



Endodontics in Systemically Compromised Patients

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12.1 Introduction

The common medical conditions encountered by the dentist in daily practice that necessitates extra knowledge include cardiac diseases, pulmonary diseases, hypertension, diabetes, bleeding disorders, pregnant patients, multiple drug interactions, infectious diseases, renal complications, diabetes, and patients undergoing radiation therapy [1]. When treatment is carried out in a healthy individual, it is sufficient to concentrate on the technical part of the procedure, but when there is a need to treat patients with systemic illness who are under medical management, it is equally important to avoid any potential medical emergency or complication.

The world is experiencing growth in the number and proportion of older persons in the population, because of this the incidence of a number of pathologies has been increasing and thus is producing an increase in the number of individuals with systemic medical conditions that can affect oral health and subsequent dental treatment. The dental management of medically compromised patients can be sometimes problematic in terms of oral complications, dental therapy, and emergency care. One of the challenges faced by dental specialists today is the assessment and management of these patients. As mentioned in detail in Chap. 11 geriatric patients are much more likely to be at least partially dentulous having a complex medical history and the use of multiple medications.

In order to ascertain a patient's medical status, a thorough history taking is essential. This chapter will focus on guidelines for endodontists to manage such medical conditions in a dental office. It should be noted that this book covers endodontic considerations in commonly occurring medical conditions, a comprehensive list of all medical conditions is exhaustive and beyond the scope of this book.

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For information on other medical conditions and more detail on those listed below, the reader is advised to refer to other books and journals and to consult their medical colleagues with respect to specific patient cases.

12.2 Importance of History Taking

Obtaining a thorough medical history is of great importance [2]. It is an information gathering process for assessing a patient's health status and comprises a systematic review of the patient's chief or primary complaint, a detailed history related to the complaint, information about past and present medical conditions, pertinent social and family histories, and a review of symptoms by organ system. Interpretation of this information collected achieves three important objectives: enables the monitoring of medical conditions and the evaluation of underlying systemic conditions of which the patient may or may not be aware, provides a basis for determining whether dental treatment might affect the systemic health of the patient, and provides an initial starting point for assessing the possible influence of the patient's systemic health on the patient's oral health and/or dental treatment [3, 4].

Each identified condition during the process of history taking can affect dental care in a unique manner. For example, medication prescribed for a medical condition might produce a problem during the administration of a local anesthetic, or it could interact with pain medication prescribed posttreatment. Certain medically compromised patients should only be treated in a hospital setting where emergency issues, should they arise, can be immediately addressed and promptly attended to in a controlled manner.

Past dental history (PDH) should also be obtained as a review of systems, especially when the patient presents with complicating dental and medical factors such as restorative and periodontal needs coupled with a systemic disorder such as diabetes. Details of any previous untoward complications of dental treatment must be recorded or must be obtained subsequently if not immediately available from the patient.

Dental treatment causes changes to the patient's homeostasis. A risk assessment should be performed to evaluate and determine the modifications to be required before, during, and after dental treatment. Different modifications may be necessary at each stage of treatment such as antibiotic prophylaxis or steroid replacement may be necessary before treatment, or it may not be possible to place the patient in a supine position during dental procedures, or specific hemostatic agents may need to be employed after extractions. Many different medical conditions are discussed hereby, and protocols for the modification of dental care are suggested.

In the patient with pre-existing disease, preparation for dental treatment should include determination of disease status. The clinician should have an understanding of the nature of the patient's disease and how it can impact their physiology and his/her response to dental management and postdental treatment healing. Knowing how to manage potential complications is also important and is discussed in the following chapter.

12.3 Cardiac Disorders

Cardiovascular disease (CVD) has become increasingly common in modern times; therefore, a dentist must be aware of the modifications and precautions to take while treating a patient suffering from cardiovascular disorders. According to WHO, Global status report on noncommunicable diseases (2014), 17.5 million people die each year from CVD, an estimated 31% of all deaths worldwide.

Patients suffering from cardiovascular disease are vulnerable to physical and emotional stress. If, in addition, the patients have to undergo dental treatment, it will add to their stress. Cardiac patients have a higher risk of collapse, other cardiac emergencies such as angina attacks and/or drug interactions, in the dental clinic.

Cardiovascular problems that require special attention and dental-treatment-plan modification include infective endocarditis, ischemic heart disease, myocardial infarction, cardiac arrhythmias, and congestive heart failure. In patients with cardiovascular disease, the most important considerations during treatment include the maintenance of blood pressure, pulse, cardiac output, and myocardial oxygen and the prevention of bacteremia via prophylactic antibiotic. A comprehensive dental evaluation involving a thorough medical history and premedical evaluation should be carried out including an assessment of vital signs (e.g., pulse, blood pressure, the rate and depth of respiration, and temperature).

12.3.1 Hypertension

Blood pressure is determined by how much blood the heart pumps (i.e., cardiac output) and by the resistance to blood flow in the vascular system. Cardiac output in turn is determined by how often the pump contracts (i.e., heart rate) and by the amount of blood ejected during each beat (i.e., stroke volume) [5]. Hypertensive patients are defined as those receiving treatment for hypertension or those with a mean systolic blood pressure (SBP) of 140 mm Hg or greater and/or mean diastolic blood pressure (DBP) of 90 mm Hg or greater [6] (Table 12.1). The same classification is used in young, middle-aged, and elderly subjects. Patients with prehypertension are at increased risk of developing hypertension, those with blood pressure values 130–139/80–89 mmHg have a two times greater risk of developing hypertension than those with lower values [7].

Patients with untreated or inadequately treated hypertension are at increased risk of developing acute complications like myocardial infarction, stroke, and chronic complications of hypertension. Hypertension is a highly prevalent cardiovascular

Table 12.1 Classification of hypertension [8]

Classification	SBP (mmHg)	DBP (mmHg)
Normal	<120	and <80
Prehypertension	120–139	or 80–89
Stage 1 hypertension	140–159	or 90–99
Stage 2 hypertension	≥160	≥100

SBP systolic blood pressure; DBP diastolic blood pressure

Table 12.2 White coat hypertension, the white coat effect, and masked hypertension [9]

Diagnosis	Office blood pressure	Blood pressure outside office	Associated with adverse outcomes
White coat hypertension	Elevated	Normal	Controversial
White coat effect	Elevated	Normal or high	Controversial
Masked hypertension	Normal	Elevated	Yes

disease, which affects over 1 billion people worldwide [8]. Hypertension was called the “silent killer” because it often affects target organs (the kidney, heart, brain, eyes) before the appearance of clinical symptoms.

12.3.1.1 White Coat Hypertension

Office BP is usually higher than BP measured out of the office, which can be attributed to anxiety and/or a conditional response to the unusual situation [1]. *White coat hypertension* (WCH) refers to a persistently elevated office blood pressure in the presence of a normal blood pressure outside of the office [4]. WCH is different from the white coat effect (WCE), which refers to a high office blood pressure but whereby hypertension may or may not be present outside the office setting. *Masked hypertension* refers to when a patient has a normal office blood pressure but has hypertension outside of the office (Table 12.2).

WCH and masked hypertension are important for clinicians to recognize. It is controversial as to whether WCH is associated with increased cardiovascular risk, but patients with masked hypertension are at increased cardiovascular risk.

12.3.2 Ischemic Heart Disease

When coronary atherosclerotic heart disease becomes sufficiently advanced to produce symptoms, it is referred to as ischemic heart disease. It is relatively common in the general population, especially with increasing age, and typically presents as angina or heart failure [10]. Angina is often precipitated by physical activity or stress and may radiate to the arm or jaw or may present as facial or dental pain. Fear and anxiety associated with a dental procedure may be a precipitating factor for angina in some patients [11].

12.3.3 General Considerations in Patients with Cardiovascular Disorders

12.3.3.1 Physician Consent

Consultation with the patient’s physician is mandatory before the initiation of dental treatment. A green signal from the patients’ physician is crucial when treating medically compromised patients for the safety of the patient from medical complications as well as the safety of the dentist from medicolegal complications. It is important for a physician/cardiologist report before initiating any elective dental surgical procedure in a cardiovascular patient. The proposed treatment plan should be reviewed, and any medical recommendations should be documented [12]. In addition, a

careful preoperative dental evaluation is recommended. This helps in reducing the incidence of dental emergencies.

12.3.3.2 Stress Reduction

Dental treatment has the potential to induce stress in patients. It can be either physiological (pain) or psychological (anxiety, fear). The body responds to stress by increased release of catecholamines (epinephrine and norepinephrine) from the adrenal medulla into the cardiovascular system. This, in turn, can increase the workload on the heart (i.e., increased heart rate and strength of myocardial contraction and an increased myocardial oxygen requirement) in patients with hypertension or coronary artery disease [13]. Therefore patients with cardiovascular disease are more vulnerable to physical or emotional stress that may be encountered during dental treatment than a normal patient [12]. Various steps should be taken to minimize stress encountered during dental treatment procedure. These are:

- Patients should be given reassurance to prevent or reduce anxiety.
- Medically compromised patients are better able to tolerate stress when rested. Therefore, appointments should be scheduled in the mornings [13].
- Angina-prone patients who experience greater than normal stress from the thought of dental work benefit from the administration of oral anxiolytics or nitrous oxide [12, 14].
- Patients should be seated comfortably (semi-supine) in the dental chair [14]
- Pain control is critical for lessening the chances of angina in ischemic heart disease patients by producing and maintaining profound local anesthesia in the surgical area via the use of longer-acting anesthetics, such as bupivacaine, or by using an anesthetic containing a vasoconstrictor, after careful aspiration [14, 15].
- Intermittent rest should be provided to the patient thereby reducing fatigue.
- Appointments should not be long [13].

12.3.3.3 The Use of Vasoconstrictors

Incorporation of a vasoconstrictor to local anesthetic provides better pain control, which in turn reduces anxiety and stress usually associated with dental treatment [16].

Control of pain and anxiety is very important in patients with high medical risk. Patients with cardiovascular disease have a high risk of complications due to endogenous catecholamines (adrenaline and noradrenaline) released from pain and stress. These catecholamines may increase dramatically BP and cardiac output. This effect is reduced by controlling dental pain. Local anesthetics with epinephrine produce a longer and more effective anesthesia than simple LA, thus avoiding an exaggerated response to stress [17]. But the commonly used vasoconstrictors such as epinephrine can cause a rise in heart rate [18]. Hence, the use of vasoconstrictor should be limited in individuals with cardiac disease, taking care not to exceed 0.04 mg of adrenaline. In turn, if anesthetic reinforcement is needed, it should be provided without a vasoconstrictor [14]. Aspiration before any injection is mandatory to avoid intravascular administration [15].

The maximum recommended dose of epinephrine in a patient with cardiac risk is 0.04 mg, which is equal to that containing about two cartridges of LA with 1:100,000 epinephrine or 4 cartridges with 1:200,000 epinephrine [16].

Vasoconstrictor is an absolute contraindication in patients with unstable angina pectoris or in patients with uncontrolled hypertension, refractory arrhythmias, recent myocardial infarctions (less than 6 months), recent stroke (less than 6 months), recent coronary bypass surgery (less than 3 months), and uncontrolled congestive heart failure [18]. Furthermore, since vasoconstrictors can interact with certain antihypertensive medications, they should be used only after consultation with the patient's physician [12].

12.3.4 Endodontic Consideration in Hypertensive Patients

Patients with hypertension are at an increased risk of suffering from angina pectoris, myocardial infarction, stroke, and heart failure. All of these are medical emergencies which can occur during and after dental care [14, 19]. Although clear guidelines for establishing a cutoff point for dental treatment emergency or routine are lacking, it is generally accepted that patients with SBP greater than 180 or DBP greater than 110 should be taken for medical consultation and treatment prior to dental treatment and only emergency management of pain or acute infection should be considered [11].

Routine dental treatment should be deferred until acceptable blood pressure levels are achieved, and the patient should be referred for medical evaluation. Antihypertensive drugs may cause certain oral side effects. Orthostatic hypotension occurs to varying degrees in most of the patients taking antihypertensive medicines [14]. Therefore, dentists should avoid making sudden changes in the patients' body position during treatment [19].

Prolonged use of certain nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen, indomethacin, or naproxen, is shown to reduce the effectiveness of certain antihypertensive drugs (beta-blockers, diuretics, ACEIs) [14, 18]. Paracetamol can be used to avoid this side effect. Excessive bleeding especially is a possibility in hypertensive patients. Therefore, aggressive dental surgical procedures should be performed with great caution in these patients [19].

Dental treatment should include short morning appointments, good procedural pain control, stress and anxiety reduction that could include preoperative or intraoperative conscious sedation or other non-pharmacologic techniques, and good postoperative follow-up with pain control using appropriate medication.

Although vasoconstrictors may precipitate significant elevations in blood pressure, they lower the risk of endogenous catecholamine release that may result from inadequate pain control.

However, elective dental care should be avoided in the following situations:

- Stage 2 hypertensive patients with blood pressure greater than or equal to 180/110
- Patients who have hypertensive symptoms such as occipital headache, failing vision, ringing in the ears, dizziness, weakness, and tingling of the hands and feet

In these cases, if emergency dental treatment is necessary, medical consultation is required and vasoconstrictor amounts should be limited to one to two cartridges of 1:100,000 solution (0.018–0.036 mg of epinephrine). In patients with Stage 2 hypertension (blood pressure of 160–179/100–109), epinephrine should be limited to three cartridges (0.054 mg). Intraligamentary and intrabony injections should be avoided in these patients [6, 20].

12.3.5 Endodontic Considerations in Patients with Congestive Cardiac Failure

In congestive cardiac failure, there is a mismatch between blood supply and organ demand. A determination must be made via physician consultation on the status of the disease prior to treatment (i.e., is it stable or unstable?). The condition is often confounded by hypertension, a history of MIs, renal failure, thyrotoxicosis, and chronic obstructive pulmonary disease (COPD).

Following a recent MI, patients may have damaged myocardium and be susceptible to reinfarctions, possibly predisposing to heart failures.

The amount of epinephrine delivered can be a critical aspect to the disease. It is advisable to avoid vasoconstrictors in patients receiving digitalis as it can precipitate cardiac arrhythmias [12]. Since aspirin can lead to sodium and fluid retention, it is important to avoid it in patients with heart failure. Medications used by patients with heart failure can be associated with certain side effects of dental significance like xerostomia, lichenoid reaction, and orthostatic hypotension [14].

The clinician should be prepared for potential complications. In the patient with multiple comorbid conditions, only urgent dental needs should be provided, preferably in a hospital setting. For the patient who is considered stable and without significant complications, routine conservative dental care can be performed in an outpatient setting. Prior to treatment, a prothrombin time should be obtained, and, during treatment, the patient should be placed in an upright position to prevent additional pulmonary fluid collection. Placing a patient with poorly compensated heart in supine position can cause shortness of breath and can precipitate pulmonary edema, thus complicating dental treatment procedures [21]. Prothrombin time is measured with the international normalized ratio (INR), and it is used to monitor the effects of anticoagulants on patients. The accepted range of INR to perform elective endodontic procedures is 2–4 [22] and should be checked on the day prior to endodontic therapy.

Important considerations are [23]:

1. Premedication, 2–5 mg diazepam 1 h before procedure to reduce anxiety.
2. Anesthesia without vasoconstrictors can be used for procedures.
3. Short appointments, semi-supine chair position, and availability of sublingual form of nitroglycerine are considered as safety procedures.
4. Patients receiving aspirin can be considered normal, though increased bleeding may be associated.

12.3.6 Endodontic Considerations in Patients with Ischemic Heart Disease (IHD)

When coronary atherosclerotic heart disease becomes sufficiently advanced to produce symptoms, it is referred to as ischemic heart disease. It is relatively common in the general population, especially with increasing age, and typically presents as angina or heart failure [10]. Angina is often precipitated by physical activity or stress and may radiate to the arm or jaw or may present as facial or dental pain. Fear and anxiety associated with a dental procedure may be a precipitating factor for angina in some patients [11].

Angina attacks resulting from cardiac ischemia may be precipitated by dental treatment. This can lead to infarction and cardiac arrest. Dental patients with previous history of angina or a myocardial infarction are approached similarly. Patients who have a history of myocardial infarction less than 6 months prior to dental consultation should be deterred from elective dental care because of their increased susceptibility to repeat infarctions and other cardiovascular complications. Dental treatment should be reserved for emergency situations intended to provide odontogenic pain relief [18]. Patients with angina in the ambulatory setting should not be sedated, as it impairs their ability to report angina. Dentist should regularly check the patient's heart rate and BP during long appointments [15].

These patients benefit from empathy, short morning appointments, oral premedication with anxiolytics or prophylactic nitroglycerin, nitrous oxide-oxygen sedation, and slow delivery of an anesthetic with epinephrine (1:100,000) with aspiration, adequate pain management (during and after dental appointment), and cardiac monitoring [24]. The patient with mild or moderate angina should be reminded to bring with them their nitroglycerin tablets in case of an attack during treatment. If comorbid pulmonary disease (chronic obstructive pulmonary disease) exists, the dose of oxygen provided via cannula or nitrous-oxygen delivery should not exceed 3 L/min. Patients should be placed in a semi-supine position in the dental chair. This helps to prevent potential aspiration of fluid or materials.

It should also be remembered that IHD can rarely be felt as an orofacial pain complaint. Such a referred pain of cardiac origin can lead to a diagnostic dilemma for the clinicians. An improper diagnosis can result in unnecessary dental treatment and more significantly, it can delay the proper treatment of the cardiac problem. Differentiating the site of pain from the source of pain is important so that the treatment will be properly directed toward the source of pain [11].

Anticoagulants and antiplatelet drugs used in the prevention of atherothrombosis in cardiac patients can be associated with increased perioperative bleeding during dental surgical procedures [22]. Since stopping these drugs can result in serious complications, it is advisable not to discontinue these medications when performing minor surgical procedures [15, 22].

If the patient is receiving antiplatelet medication, excessive local bleeding should be controlled [4]. If the patient is receiving anticoagulants, the international normalized ratio (INR) on the day of treatment should be determined. Minor oral surgical procedures can be carried out with an INR of less than 4.0, with additional aid of local hemostasis [18]. Patients with an INR greater than 4.0 should not undergo

any dental surgical procedure without being referred to their cardiologist for medication alteration, expert opinion, and consent [14].

Potential adverse reactions need to be taken into account after treatment (e.g., the interaction between NSAIDs, penicillin, tetracyclines, metronidazole, and anticoagulants) because prophylactic antibiotic may need to be considered to prevent infection. Cardiac patients may also be prescribed digitalis (digoxin in some countries), which can increase nausea as well as exacerbate the gag reflex, a consideration if a rubber dam is not used.

12.3.7 Endodontic Considerations in Patients with Valvular Disease

Prosthetic heart valves carry the higher risk of thromboembolism, and valves placed in the aortic region are more risky than the one in mitral position [24].

An infection on or near the heart valves caused by a bacteremia is termed as infective or bacterial endocarditis. Patients with valvular disease present two primary considerations for dental treatment: potential risk for infective endocarditis (IE) and risk of excessive bleeding in patients on anticoagulant therapy [25].

Though IE is not an emergency condition in the dental clinic, the bacteremia associated with dental treatment can contribute to this potentially fatal disease in patients with valvular heart disease [14]. Therefore, patients with pathologic valve disease are to be managed in close consultation with their physicians, especially to determine the need for antibiotic premedication [21].

According to the most recent guidelines, antibiotic prophylaxis is only recommended for dental procedures that involve manipulation of gingival or the periapical tissue. In general, procedures associated with nonsurgical root canal treatment such as local anesthetic injection, placement of the rubber dam, and instrumentation within the canal system do not place the patient at significant risk for infective endocarditis. The incidence and magnitude of bacteremia when canal instrumentation does not extend into the periapical tissues is very low, and therefore, antibiotic prophylaxis is not required [26].

The highest risk of infective endocarditis (IE) is for patients with prosthetic cardiac valves, those with a history of IE or significant congenital heart disease, or cardiac transplant recipients who develop cardiac valvulopathy [10, 27]. The antibiotic regimen as per the guidelines from the *American Heart Association* before a dental procedure in patients with high risk for IE is given in Table 12.3.

Maintaining good oral hygiene and eradicating dental disease is shown to decrease the frequency of bacteremia from routine daily activities. Hence, the importance of oral health should be emphasized especially in patients with valvular diseases. Moreover, all the standard infection control protocols should be followed such as sterilization of instruments, barrier techniques, and disinfecting the dental clinic and the surgical area, in general maintaining the hygiene of the operatory. Antimicrobial mouth rinse (0.2% chlorhexidine) given before any dental treatment is shown to reduce bacteremia of oral origin [14].

Table 12.3 Antibiotic Prophylactic Regimens for Endocarditis, as recommended by the *American Heart Association*

Regimen	Drugs (single dose 30–60 min before procedure)
Standard regimen	Adults: 2.0 g amoxicillin Children: 50 mg/kg amoxicillin
Patients allergic to penicillin (oral)	Adults: 2 g cephalexin or other first- or second-generation cephalosporin Or 600 mg clindamycin Or 500 mg azithromycin or clarithromycin Children: 50 mg/kg cephalexin or other first- or second-generation cephalosporin (or) 20 mg/kg clindamycin Or 15 mg/kg azithromycin or clarithromycin
For patients allergic to penicillin and unable to take oral medications, IM/IV routes of administration is considered	Adults: 1.0 g IM or IV cefazolin or ceftriaxone Or 600 mg IM or IV clindamycin Children: 50 mg/kg IM or IV cefazolin or ceftriaxone Or 20 mg/kg IM or IV clindamycin within 30 min before the procedure

12.3.8 Endodontic Considerations in Patients with Cardiac Arrhythmias

Patients with cardiac arrhythmias are at greater risk for more serious cardiac complications including cardiac arrest. Most patients presenting for dental treatment will know they have an arrhythmia and will be taking controlling medication such as procainamide, quinidine, or propranolol. If the patient's cardiac status is unclear, treating in a more controlled hospital environment may be best. Best practice also includes the avoidance of excessive anesthetic with epinephrine. The excessive delivery of anesthetic with epinephrine by intraligamentary injection is contraindicated because it has been reported to act in a similar manner to intravenous epinephrine injection.

The general considerations during dental treatment of a cardiac patient (physician consultation, patient monitoring, stress reduction, and limited use of vasoconstrictors) should be strictly adhered to. Patients with dysrhythmias are sometimes managed with electronic devices such as pacemakers that emit electrical signals. These devices have been shown to be sensitive to electromagnetic signals produced by certain dental instruments like electrosurgical unit, electric pulp tester, electronic apex locator, etc. Although the newer models (bipolar devices with electromagnetic shielding) are generally not affected by the small electromagnetic fields generated by dental equipment, care and precaution should be taken when operating ultrasonic scalers and ultrasonic cleaning systems, and selecting composite curing lights in the vicinity of individuals who have pacemakers or implantable cardioverter-defibrillators [14, 28].

12.4 Diabetes

Diabetes affects blood glucose metabolism and vessel pathology. The condition may be the result of absolute insulin deficiency (type 1 diabetes), a problem with insulin function (termed relative or type 2 diabetes), or both conditions. Other types of diabetes include gestational diabetes and diabetes occurring secondary to other diseases.

According to *International Diabetes Foundation* (2015), diabetes mellitus is now an epidemic with 415 million people affected globally. This number is projected to rise to 642 million in 2040. It is estimated that one in two adults with diabetes is undiagnosed. Diabetes is reported to have been responsible for 5 million deaths worldwide in 2015.

It is characterized by hyperglycemia (increased blood glucose level) with or without glycosuria resulting from an absolute or conditional deficiency of insulin [26, 27]. Hyperglycemia leads to an increase in the urinary volume of glucose and fluid loss, which then produces dehydration and electrolyte imbalance. It is the inability of the diabetic patient to metabolize and use glucose, the subsequent metabolism of body fat, and the fluid loss and electrolyte imbalance that causes metabolic acidosis. Complications in the diabetic patient that can occur during and after dental treatment include hypoglycemia, coma, or infection and delayed healing.

Diabetes mellitus is diagnosed as a fasting blood glucose level greater than 125 mg/dL, and the normal fasting blood glucose level is considered to be less than 110 mg/dL. Patients with fasting plasma glucose levels greater than 110 mg/dL but less than 126 mg/dL represent a transitional condition between normal and DM and are considered to have impaired glucose tolerance [29, 30].

In poorly controlled diabetes, gingivitis, periodontitis, and periodontal bone loss are common oral manifestations. In uncontrolled diabetes, there are chances of infection and poor wound healing [31, 32].

12.4.1 Endodontic Considerations

In patients with controlled diabetes, no special treatment is required for routine dentistry including prophylaxis and dental restorative care. The patient should be told to continue with their normal eating and injection regimen. Morning appointments are recommended because cortisol levels are highest at this time and will provide the best blood glucose level. The morning meal should not be skipped [33]. If an appointment is likely to lead to a delayed or missed meal, the diabetic regimen may have to be modified with the assistance of the patient's physician. For patients receiving insulin therapy, appointments should be scheduled so that they do not coincide with peaks of insulin activity, since this is the period of maximal risk of developing hyperglycemia [34]. Before the procedure, it has to be ensured that the patient has eaten normally and taken medication as usual [3]. Emotional and physical stress increases the amount of cortisol and epinephrine secretion that induces

hyperglycemia. Therefore, if the patient is very apprehensive, pretreatment sedation should be contemplated [34].

The type 1 patient should not be scheduled immediately after an insulin injection because this may result in a hypoglycemic episode. No more than two carpules of lidocaine 1:100,000, prilocaine HCL (1:200,000) or bupivacaine with 1:200,000 epinephrine should be delivered for anesthesia. In the moderately controlled diabetic patient, a maximum of two carpules of bupivacaine or prilocaine should be used. In the uncontrolled or brittle diabetic patient, only acute dental infection should be treated on an outpatient basis. Delivered anesthetic should not include epinephrine.

Non-insulin-controlled patients may require insulin, or the insulin dose for some insulin-dependent patients may have to be increased. Acute infections in diabetic patients should be managed using incision and drainage, pulpectomy, antibiotics, and warm rinses [35].

Prophylactic antibiotics are not indicated for endodontic surgery in well-controlled diabetics as they are at no greater risk of postoperative infection than the nondiabetics [36]. Whereas when endodontic surgery is required in a poorly controlled diabetic, prophylactic antibiotic should be considered due to altered function of neutrophils.

Lengthy appointments should be avoided. If a lengthy, especially surgical, procedure is to be undertaken, the patient's physician should be consulted. Blood glucose level should be constantly monitored during a lengthy surgical procedure. Hypoglycemia is a common complication during dental treatment in diabetic patients. Symptoms of hypoglycemia may range from mild, such as anxiety, sweating, and tachycardia, to severe, such as mental status changes, seizure, and coma. The patient usually senses that they are becoming hypoglycemic and requests any form sugar such as orange juice. Severe hypoglycemic episodes are medical emergencies and should be treated promptly with 15 g of oral carbohydrate such as 6 oz orange juice or 3–4 teaspoons of table sugar. If the patient is unable to cooperate or swallow, 1 mg of glucagon may be administered by subcutaneous or intramuscular injection [37].

If hypoglycemia appears to be developing, dental treatment should be terminated and glucose administered. Loss of consciousness is the most serious complication of hypoglycemia. Medical assistance should be quickly sought. Posttreatment problems can include delayed healing and infection. In uncontrolled diabetics, electrolyte imbalance can also present a problem following dental treatment.

12.5 Endodontic Considerations in Patients with Bleeding Disorders

Many dental procedures are associated with postoperative bleeding, which in most cases, is self-limiting and non-problematic. However, some people are at an increased risk of bleeding due to inherited bleeding disorders, in which even relatively minor invasive procedures can precipitate a prolonged bleeding episode [38, 39]. Although patients with congenital bleeding disorders have an increased risk of

significant bleeding from invasive dental and oral surgery procedures [40, 41], the majority of routine nonsurgical dental treatment can be provided in a general dental practice [42, 43].

Some of the bleeding disorders are hemophilia (type A and B), von Willebrand's disease, platelet function disorders, thrombocytopenia, and hypofibrinogenemia and dysfibrinogenemia.

12.5.1 Hemophilia

Individuals with hemophilia (inherited bleeding disorder) do not bleed more profusely than an individual with normal coagulation but may bleed for a longer period of time [44] and may experience delayed bleeding due to clot instability. There are two main types of hemophilia: hemophilia A is the commonest, accounting for approximately 85% of all cases of hemophilia, and characterized by a deficiency of factor VIII. Hemophilia B is characterized by a deficiency of factor IX. Both types of hemophilia are inherited as X-linked recessive conditions and share identical clinical manifestations [45].

Patients with congenital bleeding disorders require formulation of a comprehensive treatment plan with an overall goal of achieving satisfactory hemostasis. It is essential to prevent accidental damage to the oral mucosa when carrying out any procedure in the mouth by implementing general measures such as careful use of saliva ejectors and care in the placement of radiographic films [40, 46].

Local anesthetic infiltration using a slow injection technique and modern fine gauge single-use needles can usually be used without the need for factor replacement therapy [40, 46–48] (Table 12.4). There are no restrictions regarding the type of local anesthetic used, although those with vasoconstrictors may provide additional local hemostasis [49]. Articaine has been described for infiltration as an alternative to inferior dental block in the restoration of mandibular molars, removing the need for preoperative factor cover [50]. A buccal infiltration can be used without any factor replacement. It will anesthetize all the upper teeth and lower anterior and premolar teeth. The intraligamentary technique or interosseous technique should be considered instead of the mandibular block.

Endodontic treatment is generally low risk for patients with bleeding disorders. Nonsurgical endodontic procedure can be performed without any modification in anticoagulant therapy, although it is important to ascertain that patient's international normalized ratio (INR) value is in the therapeutic range of (2–3.5) especially if a nerve block injection is required [51]. Periapical surgery may pose a greater challenge for hemostasis even for patients well maintained within the therapeutic

Table 12.4 Dental anesthetic techniques and factor replacement therapy [47]

No hemostatic cover required	Hemostatic cover required
Buccal infiltration	Inferior dental block
Intrapapillary injections	Lingual infiltrations
Intraligamentary injections	

range; therefore, a consultation with the patient's hematologist is required in developing an appropriate treatment plan.

It is important that the procedure be carried out carefully with the working length of the root canal calculated to ensure that the instruments do not pass through the apex of the root canal. Sodium hypochlorite should be used for irrigation in all cases, followed by the use of calcium hydroxide paste to control the bleeding.

Dental pain can usually be controlled with a minor analgesic such as paracetamol (acetaminophen) and codeine-based preparations. Aspirin should not be used due to its inhibitory effect on platelet aggregation. The use of any nonsteroidal anti-inflammatory drug (NSAID) must be discussed beforehand with the patient's hematologist because of their effect on platelet aggregation. Antibiotics should only be prescribed if there is local spread or signs of systemic infection. There are no contraindications to any of the antibiotics for patients with congenital bleeding disorders.

12.6 Infectious Diseases

Infectious conditions that are problematic in terms of dental management include hepatitis B (HBV), hepatitis C (HCV), HIV, and tuberculosis. Less likely to cause a problem but of additional concern are viral infections such as that seen in severe acute respiratory syndrome (SARS) or healthcare-associated infections such as methicillin-resistant *Staphylococcus aureus* (MRSA). Several potential complications can occur during dental treatment such as the risk of transmission, medication interactions in patients being treated for active disease.

HIV is a blood-borne retrovirus infection transmitted primarily by blood and bodily fluids by intimate sexual contact and parenteral route. After infection, enzyme reverse transcriptase allows the virus to integrate its own DNA into the genome of an infected cell and replicate using the infected cell's ribosomes and protein synthesis. Initially, immune seroconversion with antiviral antibody production occurs followed by a significant decrease in CD4+ lymphocytes over a period of years.

The most effective management in the progression of HIV infection and AIDS is a combination of antiviral agents known as highly active antiretroviral therapies (HAART), which has significantly increased the lifespan and the quality of life of individuals infected with HIV [52, 53].

12.6.1 HIV and Endodontics

In general, endodontic treatment of patients with apical periodontitis would have a poorer prognosis in immunocompromised patients such as HIV-infected patients. This is due to the fact that T cells play an important role in the pathogenesis as well as healing of apical periodontitis.

One of the challenges faced by HIV-positive patients and their dentist is the potential for adverse drug interactions. Because HIV-positive patients usually take

an antiretroviral regimen of three or more drugs from at least two different classes, there exists a potential for unwanted side effects and toxicities [54].

Many of the medications dentists commonly administer or prescribe may interfere with the metabolism of the antiretroviral medications [55, 56]. Statistically, the chances of treating a HIV-positive patient in a dental practice have increased because of a steady state of new HIV infections annually and increasing longevity from highly active antiretroviral therapy. Thus, HIV-positive patients are seeking routine dental care rather than episodic treatment for the oral manifestations of HIV/AIDS, and dental clinicians should know how to appropriately care for them.

The dental clinician should know the medications that their HIV-positive patients are taking, understand the potential drug interactions with medications they prescribe, and be prepared to prescribe medications from a different class when interactions are possible.

Controversy exists in the literature regarding the need for antibiotic coverage before performing dentistry. A small subgroup of patients with advanced HIV disease may require customized modification, such as antibiotic prophylaxis or transfusion of blood products for their care [57]. If the granulocytes count ranges above 500 cells/ μL of blood, endodontic treatment should be performed under prophylactic antibiotic cover. Patients with CD4 cell counts below 200 cells/ μL might suffer from a disorder of blood coagulation. If the thrombocyte count is more than 60,000 cells/ mm^3 , routine dental treatment is possible without the risk of hemorrhage.

Infiltration and/or intraligamentary anesthesia is preferred to avoid any complications of block anesthesia. Antibiotic mouth rinses (chlorhexidine) can be prescribed 2–3 days before the treatment to achieve reduction in oral microorganisms and to avoid any postoperative complications.

Endodontic treatment for an HIV-infected patient is seen on an outpatient basis. These patients have the same prognosis with nonsurgical root canal treatment as medically healthy patients [53]. Finally, the practitioner should be aware of occupational risks in treating these patients, should familiarize himself / herself with the CDC's postexposure prophylactic guidelines, implement preventive measures to prevent occupational exposures, and provide occupational risk training for their staff.

Wounds and needle stick injury following dental procedures resulting in bleeding and subsequent instrument or materials contamination represent the biggest problem with respect to potential viral transmission to clinical staff. The risk of seroconversion after a needle stick injury with HIV-infected blood is approx. 0.03% [58, 59]. In case of deep penetrating injury with accidental exposure to HIV-infected blood and body fluids, a prophylactic administration of a triple antiretroviral therapy along with immediate referral to a specialist is recommended.

Precautions such as not putting the used injection needle back into the sheath and wearing gloves and goggles during the treatment are considered as adequate infection control precautions [60].

It is important to inform all staff members of the patient's infection before starting the treatment to ensure vigilance. Since HIV can be found in both pulpal tissues and apical granuloma, the use of rubber dam is considered mandatory [61]. With

using rotary instruments, not only should the used instruments but also the hand-piece must be disinfected and sterilized after every treatment.

A dentist may not ethically refuse to provide treatment purely because of the patients HIV status.

12.6.2 Hepatitis B and C and Endodontics

Hepatitis B virus (HBV) is a DNA virus and was originally known as “serum hepatitis” [62]. Hepatitis C is a hepatotropic viral infection caused by hepatitis C virus (HCV), which is a major cause of acute hepatitis and chronic liver disease. It is characterized by inflammation of the liver and in many cases permanent damage to liver tissue. The most common types of hepatitis are hepatitis A, B, C, D, E, and G. Hepatitis B and C can lead to permanent liver damage and in many cases, death [62].

Physicians, dentists, nurses, laboratory staff, and dialysis center personnel are at high risk of acquiring infection. HCV prevalence varies widely among countries, with the highest being in several African and eastern Mediterranean countries [63]. The frequency of exposure to HBV was the highest among dental healthcare workers according to a study conducted in Japan [64]. Even after the introduction of many programs and strategies, hepatitis infection continues to remain a health problem in dental settings.

The most significant problems associated with hepatitis B and C in dental settings include the risk of viral contagion on the part of the dental professionals and patients (cross infection), the risk of bleeding in patients with serious liver disease, and alterations in the metabolism of certain drug substances that increase the risk of toxicity [65]. It has been found that HBV and HCV exist on various surfaces in the dental operatory even many days after treating patient’s positive with hepatitis B and C [66]. HCV can remain stable at room temperature for over 5 days [67]. Therefore, standard precautions, i.e., the use of barrier methods, with correct sterilization and disinfection measures, must be followed [65]. The conventional sterilization techniques usually eliminate specific proteins and nucleic acids (HBV DNA and HCV RNA) from dental instruments previously infected with HBV and HCV.

Elective treatment is postponed in an unfavorable state. However, in case treatment is carried out, the dentist must have local hemostatic agents such as oxidized and regenerated cellulose, as well as antifibrinolytic agents (tranexamic acid), platelets, and vitamin K [65]. If antibiotic prophylaxis is suggested, the physician treating the patient therefore should be consulted to establish which drugs are used, their doses, and their possible interactions [68].

Endodontic treatment can be provided for these patients with adequate sterilization care and infection control protocol. The most important factor is in choosing which of the medications and drugs metabolized in the liver should be avoided. Drugs such as erythromycin, metronidazole, or tetracyclines must be avoided entirely [69]. Ampicillin is the choice of antibiotic, while acetaminophen may be used for pain relieving [70]. Nonsteroidal anti-inflammatory drugs should be used

with caution or avoided, due to the risk of gastrointestinal bleeding and gastritis usually associated with liver disease. Local anesthetics are generally safe, provided the total dosage does not exceed 7 mg/kg, combined with epinephrine.

In case there is an accidental exposure:

1. Carefully wash the wound without rubbing, as this may inoculate the virus into deeper tissues, for several minutes with soap and water or using a disinfectant of established efficacy against the virus (iodine solutions or chlorine formulations). The rationale behind these measures is to reduce the number of viral units to below the threshold count required to cause infection (the infectious dose).
2. A complete detailed medical and clinical history of the patient must be recorded to rule out possible risks.

All staff should be vaccinated appropriately. Infection control recommendations are mentioned in Appendix 12.1.

12.6.3 Endodontic Treatment in a Pregnant Patient

Pregnancy does not classify as being medically compromised; therefore, dental treatment should not be denied simply because a woman is pregnant. But the pregnant woman who presents for dental care may require special considerations.

Usually, pregnant patients are not immunocompromised; however, in pregnancy, there is suppression of the maternal immune system in response to the fetus [71] subsequently causing a decrease in cell-mediated immunity, as well as natural killer cell activity [72]. The odontogenic infections have the potential to progress rapidly to deep-space infections eventually compromising the oropharyngeal airway. In addition, pregnant women may also require a prescription and/or over-the-counter analgesics to control serious pulpal pain. Some of these drugs rather than benefitting effects may have deleterious effects on the fetus and the pregnant mother. Therefore, it is imperative that odontogenic infections should be treated promptly at any time during pregnancy. An understanding of the patient's physiologic changes, the effects of chronic infection, and the risks or benefits of medications is necessary to advise a patient on her options regarding medical care.

Fortunately, most of the drugs prescribed/used by a dentist are considered to be safe for both pregnant patients and their unborn child. However, if in any doubt, about either dental medication choices or the risk factors for pregnant patients, he or she should refer to the patient's obstetrician (Tables 12.5 and 12.6).

12.6.3.1 Local Anesthesia

Local anesthetics are most commonly used medications by dentists. Lidocaine and prilocaine are FDA category B rating when given in a therapeutic range and should be the first-line choices for local anesthesia for pregnant women who do not have any contraindications, such as allergy [73, 74]. Bupivacaine, mepivacaine, and articaine are FDA category C ratings.

Table 12.5 FDA drug categories during pregnancy [74, 75]

Category	US Food and Drug Administration risk stratification of drugs
A	Controlled studies in humans have failed to demonstrate a risk to the fetus, and the possibility of fetal harm appears remote
B	Animal studies have not been indicated fetal risk, and human studies have not been conducted, or animal studies have shown a risk, but controlled human studies have not
C	Animal studies have shown a risk, but controlled human studies have not been conducted, or studies are not available in humans or animals
D	Positive evidence of human fetal risk exists but in certain situations that drug may be used despite its risk
X	Evidence of fetal abnormalities and the fetal risk exists based on human experience, and the risk outweighs any possible benefit of use during pregnancy

Table 12.6 Common drugs used in pregnancy in dental treatment

Drug	Use in pregnancy	FDA category
<i>Antibacterial</i>		
Amoxicillin Metronidazole Erythromycin Penicillin Cephalosporins	Yes	B
Tetracycline Gentamicin	No <ul style="list-style-type: none"> • Discoloration of teeth with tetracycline • Fetal ototoxicity with gentamicin 	D
<i>Analgesics</i>		
Oxycodone	With caution	B
Aspirin Ibuprofen Naproxen	Not in 3rd trimester <ul style="list-style-type: none"> • Postpartum hemorrhage with aspirin 	B (D in 3rd trimester)
Acetaminophen Morphine Meperidine	Yes <ul style="list-style-type: none"> • Respiratory depression with morphine 	B
Codeine		C (D in 3rd trimester)
<i>Local anesthetics</i>		
Lidocaine Prilocaine	Yes	B
Mepivacaine Bupivacaine	With caution <ul style="list-style-type: none"> • Fetal bradycardia with mepivacaine and bupivacaine 	C
<i>Sedatives/hypnotics</i>		
Nitrous oxide	Not in 1st trimester <ul style="list-style-type: none"> • Spontaneous abortions with nitrous oxide 	Avoid
Barbiturates and benzodiazepines	No <ul style="list-style-type: none"> • Cleft lip/palate with benzodiazepines 	D

None of the above-listed local anesthetic agents are considered unsafe when given in dental therapeutic dose ranges [73, 75]. Additionally, the use of vasoconstrictors such as epinephrine or levonordefrin is not contraindicated when they are a part of the commercially available local anesthetics. Though they are FDA category C rating, these vasoconstrictors, when used in low concentrations in prepackaged local anesthetic cartridges, cause no fetal harm as long as normal precautions are taken. These precautions include avoiding injection within the blood vessels and maintaining total dosages at or below therapeutic ranges such as 0.04 mg for epinephrine and 0.2 mg for levonordefrin [73, 75].

12.6.3.2 Antibiotics

There are situations when antibiotics may be a necessary course of action. Most of the antibiotics used in dental care are FDA category B for pregnancy risk. These include the penicillin family, the erythromycins (except for the estolate form), azithromycin, clindamycin, metronidazole, and the cephalosporins [18]. However, tetracycline, minocycline, and doxycycline are given D ratings due to their likelihood of chelating in bones and teeth. Thus, tetracycline, minocycline, and doxycycline should be normally avoided [74].

12.6.3.3 Analgesics

Not all NSAIDs are considered safe for the fetus. Neither aspirin nor diflunisal is recommended for a pregnant woman. Both these drugs have both been associated with prolonged gestation and labor, anemia, increased bleeding potential, and premature closure of the ductus arteriosus of the heart [75]. Ibuprofen, ketoprofen, and naproxen are also contraindicated in the third trimester of pregnancy, as they are considered FDA category D choices, due to their risks of prolonged labor, hemorrhage risk during delivery, and premature closure of the ductus arteriosus.

The first-line choice of a NSAID should be acetaminophen which is considered to be FDA B rating for all three trimesters of pregnancy [18]. If stronger pain medication is necessary, most narcotic combinations are relatively safe for short durations, despite their risks for fetal growth retardation or fetal dependency if prescribed for long periods.

12.6.3.4 Anxiolytics

When treating anxiety in the dental setting, non-pharmaceutical methods are preferred because they reduce the fetus's exposure to medication. Most benzodiazepines for anxiolytic relief are classified in categories C or D for pregnancy risk [75, 76]. Intranasal nitrous oxide use is very controversial because there is risk of reduced uterine blood flow or teratogenic effects when it is used in high concentrations [76]. Short-term (i.e., %30 min) use of nitrous oxide, when used in combination with 50% oxygen for nonelective dental procedures, may be warranted if patient management is not possible without anxiolytic management.

12.6.4 Endodontic Management

Endodontic treatment in pregnancy is directed toward controlling disease, maintaining a healthy oral environment, and preventing potential problems that could occur later in the pregnancy or during the postpartum period and has been certified safe in pregnancy [77]. Nevertheless, it has been recommended that elective procedures be avoided until the end of pregnancy and only emergency treatment to be given or if possible, be delayed until the second trimester [78].

The initial 3 months of pregnancy are considered vital to the growth of the fetus. It has been recommended that any avoidable treatment in the first trimester should be moved to the next trimester to prevent any threat of untoward effects of dental treatment [72]. By the end of the first trimester, the uterine size is not large enough to make sitting on the dental chair uncomfortable, and nausea has generally waned. These make the second trimester an ideal period to undertake endodontic treatment. However, extensive elective endodontic procedures should be postponed until after delivery.

During the first trimester (conception to 14th week), there is a great risk of susceptibility to stress and teratogens, and 50–75% of all spontaneous abortions occur during this period [79]. Avoid routine radiographs. Use selectively and when needed.

During the second trimester (14–28th week), organogenesis is completed and therefore the risk to the fetus is low. Some elective and emergent dentoalveolar procedures are more safely accomplished during the second trimester. During the third trimester (29th week until childbirth), although there is no risk to the fetus during this trimester, the pregnant mother may experience an increasing level of discomfort. Short dental appointments should be scheduled with appropriate positioning while in the chair to prevent supine hypotension. The supine position poses an increased risk of developing DVT, by compression of the inferior vena cava, leading to venous stasis and clot formation. The ideal position in the dental chair is the left lateral decubitus position with the right buttock and hip elevated by 15°. Put a ref.

It has been researched that neither the cleansing irrigant, hypochlorite, nor root canal filling materials used in endodontic treatment is detrimental to the fetus [80]. Intraoral radiographs are considered safe for pregnant patients as the X-rays are directed to the mouth and not the abdomen, along with the use of protective measures such as high-speed film, collimation, filtration, lead apron, and a thyroid collar [81]. It has been proposed that *the As Low As Reasonably Achievable (ALARA)* principle should always be practiced, and only radiographs necessary for diagnosis and treatment should be obtained [82].

Local anesthetics are relatively safe when administered properly and in the correct amount during pregnancy [72]. For a healthy pregnant patient, the 1:100,000 epinephrine concentration used in dentistry, administered by proper aspiration technique and limited to the minimal dose required, is safe [77].

Feelings of joy, anxiety, or fear can be common during pregnancy. When combined with dental fears or phobia, pregnant patients may delay or avoid dental care. Anxiety may lead to transient increases in blood pressure, hyperventilation, or uterine cramping. It is important to remember that treatment is being given to two

patients: mother and child. All treatment should be done only after consultation with the patient's gynecologist. It is best to avoid drugs and therapy that would put a fetus at risk in all women of child-bearing age or for whom a negative pregnancy test has not been ensured.

12.7 Endodontic Considerations for Patients Undergoing Chemo/Radiation Therapy and on Bisphosphonates

Cancers that are amenable to surgery and do not affect the oral cavity require few treatment plan modifications. Patients who previously had or are undergoing radiation therapy, chemotherapy, and others taking bisphosphonate medications require special consideration regarding their dental treatment. Prior to the beginning of cancer treatment, the patient should always be carefully evaluated by a dentist. The main goals of preventive dental measures are to remove any oral infection, pathology, or risk factors in order to obtain a stable oral health situation, preventing the necessity for invasive dental procedures in the near or intermediate future [83].

Whenever possible, non-restorable teeth and those with poor long-term periodontal prognosis should be extracted more than 2 weeks prior to radiation therapy. Symptomatic non-vital teeth can be endodontically treated at least 1 week before initiation of chemotherapy. Conservative endodontic and prosthodontic therapies of teeth with good prognosis should be completed. American Heart Association (AHA) has recommended antibiotic prophylaxis (refer to Table 12.2) as cancer patients may have catheters which may be susceptible to infection. This is controversial in literature [84].

For a patient receiving chemotherapy, WBC count and platelet status should be carefully monitored before commencement of dental procedure. Endodontic procedures can be performed if the neutrophil count is greater than 2000 cells per cubic mm and platelets are greater than 50,000 per cubic mm. Postradiation osteonecrosis (PRON) results from radiation-induced changes in the jaws, may arise in bones exposed to high radiation, and is characterized by asymptomatic or painful bone exposure.

Preventive measures and protocols used to reduce radionecrosis include selection of endodontic therapy over extraction, atraumatic surgical procedures, use of non-lidocaine local anesthetics that contain no or low concentrations of epinephrine and prophylactic antibiotics plus antibiotics during the week of healing [85]. Although nonsurgical endodontic treatment is a relatively safe procedure, caution is essential.

12.7.1 Patients Taking Antiresorptive and Anti-angiogenic Medication

Bisphosphonates are used to treat patients with metastatic breast cancer, multiple myeloma,

Paget's disease of the bone, hypercalcemia of malignancy, and for patients with documented bone metastases from any solid tumor (prostate cancer, lung cancer, and renal cell carcinomas).

Bisphosphonates are inhibitors of bone resorption. Bone remodeling is a normal physiologic function. It removes and replaces the damaged bone with new elastic osseous tissue [86]. Bisphosphonates inhibit osteoclast function, prevent bone turnover, and have anti-angiogenic properties [87, 88].

The management of bisphosphonate-associated osteonecrosis of the jaws represents an additional challenge to professionals. In 2014, the American Association of Oral and Maxillofacial Surgeons (AAOMSs) suggested to change the nomenclature from bisphosphonate-related osteonecrosis of the jaw (BRONJ) to MRONJ to accommodate the growing number of osteonecrosis cases involving the maxilla and mandible associated with other antiresorptive (denosumab) and anti-angiogenic therapies [89]. MRONJ or medication-related osteonecrosis of the jaw is a severe adverse drug reaction, manifesting as a progressive bone destruction in the maxillofacial region of patients. The dental treatment of patients receiving oral or intravenous bisphosphonate therapy is principally preventive in nature.

Intravenous (IV) bisphosphonates are utilized to treat conditions associated with cancer as well as hypercalcemia of malignancy, skeletal-related events connected with bone metastases from solid tumor, and for the management of lytic lesion related to multiple myeloma. Patients taking IV bisphosphonates are at higher risk for developing bisphosphonate-associated ONJ than those taking oral BPs. Oral BPs are used to treat osteoporosis, osteopenia, or other less common conditions such as Paget's disease and osteogenesis imperfecta. RANK ligand inhibitor (denosumab) is an antiresorptive medication that inhibits osteoclast function, decreases bone resorption, and increases bone density [90, 91]. It is used in patients affected by osteoporosis or metastatic bone diseases. Anti-angiogenic medications hinder the development of novel blood vessels, blocking the angiogenesis-signaling cascade [92].

Osteoporotic patients starting oral BP therapy should be instructed to the risk of developing MRONJ. Informative and educational documents about the current knowledge of MRONJ as well as the instruction to quickly report every signs and symptoms should be given to patients. Periodic clinical-radiological follow-ups are recommended. The importance of oral hygiene and dental health should be underlined [89]. Data are limited, so an informed consent for a non-quantifiable risk of long-term developing of MRONJ should be obtained. The risk of developing MRONJ associated with oral BPs is very low, and it increases when the duration of therapy exceeded 4 years [93].

Nonsurgical endodontics instead of tooth extraction should be performed whenever possible, even if the tooth is non-restorable. Endodontic surgical procedures and every invasive procedure that involves bone injury are not recommended. Consider BONJ when developing a differential diagnosis of non-odontogenic pain.

Endodontic procedures should be performed with care to avoid trauma to the surrounding periodontal tissues. Rubber dam placement with clamps should avoid impinging gingival tissue, or a modified isolation technique (split dam technique) should be considered.

Procedural errors resulting in periodontal tissue damage (perforation or apical foramen damage) should be prevented. Improved knowledge of root canal anatomy, careful instrumentation, correct working length measurement, and using an operating microscope and electronic apex locator are all helpful tools. A subgingival matrix band placement should be avoided. A decoronation procedure should be considered and endodontic treatment of the remaining roots for teeth with extensive coronal destruction, subgingival margin, or if not restorable. The tooth can be left with a permanent seal or prepared as an over-denture abutment.

Utilize the entire healthcare team, including the patient's general dentist, oncologist, and oral surgeon, when developing treatment plan for these patients. Be aware that the knowledge base for MRONJ is rapidly increasing and it is likely that these recommendations may change over time. The prudent practitioner is encouraged to continually review publications for new developments and treatments in antiresorptive therapy [94].

12.8 Patients with Chronic Kidney Disease

Chronic kidney disease is associated with progressive deterioration of renal function resulting in reduced glomerular filtration rate. Drugs used for its management tend to alter the common oral manifestations associated with the disease. The patients require special considerations for endodontic management because of increased tendency toward bleeding episodes, odontogenic infections, and drug interactions.

For renal disease patients with conservative medical management, the frequent episodes of hypertension require to constantly monitor the blood pressure during the procedure. Nephrotoxic drugs such as tetracyclines and aminoglycosides must be strictly avoided. Antibiotics such as amoxicillin/clavulanate, erythromycin, azithromycin, and analgesics such as paracetamol and ibuprofen do not require any dose alteration for these patients [95].

12.8.1 For Patients on Hemodialysis

These patients have bleeding tendencies due to uremia and hemodialysis [96]. During hemodialysis, the patient's blood is anticoagulated with heparin to assist blood transportation [97]. For this reason, endodontic procedures with a risk of bleeding should not be executed on the day of hemodialysis. Dental treatment should commence on a day after dialysis, to ensure the absence of circulating heparin [98].

Local anesthetics like lidocaine are generally safe and can be administered in their usual dose, and anesthesia can be achieved through infiltration, while nerve block is generally not advised unless deemed necessary because of bleeding tendencies. These patients should undergo complete blood count and coagulation profile tests before initiating the surgical endodontics and nerve blocks in nonsurgical root canal therapy.

These patients are highly prone to the risk of infection and of transmission possibility of hepatitis B virus, hepatitis C virus, and HIV. Appropriate diagnostic tests must be carried out to confirm the negative results for these infections.

12.8.2 For Patients with Renal Transplant

It is important that in the first 6 months after transplantation, any elective dental treatment should be avoided [99]. Treatment with corticosteroids, calcineurin inhibitors (Cs, tacrolimus), and inhibitors of lymphocyte proliferation (azathioprine and mycophenolate mofetil) is common in renal patients, and hence, they will be in an immunosuppressed state. Antibiotic prophylaxis, as per nephrologist's guidelines, is mandatory prior to endodontic procedure.

12.9 Patients on Corticosteroid Therapy

For these patients, it is necessary to assess whether patient is currently on steroid therapy or if there is a history of steroid intake for 2 weeks or longer within the past 2 years. In such condition, the patient's physician should be consulted if any extra dosage of steroid will be needed and confirm the pre- and post-procedural steroid dosages to avoid the risk of adrenal crisis [100]. Increased dose shift is not compulsory if the prednisolone dose is <7.5 mg/day. Morning appointments should be preferred for these patients.

12.10 Respiratory Disorders

12.10.1 Asthma

Asthma is a respiratory disease that affects the respiratory system characterized by inflammation and bronchoconstriction. A distinction should be made between allergic and non-allergic asthma [3].

Clinicians should be aware of the potential for dental materials and products to exacerbate asthma. These include dentifrices, fissure sealants, tooth enamel dust, and methyl methacrylate. Before starting the endodontic procedure, it is essential to understand about the type (mild, moderate, and severe), frequency of attack, and precipitating factors for avoiding the stimulators, and we should follow the emergency protocols [77]. Patients' immune status depends on the level of immunosuppressive medications they are taking. Only the most severely affected asthmatic patients who are taking large doses of systemic corticosteroids fall into this category. For severe conditions, procedures should be carried out with the physician's consent.

If the patient uses a bronchodilator inhaler, it is essential to advise him/her to bring the inhaler during each dental visit. Anxiety is a trigger and dental treatments

often trigger an acute asthmatic attack. A well-planned and uncomplaining approach of the dentist and dental team members may help to lessen the anxiety.

When antibiotic therapy is indicated, macrolides (i.e., erythromycin, azithromycin, and clarithromycin), ciprofloxacin, and clindamycin should be avoided in patients taking theophylline because of the potential adverse effect of methylxanthine toxicity. NSAID group of medicines, barbiturates, and narcotics should be avoided for all asthmatic patients. Acetaminophen and Cox-2 inhibitors can be used as anti-inflammatory drugs for these patients since they do not precipitate bronchospasm. However, recent studies have suggested that long-term daily or weekly acetaminophen use is associated with a more severe asthma. Although there is reason for caution, acetaminophen still is the preferred analgesic for asthmatic patients [101].

LA-containing epinephrine should be avoided as their sulfite preservative component may induce acute asthmatic attacks and allergic reactions. Improper positioning of suction tips or the use of cotton rolls could trigger a hyper reactive airway response in sensitive subjects. Rubber dams should be used judiciously to avoid possible respiratory compromise or aggravation. Prolonged supine positioning can also trigger an asthmatic attack in the dental setting. In the event of an acute asthmatic attack during dental treatment, the clinician should stop the procedure, remove all intraoral implements and rule out foreign body aspiration, and initiate the emergency protocol for managing acute asthmatic exacerbation.

12.10.2 COPD

Chronic obstructive pulmonary disorder (COPD) is a collective term for lung diseases including chronic bronchitis, emphysema, and chronic obstructive airway diseases [74]. COPD patients have breathing problems primarily due to their constricted airways. Medical treatment is directed toward managing the acute and chronic symptoms because COPD cannot be cured completely. Endodontic considerations are the same as in asthma.

Conclusion

The potential always exists for development of a medical emergency in a medically compromised patient. Enough emphasis cannot be given to the importance of a detailed history taking. All dentists and dental office staff must be prepared to recognize and treat adverse responses using appropriate current guidelines. Although there is a huge range of systemic illnesses, this chapter focussed on only selected conditions that need utmost care. Endodontic therapy rather than extraction, maybe the treatment of choice for medically compromised patients due to their health condition as well as psychological status. Today, endodontists are very well informed regarding systemic diseases and can deliver a high standard of endodontic treatment, while at the same time minimizing the potential problem related to general health of the patient.

Appendix 12.1: Infection Prevention Recommendations (Modified and Adapted from CDC, US Department of Health and Human Resources, 2016)

Administrative measures

1. Develop and maintain written infection prevention policies and procedures specific for the dental setting based on evidence-based guidelines (e.g., CDC/Healthcare Infection Control Practices Advisory Committee [HICPAC]), regulations, or standards.
2. Infection prevention policies and procedures should be reassessed at least annually.
3. At least one individual trained in infection prevention is assigned responsibility for coordinating the program.

Dental healthcare personnel safety (DHCP)

1. All staff should be immunized according to the current CDC recommendations for immunizations, evaluation, and follow-up. There is a written policy regarding immunizing DHCP, including a list of all required and recommended immunizations for DHCP (e.g., hepatitis B, MMR (measles, mumps, rubella), varicella (chicken pox), Tdap (tetanus, diphtheria, pertussis)).
2. A log of needlesticks, sharps injuries, and other employee exposure events should be maintained.
3. Referral arrangements should be in place to qualified healthcare professionals (e.g., occupational health program of a hospital) to ensure prompt and appropriate provision of preventive services, occupationally related medical services, and postexposure management with medical follow-up.
4. Establish routine evaluation of the infection prevention program

Sharps safety

1. Sharp items (needles, burs, scalers, etc.) that are contaminated with patient blood and saliva should be considered as potentially infective.
2. Do not recap used needles by using both hands or any other technique that involves directing the point of a needle toward any part of the body.
3. Place used disposable syringes and needles and any other sharp items in appropriate puncture-resistant containers located as close as possible to the area where the items are used.

Sterilization and disinfection of patient care devices

1. Written policies and procedures should be available to ensure reusable patient care instruments, and devices are cleaned and reprocessed appropriately before use on another patient.
2. Clean and disinfect/sterilize reusable dental equipment appropriately before use on any other patient, according to the manufacturer's instructions. If the manufacturer does not provide such instructions, the device may not be suitable for multi-use.
3. Wear appropriate PPE (personal protective equipment) when handling contaminated patient equipment (e.g., examination or heavy duty utility gloves, protective clothing, masks, eye protection) to prevent exposure to infectious agents or chemicals.
4. Routine maintenance for sterilization equipment should be performed according to manufacturer instructions and documented by written maintenance records.

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