the extent that teeth are lost. The host response to this bacterial challenge is to increase the blood flow to the affected areas such that varied cells of the immune system can begin to mount a defense against the periodontal pathogens. Tissue inflammation is generally commensurate with the degree of the disease process.

The increased circulation can allow periodontal bacteria and their toxins systemic access, at which point they or agents associated with the inflammatory process can influence vascular and cardiac tissues. Actions as simple as masticating and tooth brushing can cause a bacteremia proportionate to the degree of periodontal involvement [13].

Some studies have found periodontal microbes in arterial plaques associated with the narrowing of vessels, the beginning of atherosclerosis, and even the initiation of blood clots [14]. Chronically inflamed gingival tissues can increase the amount of C-reactive protein found in the blood, an indicator of systemic inflammation [15]. This compound is also elevated in patients with cardiovascular disease.

Another substance that is elevated amidst the chronic inflammatory process of periodontitis is fibrinogen [15]. This is a high-molecular-weight compound that, in the presence of thrombin and clotting factors, is converted to fibrin, which is the basis for the coagulation of blood. While a necessity for hemostasis, this mechanism can become problematic within blood vessels when a thrombus, or localized clot, develops and occludes a blood vessel. Depending on the vessel involved, a stroke or myocardial infarction can develop. The periodontal bacterial species *Porphyromonas gingivalis* has the potential to initiate the clotting process [16].

Patients with chronic periodontitis also exhibit increased levels of tumor necrosis factor-alpha. Heightened amounts of this substance in the body can cause the liver to increase the production of triglycerides and decrease the amount of high-density lipoprotein, the beneficial cholesterol [15]. The elevation of one known risk factor and the lowering of a beneficial cardioprotective compound can increase the risk of the development of cardiovascular disease.

The correlation between the presence of periodontal disease and the development of cardiovascular disease has undergone much study, and it will continue to be scrutinized in the future. Although periodontal disease cannot be assigned the designation of an absolute risk factor for cardiovascular disease, continued research may eventually prove otherwise. A large study published in 2014 including more than 15,000 patients with chronic coronary heart disease who provided dental health information found that indicators of periodontal disease were common in this patient group and associated with numerous cardiovascular risk factors [17]. Given that many people within the older adult population are afflicted with cardiovascular disease, the control of this oral health condition is essential.

SYSTEMIC DISEASES COMMON AMONG THE OLDER ADULT POPULATION

HYPERTENSION

Hypertension, also known as high blood pressure, affects approximately 46.7% of adults in the United States [18]. Many patients with hypertension are unaware that they have the disease, as initial cases may be asymptomatic. Early diagnosis and treatment is essential, because without medical intervention, irreversible damage to the heart, blood vessels, kidneys, eyes, brain, and other organs and systems can gradually occur.

The Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure classified systolic and diastolic blood pressure numerical values with categories that reflect a philosophy for earlier intervention; these defined values were supported by a 2014 update [19]. In 2018, the American College of Cardiology, in conjunction with the American Heart Association and many other organizations, released updated guidelines for the prevention, detection, evaluation, and management of high blood pressure in adults [20]. In this guideline, the values assigning various stages of hypertension were significantly lowered.

Elevated blood pressure is defined as a sustained systolic blood pressure between 120–129 mm Hg and a sustained diastolic blood pressure less than 80 mm Hg. When the systolic levels range from 130–139 mm Hg and the diastolic levels are 80–89 mm Hg, the categorization of stage 1 hypertension is assigned. Stage 2 hypertension occurs when the systolic blood pressure exceeds 140 mm Hg and the diastolic blood pressure exceeds 90 mm Hg. Certain co-existing diseases can modify this scale [20; 21]. As many patients with high blood pressure also have other cardiovascular or cerebrovascular problems, proper medical management of this disease is essential to preventing associated morbidity and mortality.

Approximately 90% of hypertension cases have no known exact etiology; this is referred to as essential hypertension. The remaining cases are classified as secondary hypertension; in these patients, an underlying medical problem or a prescribed medication is the cause of elevated blood pressure levels [22]. Oral contraceptives, renal disease, and endocrine problems such as hyperthyroidism are among the most common causes of secondary hypertension. Certain tumors, such as a pheochromocytoma, although uncommon, can also be the basis for secondary hypertension. Pheochromocytoma is a tumor of the adrenal medulla that can cause the secretion of large amounts of the vasoconstrictors epinephrine and norepinephrine, which can cause a profound elevation in blood pressure.

Blood pressure has a tendency to rise with age; approximately 58.5% of those 65 years of age or older have chronic hypertension [23]. Many cases of hypertension are diagnosed during routine medical examinations. There is no specific symptom of hypertension that prompts patients to seek medical treatment. However, some patients who seek medical consultation for occipital headaches, blurred vision, ringing in the ears, dizziness, and tingling in the extremities are subsequently diagnosed with hypertension.

Medical Management

The goals for the management of hypertension are to lower the blood pressure to a range in which the cardiovascular risks are decreased and to minimize the side effects of any medications utilized. Lifestyle modifications are the cornerstone to management of hypertension, and pharmacotherapeutic regimens may supplement these changes. Risk factors such as smoking, a high-sodium diet, excessive weight, and a lack of physical activity are all modifiable items that patients can change to lower their blood pressure and their overall risk for cardiovascular disease. Some studies found interventions for periodontitis could help in controlling hypertension [24].

Some patients become noncompliant with antihypertensive therapy as a result of problematic side effects. Further, patients who do not have symptoms of high blood pressure may consider such therapy of minimal benefit.

Numerous medications are used in the treatment of hypertension. The degree of blood pressure elevation will dictate the type of medication used, either individually or in combination with other agents, to achieve therapeutic goals.

Most dental treatment and many medical procedures are performed with the patient in a reclined position. Upon the conclusion of an appointment and the resumption of a sitting or standing position, orthostatic hypotension can occur with any patient, but especially those taking blood pressure medications. Fainting and potential injury can occur. The incidence of orthostatic hypotension can be minimized by raising the chair gradually and allowing the patient to remain in an upright seated position for some time before attempting to stand. A staff member should be ready to assist the patient if necessary.

Diuretics

Diuretics are one of the primary agents available to treat hypertension [20]. Diuretics are a group of drugs that decrease blood pressure by decreasing the resorption of sodium, chloride, or both, within the kidneys. Along with the decrease in resorption of these elements is a decrease of the resorption of water. This leads to decreased extracellular volume and cardiac output, with a resultant decrease in blood pressure.

There are several different types of diuretics. Hydrochlorothiazide, a thiazide diuretic, acts to increase sodium and water excretion in the distal tubules of the kidneys. This medication and other thiazides can also decrease the plasma concentration of potassium, which can lead to arrhythmias. A potassium supplement may be needed.

Loop diuretics, such as furosemide, inhibit resorption of sodium and chloride in the ascending loop of Henle and distal renal tubule within the kidneys. The increased excretion of water will achieve the same therapeutic goal as hydrochlorothiazide. Medications within this category have been used in the management of treatment-resistant hypertension. Potassium-sparing diuretics, such as spironolactone, work at the kidney's distal tubules to increase sodium excretion and minimize the excretion of potassium.

Nonsteroidal anti-inflammatory drugs (NSAIDs) are a group of medications frequently used as an analgesic for dental problems. Ibuprofen and naproxen are commonly used analgesic agents within this category. These medications can decrease the efficacy of any of the thiazide diuretics and should be avoided as dental analgesics for such patients.

Because the principle mechanism by which diuretics work is a decrease in water volume, xerostomia (dry mouth) can develop. This can be a problem for those who wear prostheses, such as dentures or partial dentures, as oral tissues that are less lubricated are more prone to sore spots and ulcerations.

The increase in the frequency of urination (polyuria) that accompanies the use of thiazide diuretics will usually require that the patient be given restroom breaks during longer appointments.

Beta-Adrenergic Blockers (Beta Blockers)

Another group of medications utilized to treat hypertension are beta-adrenergic blockers, more commonly referred to as beta blockers. These medications compete with endogenous epinephrine for available receptor sites, thus diminishing the stimulatory effect. The goal is to prevent the heart from an excessive response to physical strain and emotional stress by decreasing the heart rate and causing dilation of the arterioles in the skeletal muscle and the liver.

Beta blockers such as atenolol and metoprolol are cardioselective in that they selectively bind with beta-1 receptor sites in the cardiac tissue. Propranolol is a non-selective beta blocker and can interact with beta-1 receptors in cardiac tissue and beta-2 receptors within the arterioles of skeletal muscle and the bronchiolar smooth muscle. The cardiac effect is to reduce the rate of firing of the sinoatrial node, which slows conduction through the atrioventricular node. The contractile strength of the heart is reduced as is the pressure with which the blood is pumped. The arterioles are dilated, which causes a decrease in diastolic blood pressure [25].

NSAIDs can decrease the efficacy of these medications. Patients who take propranolol may be more sensitive to the epinephrine used in local anesthetics, resulting in a pronounced increase in blood pressure followed by reflex bradycardia. Anesthetic preparations without vasoconstrictors, such as epinephrine or levonordefrin, are preferable for these patients.

Similar to thiazide diuretics, beta blockers can also cause xerostomia. Use of beta blockers can also result in side effects involving the central nervous system, such as insomnia, depression, and nightmares, which can discourage patients from continuing their use [26]. Healthcare professionals should verify compliance with prescribed medication regimes. Measuring blood pressure for all patients with hypertension before the initiation of any treatment is mandatory.

Angiotensin-Converting Enzyme (ACE) Inhibitors

Angiotensin-converting enzyme (ACE) inhibitors, such as lisinopril and enalapril, prevent the conversion of angiotensin I to angiotensin II, a potent vasoconstrictor. A decrease in vasoconstriction leads to a decrease in blood pressure via decreased peripheral vascular resistance [27]. These medications can be given alone or in combination with other antihypertensive drugs.

As a group, ACE inhibitors are generally well-tolerated by the patients for whom they are prescribed. However, some patients can develop a dry cough that can range from a minor irritation to severe spasms of coughing. Other potential side effects related to the oral tissues include xerostomia, taste alterations, oral ulcerations, and glossitis. These problems subside with discontinuation of the drug.

Calcium Channel Blockers

Calcium channel blockers (e.g., nifedipine) exert their effects by decreasing the entry of calcium into the smooth muscle within arteriolar walls. The ensuing muscular relaxation and vessel dilation causes a reduction in blood pressure. Calcium channel blockers can also cause a decrease in sodium, which decreases water resorption, blood volume, and blood pressure.

A unique oral side effect of nifedipine, seen in approximately 10% of patients, is gingival hyperplasia. This can occur within a few weeks to several months after nifedipine therapy is begun. Gingival tissues should begin to regress after the drug is discontinued, with full resolution in approximately 15 days [26]. However, resuming use of the drug generally results in recurrence of the disorder unless additional steps are taken.

If nifedipine cannot be discontinued, surgical removal of the excessive tissues may be necessary to restore optimal tissue contours. If excellent plaque control is maintained, the hyperplasia usually does not recur [26]. Oral hygiene instructions should be tailored to the degree and location of any area of nifedipine-induced hyperplasia.

The evaluation of a patient's overall health and of any medications being taken, either for hypertension or any other co-existing chronic illnesses, should be undertaken before any dental treatment is initiated. Consultation with the patient's physician may be necessary to establish a parameter in which dental treatment can be performed safely. Patients' stress during dental procedures can cause the release of endogenous epinephrine and norepinephrine, with a commensurate rise in blood pressure. This can be problematic for patients with hypertension, especially those for whom blood pressure is difficult to control. For these patients, profound anesthesia should be achieved, as a procedure perceived as being free of painful stimuli will decrease the amount of endogenous catecholamine release. Oral sedatives that do not interact with any of the patient's prescribed medications and nitrous oxide inhalation sedation can also be used to reduce stress. Extensive oral surgical procedures may need to be done in a hospital setting under general anesthesia. If the pre-procedural blood pressure measurement is high enough to be of concern to the staff, deferral of the procedure may be needed in the interest of patient safety.

ISCHEMIC HEART DISEASE

Cardiovascular disease affects one-third of people 65 years of age or older [28]. Of all deaths caused by ischemic heart disease, approximately 64% are in individuals older than 75 years of age [28]. Ischemia occurs when an obstruction within a blood vessel interrupts the flow of oxygenated blood needed to meet the metabolic demands in a given tissue, such as the myocardium of the heart. If the reduction of oxygenated blood weakens the myocardial cells but does not cause their necrosis, the resulting chest pain is known as angina pectoris. If the degree of ischemia is enough to cause necrosis of the myocardial cells, then a myocardial infarction occurs.

Angina Pectoris

Angina is classified according to the degree of cardiac stability with which the patient presents. Stable angina refers to chest pain that occurs infrequently, usually when physical exertion and/or emotional stress cause the metabolic demand of the myocardial tissues to exceed the available supply of oxygenated blood provided by the cardiac circulation. The pain is relieved by a sublingual spray or tablet of nitroglycerin. If the frequency and/or intensity of angina attacks increases when the patient is at rest, unstable angina has developed.

Patients with unstable angina are at increased risk for acute myocardial infarction and arrhythmias, including ventricular tachycardia and fibrillation. Patients with suspected unstable angina should have dental treatment deferred until their cardiac condition is stabilized. A patient with a known history of angina who presents with chest pain that is not relieved by nitroglycerin should be sent to the emergency department.

Another variant of angina pectoris is Prinzmetal angina. Spasms of the coronary artery caused by this type of angina usually occur when the patient is at rest. This type of angina is a manifestation of atherosclerosis, which is caused by atheromatous plaques developing on the inner wall of the coronary arteries. The vessel lumen narrowed in this fashion will result in a decreased flow of oxygenated blood for the cardiac myocardium.

Treatment

Angina pectoris is treated by one or more drugs that aim to decrease cardiac workload and facilitate vasodilation, the result of which is increased perfusion of the myocardium. Some medications used to treat hypertension, including nifedipine, can cause vasodilation of the coronary arteries. Furthermore, beta blockers can decrease the oxygen demand of the myocardium. Immediate-acting nitrates, such as nitroglycerin, are potent direct-acting vasodilators that decrease myocardial workload and commensurate demand for oxygen. Isosorbide dinitrate and isosorbide mononitrate are both extended-acting vasodilators with longer action as compared to the immediate vasodilation effects of nitroglycerin.

When undergoing any medical or dental procedures, patients who are afflicted with angina for whom nitroglycerin has been prescribed should have nitroglycerin with them. This medication should also be a staple of every medical emergency kit. Because the anxiety associated with a medical or dental appointment can precipitate an angina attack, stress reduction techniques may be utilized. Morning appointments are beneficial for cardiac patients as they allow the patient to arrive in a rested condition and preclude their ability to worry throughout the day about a late afternoon appointment.

Before any dental treatment is initiated, the dentist should record the vital signs and discuss any change in the frequency or duration of angina pectoris attacks. If there is a trend toward more frequent and intense angina pectoris attacks, dental treatment should be deferred and the patient should be referred to a cardiologist.

If ACE inhibitors and/or calcium channel blockers are utilized to treat angina, NSAIDs should not be utilized for pain management. Opioid-based analgesics can accentuate the hypotensive effect of nitroglycerin and should be prescribed cautiously or avoided. Epinephrine or levonordefrin, two vasoconstrictors utilized in local anesthetics, should be used sparingly. Dental surgical procedures may need to be done in an outpatient hospital setting.

Nitroglycerin and isosorbide dinitrate can diminish normal salivary flow and cause xerostomia. This problem will resolve when the medications are discontinued.

Myocardial Infarction

As noted, ischemic heart disease is common among patients older than 65 years of age, and myocardial infarction is a leading cause of death in this age group [29]. An infarction is defined as a localized area of necrotic tissue that develops when the oxygenation of that tissue is inadequate. Within the myocardium of the heart, this can occur rapidly and without any previous symptoms; the presence of angina does not always precede myocardial infarction. The substernal pain of an acute myocardial infarction can radiate to the left mandible, which may be a presenting symptom.

Because many myocardial infarctions occur without warning, initial treatment is often of an emergency nature. Within the dental office, all staff members should be trained in the current regimens of cardiopulmonary resuscitation. Requirements for offices that provide deeper levels of sedation can require training in advanced cardiac life support as well.

Many states require dental offices to have an automated external defibrillator and also require staff members to be trained in its use. A supply of oxygen, nitroglycerin, chewable aspirin (for a conscious patient), and an analgesic that can be administered intramuscularly are among the core items that should be available in the event of a cardiac emergency. All staff members should have designated assignments in the case of a medical emergency in order to ensure stabilization of the patient. One staff member should have the responsibility of contacting emergency medical services. Additionally, each office should have a protocol to practice simulated medical emergency situations, and all medications utilized for medical emergencies should be routinely inspected to ensure that they have not expired.

A myocardial infarction can have an acute onset, yet the underlying pathophysiologic causes of an infarction may be present for years before the event. The lumen of the coronary arteries can be gradually narrowed by the accumulation of atherosclerotic lesions within the walls, caused by the formation of small cholesterol-containing aggregates, or plaques, in the walls of blood vessels. This also causes the surface texture of the blood vessel to become rough and conducive to the adhesion of platelets. This process of clotting in an undamaged blood vessel is called thrombosis. The clot, or thrombus, impedes the supply of oxygenated blood to the myocardium, and when circulation is diminished enough to cause necrosis of the myocardial cells, a myocardial infarction occurs. Surgical procedures, such as the placement of stents or balloon angioplasty, may be undertaken to widen a lumen narrowed by atherosclerotic plaques and to re-establish circulation appropriate for the metabolic demands of the cardiac tissue.

Hypertension and/or angina may be precursor conditions to myocardial infarction. If a patient is taking medications for these conditions and experiences a myocardial infarction, the drugs are usually continued, although the amount, dose schedule, or agent may be modified. Many patients who experience myocardial infarction are placed on anticoagulant therapy in order to minimize platelet adhesion and blood clot formation within blood vessels.

Anticoagulant Therapy

Anticoagulant medications exert their effects either by modifying platelet function or by interfering with the synthesis of coagulation factors. Aspirin and clopidogrel are examples of medications used in antiplatelet therapy. By contrast, warfarin is an anticoagulant and minimizes coagulation by interfering with the synthesis of vitamin K-dependent clotting factors II, VII, IX, and X within the liver [30].

The most frequently utilized platelet-inhibiting medication for prophylaxis against ischemic heart disease or a cardiovascular or cerebrovascular incident is aspirin [31]. As a single agent or combined with clopidogrel, aspirin acts to prevent the aggregation of platelets and increases bleeding time. Aspirin ultimately interferes with the release of thromboxane A2, a substance that is responsible for platelet aggregation [31]. This effect lasts for the 10-day average life span of any platelet affected. Clopidogrel acts by blocking adenosine diphosphate (ADP) receptors on the platelet membrane, inhibiting platelet aggregation [31].

Prior to any dental treatment, especially oral surgery or periodontal treatment, the reason for which the patient has been placed on anticoagulant therapy should be discerned. If a dental procedure may affect hemostasis, the best route of action should be discussed with the patient's physician. The patient's prothrombin time should be noted. Prothrombin time is reported as an international normalized ratio (INR). The INR is a ratio of the prothrombin time for the patient and a control and is based on a scale of 1.0–5.0 [32]. An INR of 1.0 indicates a patient who clots normally. The target INR of patients who take anticoagulants depends upon the goals of treatment and underlying medical condition and can range from 2.0 to 3.5 [32]. If a surgical procedure is planned, an INR value should be obtained as close to the time of surgery as possible. Higher values are associated with more difficulty in obtaining hemostasis. It is important to determine if the patient's status allows for a temporary discontinuance of anticoagulant medication. In some cases, this is an option. However, the cardiovascular or cerebrovascular status of some patients may preclude the discontinuance of anticoagulant therapy due to the potential risks of a thromboembolic event. Those patients who cannot cease anticoagulant therapy may require that invasive treatment modalities, such as oral surgery, be performed in a hospital environment, especially when numerous teeth are involved. It is imperative that only a cardiologist or primary care physician with knowledge of the patient's condition direct the patient to stop anticoagulant or antiplatelet therapy. Patients should never stop taking anticoagulants on their own volition to expedite the completion of a surgical procedure.

Before any oral surgery or periodontal treatment is begun, compliance with the agreed upon regimen (e.g., discontinuance of anticoagulants) should be verified. Anticoagulant medications can interact with many medications. As noted, many medications prescribed for dental pain, including NSAIDs, can accentuate the anticoagulant effect of clopidogrel and warfarin. Additionally, macrolide antibiotics, such as erythromycin and clarithromycin, can attenuate the anticoagulant effect of clopidogrel but enhance this same activity for warfarin. It is essential that analgesics and/or antibiotics used for dental conditions do not enhance or detract from the intended effect of any anticoagulant medication.

STROKE AND CEREBROVASCULAR ACCIDENTS

Approximately 9% of Americans older than 65 years of age have a history of stroke, and 75% of all strokes occur in people older than 65 years of age [2; 28]. Strokes are usually caused by atherosclerosis of the cerebral arteries, an aneurysm, or an embolism. Emboli or atherosclerotic plaques of the cerebral arteries can reduce or completely block the flow of oxygenated blood to brain cells. Similarly, a ruptured aneurysm causes damage to neurons by blood seeping into neural cells with a commensurate rise in intracranial pressure. These events may occur with no prior symptoms. However, some patients may experience transient ischemic attacks, which are characterized by sudden-onset, reversible neurologic deficits. Most transient ischemic attacks last less than five minutes. Nearly 1 in 5 patients who experience transient ischemic attacks progress to having an actual stroke within 90 days [33].

Management

The degree of recovery from a stroke depends upon the area(s) of the brain involved and the extent of neural cells lost. Many patients experience permanent motor, cognitive, and sensory impairment. When the dominant side is affected, the ability to maintain oral hygiene can become an arduous task. Patients may require toothbrushes mounted in special hand grips to facilitate proper cleansing techniques. Flossing devices may be needed to assist in flossing. The assistance of a caregiver may be necessary to maintain ideal oral hygiene. If plaque control becomes problematic, more frequent recall appointments should be considered.

The ability to comprehend and remember instructions related to oral hygiene may be difficult for patients who have suffered a stroke. Written instructions that can be relayed to a family member or caregiver may assist in the ability for stroke victims to maintain oral health. Patients who wear prostheses such as partial dentures or complete dentures may need assistance with their placement and maintenance. Dentists should consult with patients' physicians when oral surgery or periodontal therapy is necessary. Blood pressure levels should be recorded before the start of any dental procedure, and treatments should be deferred if these levels are elevated.

Because hypertension is a contributing factor to the development of cerebrovascular accidents, many patients who have had a stroke take medication for the condition. Anticoagulant medications may also be used if a thromboembolic event was the precipitating event. The impact of these medications on oral health and the delivery of oral care have been discussed in this course.

DIABETES

Two types of diabetes comprise the majority of diabetes cases in the United States: type 1 diabetes, previously referred to as insulin-dependent diabetes mellitus, and type 2 diabetes, which was previously known as non-insulin-dependent diabetes mellitus. Type 2 diabetes is responsible for more than 90% to 95% of all diabetes cases [34]. Approximately 22% of patients who present with type 2 diabetes are 65 years of age or older [35]. There are numerous systemic complications of diabetes, all of which contribute to it being the seventh leading cause of death in the United States [35; 36].

The physiologic basis for type 1 diabetes is a total deficiency in insulin due to destruction or impaired function of the insulin-producing beta cells within the pancreas. Most cases are diagnosed at an early age, and patients within this population have a lifelong dependence upon insulin. Type 2 diabetes is characterized by insulin resistance and defects in the secretion of insulin. Patients with either type of diabetes require special oral care.

Management

Varied formulations of insulin are used to treat type 1 diabetes; type 2 diabetes is often managed with oral hypoglycemic agents, which may or may not be supplemented with insulin.

As a hormone, insulin is the only compound that lowers blood glucose levels. Insulin acts by hastening the transport of glucose into the cells, particularly skeletal muscle cells, and stimulating the formation of glycogen, the storage form of glucose, in the cells of the liver and skeletal muscle. It also decreases the rate by which glycogen is converted into glucose. The dosage schedule of insulin will depend upon the degree of hyperglycemia experienced by the patient.

Insulin is compatible with most medications prescribed for dental problems. However, there are some medications that may result in untoward effects. Extended doses of NSAIDs and salicylates can enhance the hypoglycemic effect of insulin and should be used sparingly. Epinephrine can decrease the hypoglycemic effect of insulin, and the minimum possible dose should be used in conjunction with local anesthetics [37]. Extensive surgical cases, such as full-mouth extractions, may need to be completed in a hospital environment, especially for patients with type 1 diabetes with uncontrolled blood glucose levels.

Metformin, a biguanide oral hypoglycemic agent, may be used in patients with type 2 diabetes to decrease glucose release and production and to reduce insulin resistance of the liver cells [38]. Another agent used in the management of type 2 diabetes, rosiglitazone, improves the target cell response to insulin without increasing the beta-cell production of insulin [39]. Due to findings of an increased risk of stroke and heart attack, in 2010 the U.S. Food and Drug Administration (FDA) recommended rosiglitazone be used only if all other medications are ineffective in controlling diabetes [40]. However, following review of data from a large, long-term clinical trial and a re-evaluation of the elevated risk of heart attack, the FDA removed the prescribing and dispensing restrictions for rosiglitazone in 2013 [41]. Sulfonylurea oral hypoglycemic agents, such as glyburide, act by stimulating the release of insulin from the pancreatic beta cells and by reducing hepatic glucose production; the response of peripheral target cells to insulin is also heightened [26]. Metformin and rosiglitazone have no reported interactions with medications used for dental treatment. Due to the action of glyburide, an increase in hypoglycemic effect similar to the reaction with insulin may be noted with extended concomitant use of NSAIDs and salicylates. Similarly, the tablet form of the antifungal agent ketoconazole, which is used for some cases of oral candidiasis, can also enhance glyburide's hypoglycemic effect.

Diabetes is a treatable disease, but it is not curable. Patients who exhibit good glycemic control can usually tolerate dental treatment. Further, studies showed that periodontal therapy combined with good home oral health care was effective in improving glycemic control for patients with type 2 diabetes in 3 to 4 months [42]. However, one complication that may arise when treating patients with diabetes is hypoglycemia. This can occur when patients take the prescribed dose of insulin and/or oral hypoglycemic agent and eat either minimally or not at all prior to their dental appointment. Before dental treatment is initiated for patients with diabetes, it is important to verify that they have taken their prescribed dose of medication and have eaten appropriately. Even with these precautions, hypoglycemia may still develop. Initial signs of a hypoglycemic crisis can include hunger, sweating, pallor, tachycardia, and tremors. This can progress very rapidly to incoherence, disorientation, and unconsciousness. It is important to treat patients immediately at the onset of symptoms of insulin shock. Glucose (in paste

form) or sugar-containing beverages can be given to conscious patients. Patients who have lapsed into unconsciousness may require intravenous glucose or an injection of glucagon; emergency medical services must be contacted. After the patient is stabilized, any remaining dental treatment should be deferred until after consultation with the patient's physician.

Patients with diabetes should be given specific instructions to avoid insulin shock. Patients who have extensive oral surgery or placement of prostheses may have difficulty eating for several days. A pureed or liquefied diet can be planned in order to maintain appropriate blood glucose levels. Adjustments in the dosage of insulin or hypoglycemic medications should only be made by a physician.

Patients with diabetes are vulnerable to the same odontogenic infections as those unaffected by the disease. However, the effects may be greater among patients with diabetes. Diabetes increases the incidence and progression of periodontitis by 86% [43]. The generalized systemic defense against infections causes an increased metabolic demand, with a commensurate increase in the need for glucose to provide the energy source. Therefore, patients with type 1 diabetes with infections may require increased insulin dosages. Patients with type 2 diabetes, alternatively, may require temporary supplementation with insulin until the infection is resolved.

Patients with chronic poor glycemic control may be immunocompromised as a result of problems with neutrophil dysfunction, T-lymphocyte dysfunction, and decreased bactericidal activity of immune system cells [44]. Problems related to immunosuppression can also increase the risk of developing oral candidiasis, aphthous ulcers (canker sores), and oral lichen planus [45]. Infections in all patients with diabetes should be treated aggressively, and some within this group may require intravenous antibiotics and even hospitalization.

Gingivitis, periodontal disease, and alveolar bone loss occur with increased frequency in patients with diabetes with poor glycemic control [46]. Variances in the host response to periodontal pathogens and the production of collagen along with diabetes-associated vascularity problems may contribute to the heightened prevalence of the spectrum of periodontal problems in this patient population [47].

It is important to stabilize patients with diabetes and chronic periodontal problems as mounting evidence demonstrates a correlation between poor glycemic control and periodontal pathology [48]. If periodontal problems cannot be rectified by nonsurgical and/or surgical periodontal therapy, extractions may be necessary. Patients with generalized periodontal problems who are not motivated to maintain optimal oral hygiene may require drastic interventions, including full-mouth extractions and the placement of dentures. Dental treatment for patients with diabetes should be done in a way that does not compromise their ability to maintain glycemic control.

Consultations with the interdisciplinary healthcare team should be made if there is doubt about the ability of a patient with diabetes to withstand any form of dental treatment. Referral to an oral surgeon with hospital privileges may be necessary for patients with poor control of their diabetes for whom oral surgery is planned. The goal of maintaining optimal oral health amidst proper diabetic control should be shared by the patient and by the allied healthcare professionals involved in his or her care.

ARTHRITIS

Arthritis affects approximately 47% of individuals 65 years of age and older [49]. Osteoarthritis is the most common form of the disease, affecting approximately 32.5 million people in the United States [50]. Rheumatoid arthritis affects about 1.5 million people in the United States; 70% are women [51]. While the etiology of each form of arthritis is unknown, studies indicate that rheumatoid arthritis and periodontal disease may have a bidirectional relationship [52; 53].

The types of arthritis manifest in different ways. Osteoarthritis usually occurs in weight-bearing joints such as the spine, hips, and knees; for this reason it is considered "wear-and-tear" arthritis. Cartilage in the arthritic joint degenerates over time, allowing two adjacent bones previously separated by a disc of cartilage to have direct bone-to-bone contact. Pain, joint stiffness, and restricted mobility can result.

Rheumatoid arthritis occurs when the synovial lining of a joint becomes swollen and thickened. Inflamed cells within the area can release enzymes that cause degeneration of the bone and cartilage. The shape of the involved joint can change with accompanying loss of function and pain. This disease can have periods of remissions and painful exacerbations, with the majority of the destruction occurring in the initial years. Most patients require long-term pharmacologic treatment to provide pain relief and allow for some function of the involved joints. The joints of the hands and wrists are most commonly affected [54]. Some patients with rheumatoid arthritis may develop arthritic degeneration of the temporomandibular joint. Treatment of rheumatoid arthritis of any joint may include splint therapy, physical therapy, and surgery. Unlike osteoarthritis, rheumatoid arthritis is a systemic disease and can result in generalized manifestations such as lethargy, malaise, and weakness.

The medications used to treat rheumatoid arthritis and osteoarthritis may have interactions with medications used for dental treatment. Additionally, some medications used in the treatment of arthritis may have adverse effects upon the oral mucosa.

Several NSAIDs are utilized to treat the inflammation characteristic of both forms of arthritis. Long-term administration of NSAIDs may prolong the ability to attain hemostasis after surgical procedures. Determination of prothrombin time may be helpful prior to planned surgical procedures.

Methotrexate is another medication used in the management of arthritic symptoms. When methotrexate is combined with NSAIDs for a sufficient duration, problems such as bone marrow suppression and aplastic anemia may develop [55]. Therefore, care should be taken to avoid the use of NSAIDs in these patients, if possible. Methotrexate may also cause oral ulcerations in some patients; ulcerations should resolve with discontinuance of the medication. The medication carries a boxed warning due to the increased risk for fetal abnormalities, bone marrow suppression, and hepatic and pulmonary side effects [55]. Gold sodium thiomalate, which is used to treat progressive rheumatoid arthritis, can cause gingivitis, glossitis, and stomatitis in some patients. This medication can also decrease both the white blood cell and platelet counts [26]. Therefore, a complete blood count should be obtained for patients using gold sodium thiomalate prior to surgical or periodontal procedures. Antibiotic prophylaxis is no longer recommended for all patients with prosthetic joint implants prior to dental procedures [56].

Hands and wrists that have been damaged by rheumatoid arthritis may have impaired dexterity, which can affect proper oral hygiene. Custom-modified toothbrushes and flossing aids can assist patients in maintaining oral health. If plaque accumulation is excessive, more frequent recall appointments will be necessary to minimize periodontal involvement and decrease the development of caries. If partial dentures are made for patients with arthritis, the design and placement of the clasps should be such that the placement and removal of these prostheses is facilitated. Because most patients with arthritis have joint stiffness and decreased mobility upon arising in the morning, appointments should be scheduled for late in the morning or the afternoon. Long appointments may be difficult for patients with arthritis to withstand, so those with extensive treatment plans may require a series of shorter appointments. The preventive approach to dental problems will assist in the maintenance of oral health, which will positively impact their quality of life.

OSTEOPOROSIS

The National Institutes of Health defines osteoporosis as a disease characterized by low bone mass and structural deterioration of bone tissue, leading to bone fragility and an increased risk of fractures [57]. The hip, spine, and wrist are the most common sites of osteoporotic fracture [57; 58].

There is a significant gender differential in the occurrence of osteoporosis, as women are eight times more likely to develop osteoporosis than men [59]. Hormones appear to be a factor. Women may lose up to 20% of their bone mass in the five to seven years after the onset of menopause [60]. More than 54 million Americans 50 years of age and older have osteoporosis, a number that is expected to increase to 64.4 million by 2030 [61].

Osteoporosis is often an asymptomatic disease process, and it may be first identified by a bone mineral density test [62]. Fractures in patients with osteoporosis can occur from minor injury, the magnitude of which would not fracture a non-osteoporotic bone.

In terms of oral health, the bone density of the mandible may be significantly decreased and at an increased risk for fracture in patients with osteoporosis. However, this is not the most significant osteoporosis-related concern for the oral and maxillofacial complex. The primary concern is with the adverse effects of osteoporosis medications upon the bone of the maxillary or mandibular arch.

Healthy bone metabolism is characterized by a delicate balance between bone formation and bone resorption. Osteoblasts are responsible for the formation of new bone during growth and repair; osteoclasts are the large multi-nucleated cells responsible for the resorption of bone. During the aging process, osteoblastic activity decreases, with an associated decrease in bone mass and an increased susceptibility to the fracture. Thus, bone metabolism will have a tendency toward bone resorption and bone weakening via osteoclastic activity. Oral bisphosphonates, such as risedronate and ibandronate, suppress the activity of osteoclasts and increase bone mineral density, thereby reducing the risk of fractures [63; 64]. Intravenously administered bisphosphonates such as pamidronate and zoledronic acid are used to treat the pathologic resorption of bone that occurs with systemic malignancies such as multiple myeloma and metastasized breast cancer. More than 50% of intravenously administered bisphosphonate agents reach the bone. Due to the physiologic pH of the intestinal mucosa, only about 1% of oral bisphosphonates localize in the bone [65].

With the increased use of these agents has come a pathologic entity called medication-related osteonecrosis of the jaw (MRONJ), which develops in a small segment of patients who have taken bisphosphonates, antiresorptive (i.e., denosumab), or antiangiogenic treatments [64; 66]. The exact process by which this condition develops is unknown. One possible explanation is that the decrease in osteoclastic activity with bisphosphonates may be of such magnitude that localized areas of damaged bone do not undergo the usual resorptive repair, resulting in necrotic sequestra of bone [67]. The true incidence of bisphosphonate-related MRONJ is unclear [66]. Although it is possible, patients with osteoporosis rarely require the high-dose IV bisphosphonates associated with the development of MRONJ. Patients undergoing treatment for multiple myeloma or metastasized breast cancer are much more likely to be administered bisphosphonates at the level required to initiate MRONJ [68].

The exact causal relationship between bisphosphonate medications and MRONJ has not been definitively established [68]. However, the FDA and the pharmaceutical companies that manufacture these medications have identified enough of a risk to include osteonecrosis of the jaw as a potential adverse effect in package inserts [26; 69]. Dental trauma and dental surgery are among the most common predisposing factors for MRONJ. Osteonecrosis of the jaw appears more frequently in the mandibular arch than it does in the maxillary arch [66].

Surgical sites associated with MRONJ experience a delay in closure, as exposure of alveolar bone may not be followed by the usual pattern of tissue migration and closure. Ultimately, bone exposed in this manner can develop into a necrotic sequestrum. Suppuration, pain, and swelling often accompany the necrosis. Some cases respond to antibiotic therapy, antimicrobial rinses, discontinuation of bisphosphonate therapy, and no or minimally invasive dental therapy [66]. Surgical intervention remains limited due to impaired ability of the bone to heal [66]. Some cases seem to be refractory to any form of treatment, even hyperbaric oxygen [66].

Patients who require dental surgery and have a history of taking bisphosphonates should be appraised of the risk of MRONJ prior to the initiation of any treatment. Patients beginning bisphosphonate therapy should have a comprehensive dental examination to identify areas for which oral or periodontal surgery is required so the procedures may be completed prior to initiation of the bisphosphonate therapy. As an increasing number of patients in the aging population will be affected by osteoporosis, pharmaceutical research into the causes of MRONJ and modalities to treat this problem successfully should be pursued.

ORAL AND SYSTEMIC CANCERS

Within the United States, cancer of all types is the second leading cause of death [70]. The following section will highlight the initial and long-term oral effects of oral malignancies and the surgery and radiotherapy that are used for their treatment. The oral effects that can develop after chemotherapy will also be discussed. Dental treatment considerations before, during, and after oral and systemic cancer therapy treatment will be provided, with a focus on interventions that can positively impact the oral and overall health of these patients.

ORAL CANCER

The average age of the patient diagnosed with the most common oral malignancy, squamous cell carcinoma, is 65 years of age. An estimated 29.9% of patients with oral malignancies are 50 to 64 years of age, 33.7% are 65 to 74 years of age, and another 28.7% are 75 years of age and older [71].

Approximately 58,450 new cases of oral cancer will be diagnosed in 2024, with a 26% mortality rate. The five-year survival rate of 69.0% reflects the late stage at which many of these lesions are diagnosed [71; 72]. Oral malignancies can remain asymptomatic for long periods, during which time direct extension into the surrounding tissues and metastasis will occur. Many oral squamous cell carcinoma lesions form on the floor of the mouth and the ventral and lateral surfaces of the tongue, where a rich vascular network is conducive to metastasis [73; 74]. Surgical removal and subsequent radiotherapy are the usual means by which these oral malignancies are treated. Earlier diagnosis and treatment of these lesions improves prognosis and is associated with fewer initial and long-term complications. Unfortunately, many oral malignancies are discovered in an advanced stage, and extensive surgical resection of oral mucosa, muscle layers, and bone is often required. The loss of tissue mass can present a difficult challenge in reconstruction of the affected areas for appropriate form and function.

Surgical Treatment

Surgical excision of oral malignancies consists of removal of the lesion, the adjacent tissues, and any lymph nodes suspected of being involved in the metastasis of cancerous cells. As noted, most lesions are diagnosed in advanced stages, requiring extensive surgery to remove the tumor and the contiguous tissues damaged by direct growth of the malignancy.

Mucosal, muscular, osseous, and neural tissues can be destroyed by an infiltrating lesion and by the surgery that is used to remove lesions, especially those for which the boundaries are extensive and/or difficult to delineate. Functions as basic as speaking, eating, swallowing, and masticating can become arduous tasks when surgical intervention requires the removal of the muscles, nerves, bone, and supporting connective tissue. Reconstructive surgery may not be successful in restoring the patient to presurgical form and function. Physical therapy may be required to help patients adjust to an oral and maxillofacial environment that functions in a vastly different fashion. In some cases, specialized prostheses may be needed to replace lost teeth, gingival tissues, mucosa, and alveolar bone. Dentures and partial dentures can be difficult to wear by any patient, but the level of difficulty is often magnified for patients with oral cancer who have a substantial loss of supporting tissue. Again, the emphasis should be on the early identification of oral malignancies. This would allow the lesion(s) to be diagnosed and treated in an early stage of development, and the excision could be as conservative as possible.

Radiotherapy

Surgical excision of an oral malignancy, the affected adjacent tissue, and ipsilateral and contralateral lymph nodes, where applicable, is followed by several sessions of radiation therapy, or radiotherapy. Some malignant cells may remain in tissues in close proximity to the site from which the tumor was removed. Radiotherapy is designed to irradiate the affected area with tumoricidal doses of radiation to kill the remaining malignant cells. Doses of radiation are measured in gray (Gy) or centigray (cGy). The cumulative dose of radiation is dependent upon tumor size and location; doses are fractionated on a daily basis for several weeks. Despite improvements in shielding techniques, radiotherapy will kill healthy cells of any oral structure within the primary beam of radiation. These deleterious effects can be temporary or permanent and can have a profound influence upon the patient's quality of life.

Patients undergoing radiotherapy can experience a wide range of complications within and around the oral and maxillofacial complex. The associated morbidity can vary from annoying to life-threatening. The most common complications will be discussed in the following sections.

Mucositis

Most patients with oral cancer receive a cumulative dose of 66–72 Gy (6,600–7,200 cGy) during radiotherapy [75]. The cumulative radiation dose at which mucositis develops varies, but the majority develop with a dose of 10–30 Gy (1,000–3,000 cGy) [76]. Therefore, most patients with oral cancer will develop mucositis during treatment [77].

Radiation impairs the ability of the basal cell layer to provide new cells for the renewal of the outermost surface of the multi-layered oral epithelium. Because the external surface of the oral epithelium has a lifespan of two to three days, ulcerative mucositis generally develops during the second week of therapy.

These ulcerative lesions can vary from singular areas of mild erythema to multiple areas of hemorrhage and necrosis in the deep layers of connective tissue.

Some cases may advance to such severity that the scheduled treatment regimen of radiotherapy should be interrupted until the initial epithelial healing has occurred. Patients with more severe forms of mucositis may be unable to eat, requiring hospitalization to provide intravenous therapy for nutrition, analgesia, and prophylactic antibiotic therapy. Patients who wear dentures or partial dentures may be unable to do so if the supporting tissues have been afflicted with any degree of mucositis. A pureed or liquid diet may be required in order for these patients to maintain adequate nutrition. Oral lesions of mucositis of any degree are potential areas of bacterial, fungal, or viral entry and systemic dissemination of infections.

Mucositis will resolve after radiotherapy is completed, with healing time proportionate to the extent of the lesions [77]. Only emergency dental treatment should be attempted while the patient is undergoing radiotherapy, and even this should be discussed with the patient's oncologist and surgeon.

Treatment for mucositis, as determined by the extent of the lesions, usually involves palliative care with non-narcotic or narcotic analgesics. Oral rinses such as benzydamine hydrochloride can provide limited temporary topical anesthesia for mucositis lesions. Oral rinses work best if they are initiated the day before radiotherapy begins. Patients should rinse, hold the analgesic against the afflicted areas for 30 seconds, then expectorate the excess. This protocol can be repeated three to four times daily, as needed [77]. Viscous lidocaine in a 2% solution may also be used three to four times daily. A dose of 5 cc of this solution is placed in contact with afflicted areas for 30 seconds to 1 minute, followed by the expectoration of any excess. Patients should be cautioned to avoid biting or traumatizing any tissue that is anesthetized; traumatic ulcers can develop and prolong the healing time. Patients with mucositis should be advised to remain on a cooler, softer diet that excludes foods with sharp edges. Hot, spicy, and acidic foods should not be consumed until the mucositis has resolved. Patients should be instructed to maintain optimal oral hygiene [77]. However, alcohol-based mouth rinses should be avoided due to the potential to irritate the lesions of mucositis. Established guidelines for oral care for patients in whom mucositis has developed include twice daily oral assessments (for hospitalized patients) and frequent oral care (i.e., minimum every four hours and at bedtime) that increases in frequency as the severity of mucositis increases [77].

Salivary Gland Problems

The major salivary glands, including the bilateral parotid, submandibular, and sublingual, are very sensitive to ionizing radiation. Damage can occur to these glands with a cumulative dose of 10 Gy (1,000 cGy) radiation. When the cumulative dose of 54 Gy (5,400 cGy) has been reached, the secretory elements of the major salivary glands will have sustained irreversible damage [77]. If the malignancy occurs in the area of the parotid gland, which is a pure serous (watery secretion) gland, shielding techniques may not be able to prevent its subsequent damage. A higher degree of damage to this gland, with a subsequent loss of the serous component of saliva, causes the remaining saliva to be increasingly viscous. Patients with oral malignancies in which the primary beam of radiation minimizes or avoids damage to any or all of these glands are rare.

Unlike mucositis, salivary gland dysfunction, which is associated with higher cumulative doses of radiation, will not resolve after the cessation of radiotherapy. Eating, swallowing, speaking, and enjoying a good quality of life become difficult when the quantity and quality of saliva is diminished.

Serous secretions are important in the lubrication of the tissues. Oral soft tissues become more prone to damage when long-term desiccation occurs. Patients may have difficulty or be unable to wear dental prostheses on tissue that has become inadequately lubricated.

Interventions for xerostomia (dry mouth) include artificial saliva substitutes, frequent sips of water, or cholinergic medications, such as pilocarpine [77]. Unfortunately, cholinergic medications have minimal or no effect on salivary flow when severe damage from higher cumulative doses of radiotherapy has occurred. Immunoglobulins and other compounds present in saliva that support immune functions will have a decreased output and can subject patients to recurring opportunistic infections, such as oral candidiasis. Impaired salivary flow will also cause a decrease in saliva's cleansing action upon the teeth. Further, the ability of salivary components to maintain the pH of saliva as a mild base is altered, which causes the oral environment to become more acidic. This combination of effects can have devastating effect on teeth, resulting in radiation caries [77].

Radiation caries are characterized by a pattern of aggressive progression of dental caries on surfaces of teeth that are usually considered to be at a low risk for caries, such as the buccal (outer) and lingual (inner) surfaces of posterior teeth and the labial (outer) and lingual (inner) surfaces of anterior teeth. The incisal edges of anterior teeth and the cusp tips of the posterior teeth are also at increased risk for these caries. Teeth that are affected in this manner need not have pre-existing decay or existing restorations. Unfortunately, teeth afflicted with radiation caries can be difficult to restore and may eventually need to be extracted.

Osteoradionecrosis

Among the deleterious effects of radiotherapy, the most severe is osteoradionecrosis (ORN). Ionizing radiation can cause deterioration of the vessels that supply oxygenated blood to the bones of the maxillary and mandibular arches. The resultant hypoxia can lead to the necrosis of osseous tissue unable to be protected from the primary beam of radiation. ORN occurs more frequently on the mandibular arch, which has less of a blood supply as compared to the maxillary arch [78].

Risk of ORN is directly related to radiation dose and the volume of tissue irradiated [78]. However, osteoradionecrosis can occur at any time after radiotherapy, and passage of time does not decrease the risk [78; 79]. ORN is rare in patients who receive less than 60 Gy radiation therapy. The overall incidence of ORN has decreased from up to 11.8% in the last part of the 20th century to around 3.0% currently. However, the true frequency of ORN is impossible to determine because no mechanism exists for reporting the disease. More valuable than understanding the frequency is understanding the decrease in reparative capacity in tissue exposed to more than 60 Gy radiation [78]. Necrotic pieces of bone, which can have a considerable range in size, often break away from the affected bone and may emerge though the tissues. Small segments of bone can be removed with conservative surgical techniques, but large segments require extensive surgical resection. The development of osteoradionecrosis may be precipitated by trauma to the alveolar bone, as encountered with oral or periodontal surgery, odontogenic infections from periapical or periodontal pathology, or tissue irritation and subsequent ulceration that extends toward the bone. Patients who wear dentures or partial dentures may require the fabrication of new prostheses if this pathologic process dramatically alters the shape of the underlying supporting alveolar bone.

CHEMOTHERAPY

In 2024, an estimated 2 million new cases of cancer will be diagnosed, and approximately 611,720 patients will die as a result of the disease [74]. These figures do not include those patients who already had cancer and were in varying stages of treatment. Many patients older than 65 years of age are diagnosed with cancer and will receive chemotherapy as part of their cancer treatment.

Unlike the localized effects of radiotherapy, chemotherapeutic drugs are administered systemically. These medications are utilized to target the rapidly dividing cells found in malignant lesions. Unfortunately, these medications also target healthy, rapidly dividing cells, such as those of the oral mucosa and the hematopoietic cells of the bone marrow. The resultant problems of mucositis and a compromised immune system can develop. Approximately 40% of patients who receive chemotherapy will develop mucositis [80]. About one-half of these patients will experience mucositis that is severe enough to postpone or modify the chemotherapeutic regimen [81].

Management of chemotherapy-related oral complications include oral debridement and decontamination, topical and systemic pain management, prophylaxis (e.g., sucking ice chips), antiviral medications, and control of bleeding [82]. Medications used to treat the mucositis of patients with oral cancer can also be used for those undergoing chemotherapy.

Upon the cessation of chemotherapy, most cases of mucositis will resolve and, in general, the production of normal levels of hematopoietic cells will resume. However, some patients may experience chronic problems with either or both of these issues. Those who have had a bone marrow transplant will take immunosuppressive medications for the balance of their lives and can face chronic long-term problems with their immune system.

ORAL CONSIDERATIONS FOR PATIENTS BEING TREATED FOR CANCER

Patients who have been diagnosed with any type of cancer should have a comprehensive clinical and radiographic dental examination completed as far in advance as possible of any surgical and/or chemotherapeutic treatments. Oncologists and physicians who treat patients with cancer should be cognizant that optimal oral health will minimize the potentially serious oral complications that may develop after surgery, radiotherapy, and chemotherapy. Further, many patients do not receive routine preventive dental treatment and should be referred to a dentist prior to the initiation of treatment.

The American Cancer Society recommends that primary care clinicians should refer survivors of head or neck cancer to a dentist or periodontist for thorough evaluation and should counsel survivors to seek regular treatment from and follow recommendations of a qualified dental professional and reinforce that proper examination of the gingival attachment is a normal part of ongoing dental care.

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Level of Evidence: 0 (Expert opinion, observational study, clinical practice, literature review, or pilot study)

It is imperative to extract teeth that cannot be restored or those with periodontal problems that cannot be rectified. Teeth in these categories may cause minor problems for healthy patients, but they can cause life-threatening infections for patients being treated for any form of cancer. Custom trays for fluoride gels should be provided for patients who receive radiotherapy for oral cancer or head and neck malignancies in order to minimize radiation caries. Patients who develop xerostomia secondary to radiation require more frequent dental appointments to optimize oral hygiene and evaluate the patient for the onset of radiation caries. To prevent infection, supplemental rinses with 0.12% chlorhexidine should be considered, as the rinse has the ability to remain bound to hard and soft tissue for several hours while retaining its antibacterial properties.

However, it should not be used if mucositis has developed. If alcohol-based products cannot be used, a suitable alternative should be prescribed.

Dental emergencies can arise at any point during cancer therapy. The patient's oncologist should be consulted prior to the initiation of any emergency dental treatment while the patient is receiving chemotherapy or is in the midst of radiotherapy. Laboratory values for platelets and white blood cells should be determined to evaluate if the values are of an appropriate range for hemostasis and if white blood cells are present in sufficient levels to successfully mount a defense against pathogenic organisms. Extracting teeth after oral radiotherapy can cause osteoradionecrosis. Prostheses with any rough surfaces should be smoothed. Those that are a poor fit against the supporting tissues should be relined or remade.

Patients undergoing cancer treatment are often taking medications for other chronic conditions in addition to chemotherapy. Medications prescribed for dental concerns should be selected carefully to prevent negative reactions with any medication currently prescribed for the patient.

PHYSIOLOGIC CHANGES DURING THE AGING PROCESS

The process of aging at the cellular, tissue, organ, and systemic levels can vary widely. Changes that result from the aging process may impact immune function, drug absorption, drug distribution, drug metabolism, and drug excretion, all of which have effects on dental health and treatment.

Medications prescribed to elderly patients often require modification in the dosage, the duration of the prescription, and the frequency with which they are taken. When chronic disease is present, the ability to withstand any dental treatment, especially that of a surgical nature, may be compromised. The type of procedures performed and the number and duration of appointments involved are influenced by the cumulative biologic changes associated with the aging process.

Muscle mass and total body water both decrease during the aging process, while total body fat increases. Thus, the distribution of water-soluble medications decreases, but distribution increases for lipid-soluble medications. Because water-soluble medications, such as acetaminophen, are distributed in a smaller volume of water, they are more concentrated in older patients as compared to the same dose in a younger patient. This results in an amplified effect of water-soluble medications in older adult patients [83]. Lipid-soluble medications, such as diazepam and lidocaine, are distributed throughout the greater volume of adipose tissue in older adults as compared to younger adults. This will have the effect of prolonging the actions of these medications, and dosages may need to be adjusted for optimal outcomes [84; 85].

Age-related changes in the liver and the kidneys can also influence the metabolism and clearance of medications used in dentistry. The mass of the liver decreases approximately 1% per year in patients older than 40 years of age. Furthermore, the blood flow to the liver can decrease by 40% to 45% as the aging process continues [86]. These two conditions lead to a decrease in the hepatic metabolism of specific medications.

Chronic diseases, such as hepatitis and cirrhosis, that damage the hepatocytes can further complicate the ability of the liver to metabolize medications properly. Slower metabolism and decreased clearance can lead to accrual of the medication in the plasma, increasing the concentration and potentially leading to toxicity. When addressing dental concerns, care should be taken in prescribing medications for older adult patients with impaired liver function, especially those who take prescribed medications for other chronic disease(s).

As an individual ages, the functional unit of the kidney, the glomerulus, decreases in overall size and filtration rate [86]. Medications that are excreted through the kidneys, including NSAIDs such as ibuprofen and naproxen, may take longer to achieve proper clearance. This effect is amplified

for patients who have chronic kidney disease and for whom other prescribed medications also rely on renal clearance. A physician should be consulted if there is any concern about the ability of the patient to metabolize and excrete standard doses of medications in the presence of hepatic or renal disease.

XEROSTOMIA

Increasing age is not automatically equated with decreasing salivary gland production and xerostomia, and secretions from the major salivary glands do not generally undergo a significant decrease in output during the aging process [87]. However, nearly 30% of patients 65 years of age or older experience xerostomia, most commonly medication-induced xerostomia [88]. There are an estimated 300,000 over-the-counter and more than 20,000 prescription medications available in the United States, and many list dry mouth as a possible side effect [89; 90]. Medication-induced xerostomia can be a long-term problem for older patients, as they are more likely to be taking multiple medications for longer periods of time or indefinitely. Medications that decrease salivary production usually affect the unstimulated flow of saliva; saliva produced in response to a stimulus, such as food, remains unaffected [91].

Xerostomia can also be associated with certain diseases and their treatment modalities. The permanent problems that radiotherapy can directly cause to saliva production have been discussed. Similarly, chemotherapy can cause temporary disruptions to normal salivary flow. Systemic and autoimmune diseases, such as diabetes and Sjögren syndrome, can cause disruptions in the normal production of saliva.

The preventive measures outlined for use in the reduction of dental caries and maintenance of optimal oral health for postradiotherapy patients with oral cancer may be utilized for any patient with xerostomia. There are many saliva substitute products available to decrease the discomfort associated with chronic xerostomia. Cholinergic medications designed to stimulate salivary production may be useful as long as there is functional salivary gland tissue. Sugar-free gum and sugar-free candy can provide a more conservative approach to salivary gland stimulation [77]. Treatment of xerostomia may involve a team approach to identify the cause(s) and to provide treatment to induce salivary production, provide improved oral comfort, and maintain oral health.

PHYSICAL AND COGNITIVE DEFICITS AND ORAL HYGIENE

The prevention of dental caries and periodontal disease requires appropriate diagnosis and treatment from the dental team, but it also requires that patients adhere to the use of proper oral hygiene techniques on a daily basis. Effective brushing and flossing are essential in maintaining periodontal health and minimizing the development of caries, but these home-care procedures require persistence and an average degree of dexterity. The latter can be an issue to some members of the older adult population for whom medical problems may impair the neuromuscular coordination required for even the most basic of oral hygiene techniques. As discussed, this can be particularly pronounced in patients with rheumatoid arthritis, with its predilection to afflict the joints of the hands and the wrists. Rheumatoid arthritis flare-ups can make brushing and flossing a difficult task and result in a decrease in the quality of the patient's oral hygiene, leading to periodontal disease and caries. The healthcare team should evaluate the patient's ability to brush and floss properly and make appropriate recommendations if these skills are lacking. The use of a toothbrush with a custom grip and flossing aids can be excellent adjuncts for the daily oral hygiene of patients with physical impairments. For some patients, supplemental items, such as antibacterial mouth rinses, including 0.12% chlorhexidine, prescription-strength fluoride gels, and custom fluoride trays, may be required to meet their oral hygiene requirements.

If plaque accumulation remains a problem despite the best of concerted efforts, prophylaxis appointments should be made at a more frequent interval. Caretakers should be given the necessary information to assess the ability of patients to provide for their own oral hygiene, if applicable. In some instances, caretakers may need to take an active role in assisting patients with oral hygiene regimens. These physical impairments can occur as a result of many conditions, including stroke, connective tissue disease, and joint conditions. It may be an issue for stroke victims when the dominant side is involved. Connective tissue diseases, such as scleroderma and fibromyalgia, may affect the dexterity of older adult patients and make attempts to maintain an appropriate level of oral hygiene difficult.

Cognitive impairment may also cause oral hygiene problems. Estimates indicate that about 5% to 8% of individuals 65 years of age and older and 50% of patients 85 years of age and older have dementia [92]. Alzheimer disease is the origin of 60% to 80% of all dementia cases [92]. Dementia is the general term for a condition of progressive deterioration of brain function and eventual decline in intellectual capacity. In patients with dementia, abilities related to memory, thinking, and speaking all worsen over time. Individuals afflicted with Alzheimer disease often live for many years after the diagnosis. The initial stages of Alzheimer disease are characterized by subtle mild cognitive impairment that may not be readily apparent, even to family members.

The disease progresses at variable rates but ultimately leads to the inability to speak coherently or respond appropriately to stimuli within the local environment. Eventually, ambulation, mastication, and swallowing will become extremely difficult or impossible. Death usually ensues as a result of complications of the condition, such as aspiration pneumonia [93].

The oral health of patients diagnosed with Alzheimer disease can vary considerably. Patients who have maintained optimal oral health prior to their diagnosis will require minimal specialized dental treatment. Treatment to preserve oral health should reflect patients' ability to maintain proper oral hygiene, optimal periodontal health, and control of the development of carious lesions. Patients who have poor periodontal health and a high incidence of dental caries upon diagnosis of Alzheimer disease require a comprehensive dental exam and a specialized treatment plan.

Progression of Alzheimer disease usually leads to deterioration in oral health as the cognitive and neuromuscular elements essential for the basic skills for brushing and flossing continually diminish. Caregivers of patients with Alzheimer disease may have difficulty in performing these tasks. Further, with the advancement of the disease, patients may become less tolerant of and less cooperative with dental treatment. There will come a time when only emergency dental treatment performed under sedation is possible. Clinicians involved in the care of patients with Alzheimer disease may need to establish a protocol of more frequent periodic visits to monitor oral health.

If clinical presentation indicates poor oral hygiene and the rapid development of periodontal problems and dental caries between appointments, extractions should be considered; costly restorative treatment and periodontal therapy have a poor prognosis for success. If a patient is fitted for new dentures, the prosthesis should have the name of the patient placed in the acrylic. This is particularly important for institutionalized patients, as this step can help in the recovery of misplaced prostheses. Before surgical procedures are initiated, the patient's capacity to give informed consent should be determined and/or the healthcare proxies should be located.

Treatment of Alzheimer disease is generally palliative. However, patients in the initial stages of the disease may take antidepressants or antipsychotics to attenuate symptoms. Some of these medications can cause xerostomia and, by extension, oral hygiene problems.

Two medications often prescribed for Alzheimer disease, donepezil and rivastigmine, do not have known interactions with vasoconstrictors used in local anesthesia. However, tricyclic antidepressant medications can interact with vasoconstrictors. Therefore, patients taking tricyclic antidepressants should have their dental treatment completed with nonvasoconstrictive anesthetics. All dental treatment should be aimed at proactive early intervention to prevent dental complications. During the latter stages of Alzheimer disease, the provision of complicated treatment will be a daunting challenge.

Parkinson disease is a progressive neurodegenerative disorder characterized by motor and non-motor symptoms that affects patients physically, emotionally, and cognitively [94]. Motor impairments due to tremors and rigidity of the orofacial musculature cause difficulty with tooth brushing, leading to increased risk for caries and periodontal disease [95]. The prevalence of periodontitis in patients with Parkinson disease has been reported to be 75% [95]. Conversely, patients with periodontitis had a 43% increased risk of developing Parkinson disease [96]. Involuntary jaw movement may cause temporomandibular joint discomfort, cracked teeth, tooth wear, orofacial pain, and dysphagia [97]. Treatments for Parkinson disease can induce xerostomia [94; 98]. Because the disease is progressive in nature, dental treatment should be considered at the early phase and continue throughout the course [97].

ACCESS TO DENTAL CARE: ISSUES FOR OLDER ADULT PATIENTS

Numerous socioeconomic issues can present obstacles for patients of any age who wish to obtain dental care. However, older adult patients may experience additional barriers in their attempts to maintain dental health.

Financing of dental care is the primary obstacle for many older adults. Most patients older than 65 years of age are retired and therefore no longer have dental insurance as an employee benefit. Without this option and income limited to retirement savings, social security income, and any pension plan benefits, the costs associated with dental treatment may not be easily accommodated. Funding from federal, state, and county sources is often limited, both in available funds and treatment coverage.

Available financial resources among the geriatric population vary considerably. Unfortunately, many older adults live near or even below the poverty level and have difficulty in affording basic preventive dental care.

Medical problems can also present as a major obstacle in the provision of dental care for older adult patients. As discussed, many older adults are afflicted with at least one chronic disease and most have experienced medical problems. Even with Medicare insurance, the cumulative costs of medical treatment and medications can escalate and contribute to budgetary concerns, making it difficult to afford dental care.

Coping with serious medical problems may leave older adults without the motivation and ability to seek dental care. Some medical problems may also lead to one spouse assuming the role of caretaker for the other. If this is the case, both can have difficulties in obtaining dental care. The caregiver spouse may have difficulty setting aside time for a dental appointment, while the morbidity of the medical problem and transport issues make dental appointments difficult for the infirmed. Patients in

long-term care facilities may also face obstacles in obtaining dental care [99]. The cost of long-term care is often a strain and may limit patients' ability to afford dental treatment. Difficulties with transportation, especially to an outside dental office, may also be a barrier to seeking dental care. In order to overcome this barrier, some long-term care facilities may contract with a private dentist to provide care within the facility. However, the fees associated with this level of service are prohibitive to many.

While there are other barriers in the provision of dental treatment of older adult patients, including the availability of clinicians specializing in treating older patients, financial and transportation issues are the most frequently encountered. Because oral health is such an important component to overall health and quality of life, efforts should be made toward the improvement of access to dental care for all within the geriatric population.

CONCLUSION

The growth of the geriatric population in the United States will have a significant impact on all aspects of society, especially in the healthcare system. The dental and medical needs of this heterogeneous group will be vast and diverse.

A wide range of medical problems can affect older adult patients. This course has considered a select group of the most frequently occurring diseases and conditions among the older population and the manner in which they and associated treatments can influence the course of dental care and treatments. Clinicians should consider all of the unique health issues of each patient to allow for safe and efficient treatment. The goal for older adult patients is to achieve optimal oral health, thus enhancing overall health. This begins with a concerted effort between the patient and the healthcare and dental teams. When medical problems exist, the physician and other involved healthcare professionals should be consulted, as these diseases can affect the safety and efficacy of dental treatments. This unified approach should assist older adult patients to maintain optimal oral health and a high quality of life.

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