Hypertension: Risk Stratification and Patient Management in Oral Healthcare Settings

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Disclaimer: Participants must always be aware of the hazards of using limited knowledge in integrating new techniques or procedures into their practice. Only sound evidence-based dentistry should be used in patient therapy.

Conflict of Interest Disclosure Statement
- Dr. Huber is a member of the dentalcare.com Advisory Board.
- Dr. Ojeda Diaz reports no conflicts of interest associated with this course.

Introduction – Hypertension
Hypertension: Risk Stratification and Patient Management in Oral Healthcare Settings presents information on hypertension and its impact on the clinical process in dentistry. It emphasizes disease-specific and procedures-specific risk factors and the importance of determining a patient's functional capacity to minimize intraoperative hypertensive, hypotensive, and cardiac risks.
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Overview

Hypertension is the most common primary diagnosis in the United States. Based on the best available evidence, recommendations are provided on the safe delivery of dental care to patients with hypertension and on the pivotal role of oral healthcare personnel (OHCP) in a hypertension-related preventive medicine program, i.e., hypertension-related wellness program in the oral healthcare setting.

Learning Objectives

Upon completion of this course, the dental professional should be able to:

- Discuss the etiology, epidemiology, diagnosis, and principles of medical management of patients with hypertension.
- Based on historical and clinical evidence, stratify the intraoperative risks associated with the dental treatment of a patient with hypertension.
- Develop a hypertension-related wellness program appropriate for the oral healthcare setting.

Introduction

Fluid homeostasis is chiefly controlled by the renin-angiotensin-aldosterone system (Figure 1).1 The juxtaglomerular apparatus (JGA) senses low salt load and low blood pressure (BP). In response, renin is released into the vascular compartment.
where it reacts with angiotensinogen converting it to angiotensin I. Angiotensin I is then converted to angiotensin II via the angiotensin-converting enzyme (ACE). Angiotensin II, a powerful vasoconstrictor, also acts on the adrenal cortex to stimulate the synthesis of aldosterone, which in turn promotes increased uptake of sodium and water and thus the volume expansion necessary to maintain BP. When homeostatic mechanisms fail and the blood volume becomes greater than the limited volume capacity of the vascular compartment, the patient develops high BP.

**Etiology and Epidemiology**

**Primary Hypertension**
Primary hypertension (HTN) appears to be related to hereditary and environmental factors. While the exact mechanism is unclear, the heritable component of HTN has been documented in familial and twin studies.\(^1\) In genetically susceptible persons, environmental factors (dietary sodium, obesity, and stress) appear to increase the likelihood of HTN. Tubular sodium ion concentrations are sensed by specialized cells located in the JGA and signal changes in glomerular filtration rate and renin production.\(^2\) Several populations are also known to be prone to salt sensitivity including African-Americans, those with a family history of HTN, the obese, and the elderly.\(^3-6\) The JGA also has a dense sympathetic nerve supply and sympathetic activity has also been shown to increase renin synthesis.\(^7\) In patients with high BP, defects in sodium transport have also been described.\(^8,9\) Abnormal sodium transport across the cell membrane increases intracellular sodium concentrations, which leads to increased intracellular calcium ion concentration and increased vascular smooth muscle sensitivity to sympathetic stimulation. There is also evidence that persons with HTN may have decreased nitric oxide activity, a vasodilating substance produced by endothelial cells.\(^10\) The mosaic theory holds that multiple factors sustain elevated BP even though initially only one aberrant factor may have been responsible (Figure 2).\(^11\)

Moreover, modified by genetic and environmental factors, BP consistently increases with age. Data suggests that individuals with normal BP at 55 years of age have a 90% lifetime risk of developing primary HTN.\(^12\)

**Secondary Hypertension**
About 5 to 10 percent of patients with high BP have secondary HTN. By definition, secondary HTN has an identifiable and potentially correctable cause (Table 1).\(^13\) Whenever a patient is diagnosed with high BP, one purpose of the initial assessment (i.e., history, physical examination, and basic laboratory testing) is to identify possible secondary causes. The dietary habits and medication profile is also assessed. Excessive consumption of sodium, licorice, and alcohol...
is known to increase the BP. Agents such as estrogen (e.g., oral contraceptives), herbas and supplements (e.g., ephedra, ginseng, and ma huang), illicit drugs (e.g., amphetamines and cocaine), NSAIDs, CNS drugs (e.g., buspirone, carbamazepine, clozepine, fluoxetine, lithium, and tricyclic antidepressants), steroids, and sympathomimetic agents (e.g., decongestants and diet pills) may also affect BP.

The most recent American College of Cardiology/American Heart (ACC/AHA) Association Task Force on Clinical Practice Guidelines for BP management introduced a more conservative threshold for hypertension (Figure 3). As a consequence, the number of patients with HTN has increased from 32 percent to 46 percent (68 million to 103 million) of adults 18 years and older in the United States.

**Table 1. Common Age-based Identifiable Causes of Hypertension.**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>% of Hypertension with an Identifiable Cause</th>
<th>Common Etiologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth to 12 years</td>
<td>70 to 85%</td>
<td>Coarctation of the aorta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Renal parenchymal disease</td>
</tr>
<tr>
<td>13 to 18 years</td>
<td>10 to 15%</td>
<td>Coarctation of the aorta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Renal parenchymal disease</td>
</tr>
<tr>
<td>19 to 39 years</td>
<td>5%</td>
<td>Fibromuscular dysplasia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Renal parenchymal disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thyroid dysfunction</td>
</tr>
<tr>
<td>40 to 64 years</td>
<td>8 to 12%</td>
<td>Aldosteronism</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cushing syndrome</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pheochromocytoma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sleep apnea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thyroid dysfunction</td>
</tr>
<tr>
<td>≥65 years</td>
<td>17%</td>
<td>Atherosclerotic renal artery stenosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hypothyroidism</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Renal failure</td>
</tr>
</tbody>
</table>

**Figure 3. Classification of blood pressure for adults aged 18 or older.**
classification includes new category of “elevated” for those individuals with BP ranging from 120-129/<80. The elevated BP category is not a disease category. Rather, it is a designation intended to identify individuals who require health-promoting lifestyle modifications to reduce their risk of developing HTN.

The basic evaluation recommended for patients with elevated BP includes a review of the medical history, physical examination, and routine laboratory testing. The medical evaluation of patients with documented elevated BP has 3 objectives:

1. To assess lifestyle and identify other cardiovascular risk factors or other concomitant disorders that may affect prognosis or treatment strategies (Table 2).
2. To discover identifiable causes of high BP (Table 1).
3. To assess the presence or absence of target-organ damage (Table 2).

### Table 2. Lifestyle and Cardiovascular Risk Factors and Target-organ Damage.

<table>
<thead>
<tr>
<th>Lifestyle and Cardiovascular Risk Factors</th>
<th>Target-organ Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>Heart</td>
</tr>
<tr>
<td>Age, i.e., men &gt;55 years, women &gt;65 years</td>
<td>Left ventricular hypertrophy</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>Angina/prior MI</td>
</tr>
<tr>
<td>High LDL or low HDL cholesterol</td>
<td>Prior coronary revascularization</td>
</tr>
<tr>
<td>Estimated GFR &lt; 60 mL/min</td>
<td>Heart failure</td>
</tr>
<tr>
<td>Family history of CVD, i.e., men &lt; 55 years of age, women &lt; 65 years of age</td>
<td>Brain</td>
</tr>
<tr>
<td>Microalbuminuria</td>
<td>Stroke, transient ischemic attack</td>
</tr>
<tr>
<td>Obesity, i.e., BMI ≥ 30 kg/m²</td>
<td>Dementia</td>
</tr>
<tr>
<td>Physical inactivity</td>
<td>Chronic kidney disease</td>
</tr>
<tr>
<td>Tobacco usage, particularly cigarettes</td>
<td>Peripheral arterial disease</td>
</tr>
<tr>
<td></td>
<td>Retinopathy</td>
</tr>
</tbody>
</table>

States. The risk of developing HTN varies by race and increases dramatically with age. For adults 45 years of age without HTN, the 40-year risk of developing HTN was 93% for African-American, 92% for Hispanic, 86% for white, and 84% for Chinese adults.

Only 30% of adults with HTN are aware of their condition and only about 60% of those diagnosed with HTN are receiving antihypertensive therapy.

**Diagnosis**

High BP is called the “silent killer” because many people do not realize that they have a problem until HTN puts them at risk for heart disease, stroke, chronic renal failure, peripheral vascular disease, and retinopathy. The diagnosis of primary HTN is based on evidence of elevated SBP and/or DBP in the absence of secondary causes. When SBP and DBP fall into different categories, the higher category is used to determine treatment strategies. The diagnosis includes new category of “elevated” for those individuals with BP ranging from 120-129/<80. The elevated BP category is not a disease category. Rather, it is a designation intended to identify individuals who require health-promoting lifestyle modifications to reduce their risk of developing HTN.

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1. To assess lifestyle and identify other cardiovascular risk factors or other concomitant disorders that may affect prognosis or treatment strategies (Table 2).
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3. To assess the presence or absence of target-organ damage (Table 2).
Determining the Blood Pressure
The accurate measurement of BP is the *sine qua non* for successful patient management. In the everyday practice of medicine (including medical dentistry), the BP should be determined by sphygmonanometry, using a combination of the palpatory and auscultatory methods.\textsuperscript{12,14} A sphygmonanometer consists of a pressure manometer (mercury-gravity or aneroid type), a compressor cuff, and a pressure source. Environmental concerns (mercury spillage) have led to the decreased use of mercury-gravity manometers. When other technology is used, i.e., aneroid or electronic, the devices must be appropriately validated and checked (calibrated) for accuracy as specified by the manufacturer.

Mercury-gravity Manometer
The mercury-gravity manometer consists of a uniform diameter straight glass tube with a reservoir containing mercury. The pressure chamber of the reservoir communicates with the compression cuff through a rubber tube. When pressure is exerted on the mercury in the reservoir it falls, and the mercury in the glass tube rises. Since the weight of the mercury is dependent on gravity, which is constant, a given amount of pressure will always support a column of mercury of the same height. The mercury-gravity manometer is the most accurate, does not require recalibration, and is the standard for measuring BP.

Aneroid Manometer
The aneroid manometer consists of a metal bellows, which is connected to the compression cuff. Variations of pressure within the system cause the bellows to expand and collapse. The movement of the bellows rotates a gear that turns a needle, pivoted on bearings, across a calibrated dial. Since the BP recorded with the aneroid manometer depends upon the elasticity of the metal bellows, it is subject to errors inherent in the elastic properties of the metal. For this reason, the aneroid manometer must be calibrated against a mercury manometer at intervals specified by the manufacturer.

Compressor Cuff
The compressor cuff consists of an inflatable rubber bladder enclosed in an inelastic covering and the pressure source consisting of a rubber hand bulb and pressure control valve. An appropriately sized cuff should cover 2/3 of the biceps; it should have a width that equals at least 40% of the arm’s circumference; and its bladder should be long enough to encircle >80% of the arm.\textsuperscript{12,14} Thus, children require smaller cuffs and obese patients require larger cuffs (Table 3).

Technique
Ideally, the BP should be measured after the patient has rested comfortably for at least 5 minutes (caffeine, exercise, and smoking should have been avoided for 30 minutes) sitting in a chair, with feet on the floor.\textsuperscript{12,14} The examiner’s chair should be arranged so that the patient’s right arm is always and inevitably presented for recording the BP. The arm should be abducted, slightly flexed, and supported by a smooth, firm surface. If the arm is unsupported, the BP may be elevated by as much as 10-12 mmHg due to added hydrostatic pressure induced by gravity. The brachial artery over which the BP is to be recorded should be at a level with the heart (Figure 4).\textsuperscript{12,14}

![Table 3. Cuff selection sizing.](image-url)
A deflated cuff should be applied snugly around the right arm. The lower edge of the cuff should be 2-3 cm above the antecubital fossa. The radial pulse should be palpated and the rate noted. The compression cuff should then be inflated until the radial pulse disappears. The palpated radial pulse obliteration pressure should be used to estimate the SBP. In preparation for the auscultatory determinations the cuff is deflated, the brachial artery is palpated, and the bell of the stethoscope is applied lightly but snugly over it in the antecubital fossa to produce an airtight seal. The cuff is then rapidly inflated to about 20-30 mmHg above the estimated SBP, determined previously by the palpatory method, and then deflated at a rate 2-3 mmHg per second. SBP is the point at which the first Korotkoff sound is heard (onset of phase 1), and the disappearance of Korotkoff sound (onset of phase 5) is used to define DBP (Figure 5).

Changing patterns of BP occur with increasing age. The rise in SBP continues throughout life. In contrast, the DBP rises until about age 50, then levels off over the next decade, and may remain the same or fall later in life. DBP is a more potent cardiovascular risk factor than SBP until age 50; thereafter, SBP is more important. The pulse pressure reflects the numerical difference between the SBP and the DBP. The “hammering” or “pounding” effect of elevated pulse pressure (noted when palpating the radial artery) damages arterial walls, contributes to arteriosclerosis, and leads to target-organ damage. The pulse pressure closely correlates with the SBP and is a reliable cofactor that provides further evidence of significant cardiovascular disease.

**Figure 4.** Proper relationship between the heart and the brachial artery.

**Figure 5.** Characteristics of Korotkoff sounds.
Principles of Medical Management
The goal of antihypertensive therapy is to reduce target-organ damage and death. The 2014 Guideline for the Management of High Blood Pressure in Adults recommends that in the general population ≤60 years of age, if the blood pressure is ≥140/90 mm Hg, the treatment goal should be a BP of ≤140/90 mm Hg; in the general population ≥60 years of age, if the blood pressure is ≥150/90 mm Hg, the treatment goal should be a BP of ≤150/90 mm Hg.

Lifestyle Modification
Adoption of healthy lifestyles is an indispensable part of the management of all patients with high BP. Individuals with Elevated BP are not candidates for drug therapy but should be firmly and unambiguously advised to practice health-promoting lifestyle modifications in order to reduce their risk of developing HTN in the future. Major lifestyle modifications shown to lower BP include weight loss, increased physical activity, a healthy diet, reduced sodium intake, increased potassium intake, and moderation of alcohol consumption.

Pharmacological Strategies
If the target BP is not achieved by lifestyle modification alone, drug therapy is initiated with a thiazide diuretic, a calcium channel blocker, an angiotensin-converting enzyme inhibitor, or an angiotensin receptor blocker. Beta1-adrenergic receptor blocking agents are no longer recommended as first-line therapy. Since more than two-thirds of patients with HTN do not adequately respond to mono-drug therapy, especially if the BP is 20/10 mmHg above goal, many require treatment with two or more agents from different antihypertensive classes. The efficacy of the initial drug therapy is closely monitored and adjusted as necessary until the target BP is achieved. After the target BP is achieved, follow-up visits are usually scheduled at 3- to 6-month intervals.

Risk Assessment
The American College of Cardiology/American Heart Association (ACC/AHA) Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery provide an evidence-based approach to perioperative evaluation. According to these guidelines, the preferred approach to the diagnostic evaluation of the patient at risk of a major adverse cardiac event (MACE) (e.g., MI or sudden death) in association with a noncardiac surgical procedure depends on the interactions of three factors: (1) patient-specific factors, (2) procedure-specific factors, and (3) exercise (functional) capacity of the patient. This approach is applicable to the perioperative evaluation of the patient with HTN requiring dental intervention.

Patient-specific Risk Factors for MACE
Uncontrolled systemic hypertension
The presence of certain cardiovascular conditions or diseases are risk factors for the occurrence of MACE in association with a noncardiac surgical procedure and are categorized as major, intermediate, and minor. Uncontrolled systemic HTN (BP ≥180/110mmHg) is a minor risk factor for MACE in association with noncardiac surgical procedures. Other minor risk factors for MACE in association with a noncardiac surgical procedure are: advanced age (>70 years), abnormal ECG (LV hypertrophy, left bundle branch block, ST-T abnormalities), and rhythm other than sinus.

In general, the patient with HTN of < 180/110 will tolerate the delivery of any routine dental care. However, HTN is a risk factor for stroke and an awareness of the patient's elevated BP should lead to a higher suspicion of coronary artery disease. The ACC/AHA recommends HTN be brought under control prior the delivery of surgical care.

Severely Elevated Blood Pressure
Patients with uncontrolled systemic HTN are at increased risk for the development of severely elevated BP. Severely elevated BP is defined as SBP >180 mmHg or DBP >110 mmHg. The mechanisms that lead to severely elevated BP (which tends to develop gradually over days, weeks, or months) appear to be related to a failure of normal autoregulatory function and an increase in systemic vascular resistance.

For patients with severely elevated BP, dental care should be deferred, and the patient should be referred for medical assessment and management. The patient who is symptomatic
or has evidence of target-organ damage (Table 4), should be transported by EMS to an intensive care unit within one to two hours for immediate treatment and observation. While awaiting transport, supportive measures should be undertaken, but the BP should not be acutely lowered. Normal tissue perfusion in the brain, heart, and kidneys is tightly regulated within a certain range of mean arterial pressure (MAP), despite fluctuations in systemic BP. Abruptly decreasing the MAP can lead to a significant drop in cerebral blood flow and, thus, cerebral ischemia. Patients with severely elevated BP who are asymptomatic and without evidence of target organ damage should be medically evaluated within seven days of presentation.

**White Coat Hypertension**

White coat hypertension (WCH), characterized by transient elevation of SBP of up to 30 mmHg and DBP elevation of up to 20 mmHg, is precipitated by a vigorous sympathetic response in the medical or dental setting. The incidence of WCH is unknown with estimates in the range of 12-50 percent. There is a paucity of information available addressing the number of patients with WCH who eventually develop unequivocal HTN; however, WCH is noted in as many as 20 to 35 percent of patients diagnosed with HTN. Many authorities believe that patients with WCH are at risk for major cardiovascular events. Consequently, a referral to a physician is indicated for a thorough medical evaluation to rule out risk factors for cardiovascular diseases and the presence of target-organ damage. Since BP has a reproducible “circadian” profile, suspected WCH in patients with HTN, and no target-organ damage, are candidates for ambulatory blood pressure monitoring (ABPM).

**Table 4. Potential Signs and Symptoms of Severely Elevated Hypertension.**

<table>
<thead>
<tr>
<th>Symptoms and Signs</th>
<th>First Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restlessness</td>
<td>Elevate head</td>
</tr>
<tr>
<td>Flushed face</td>
<td>Administer oxygen</td>
</tr>
<tr>
<td>Headache, dizziness, tinnitus</td>
<td>6 L/min by nasal cannula</td>
</tr>
<tr>
<td>Visual disturbances</td>
<td>Activate Emergency Medical Services</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>Rapid transport</td>
</tr>
<tr>
<td></td>
<td>Monitor vital signs</td>
</tr>
<tr>
<td>Pulmonary edema or congestive heart failure</td>
<td>Blood pressure, pulse rate and character</td>
</tr>
<tr>
<td>SBP &gt;180 mmHg and/or DBP &lt; 120 mmHg</td>
<td></td>
</tr>
<tr>
<td>A “hammering” pulse</td>
<td></td>
</tr>
<tr>
<td>Altered mental state</td>
<td></td>
</tr>
<tr>
<td>Chest pain</td>
<td></td>
</tr>
<tr>
<td>Myocardial ischemia, infarction, or aortic dissection</td>
<td></td>
</tr>
<tr>
<td>Seizure</td>
<td></td>
</tr>
<tr>
<td>Hypertensive encephalopathy</td>
<td></td>
</tr>
</tbody>
</table>
Orthostatic (Postural) Hypotension

Normally, when patients assume an upright posture, approximately 500 to 700 ml of blood is pooled in the lower extremities and in splanchnic and pulmonary tissues. In response to decreased venous blood return to the heart, there is a transient reduction in cardiac output and reflex stimulation of the cardiopulmonary, aortic, and carotid baroreceptors, which in turn increase sympathetic outflow and inhibit parasympathetic activity. The initial reduction in blood volume and inadequate cardiovascular compensation for the decline in cardiac preload may in susceptible patients (i.e., those with age-related physiologic changes and diseases) and/or those taking medications (alpha-adrenergic blocking agents, alpha-beta-adrenergic blocking agents, diuretics, and nitrates), impair homeostatic mechanisms of BP regulation and lead to orthostatic hypotension (OH).

OH is commonly defined as a supine-to-standing BP decrease >20 mmHg systolic or >10 mmHg diastolic. It has been shown to be a significant risk factor for syncope and falls and it is associated with a 64% increase in age-adjusted mortality compared to a control population. When treating older hypertensive patients, clinicians should be alert to the potential of OH as suggested by historical or clinical evidence of postural unsteadiness, dizziness, or fainting.

In a survey of 2,704 dentists throughout North America, a total of 13,836 medical emergencies occurred in 2704 dental offices within a 10-year period. Of these, 2,475 (17.9%) were diagnosed as postural hypotension. Based on these data, the incidence of OH is 0.02 cases per dental office per year. The lack of prodrome associated with OH should prompt OHCP to be proactive. Since antihypertensive medications and meals can cause major BP reductions in susceptible, especially elderly patients, it is prudent to schedule dental appointments 30 to 60 minutes after the ingestion of medications and meals. Following completion of dental treatment, the patient should be allowed to assume a sitting position for at least two minutes and then allowed to stand. Strategies to manage OH are summarized in Table 5.

Procedure-specific Risk Factors

In medicine, a stepwise approach to assess the risk for MACE in association with noncardiac procedures is both efficacious and cost-effective. Clearly, different procedures are associated with different cardiac risks and these differences predictably reflect such procedure-specific variables as fluid shifts, blood loss, duration of a procedure, and associated psychological and physiological (i.e., general anesthesia-associated) stress levels. Procedures with a risk of MACE of ≤ 1% are

Table 5. Diagnosis and Treatment of Orthostatic Hypotension in the Oral Healthcare Setting.

<table>
<thead>
<tr>
<th>Symptoms and Signs</th>
<th>First Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of prodromal symptoms</td>
<td>Return patient to supine position</td>
</tr>
<tr>
<td>Postural unsteadiness, dizziness, or syncope when the patient assumes an upright</td>
<td>Administer oxygen (6 L/min by nasal cannula)</td>
</tr>
<tr>
<td>posture</td>
<td></td>
</tr>
<tr>
<td>A decline &gt;20 mmHg in the systolic blood pressure OR</td>
<td>Monitor BP and pulse rate</td>
</tr>
<tr>
<td>A decline &gt;10 mmHg in the diastolic blood pressure</td>
<td>When BP returns to baseline values, allow patient to assume a sitting position for two min.</td>
</tr>
<tr>
<td></td>
<td>Allow patient to stand for two minutes</td>
</tr>
<tr>
<td></td>
<td>Medical referral as appropriate for evaluation</td>
</tr>
</tbody>
</table>
considered low-risk, while those with a risk of MACE of ≥1% are considered high-risk. There are no adequately controlled or randomized clinical trials that help define dental procedure-related hypertensive or other cardiovascular risks. However, in a retrospective study in Seattle and King Counties, Washington, with a combined population 1.5 million based on the 1990 census, over a period of seven years (1990-1996), only six cardiac events were documented in 976 community-based dental practices at an annual rate of <0.002 per dental practice (note: per dental practice not per dentist). Based on this evidence, it can be concluded that dental procedures, in general, are low- or very low-cardiac risk procedures. Several other investigators found no significant BP increase during dental treatment. In one study comparing the blood pressure during dental examination and dental treatment, a mean difference of 8 mmHg in SBP and 1 mmHg in DBP was noted with the most traumatic procedure (oral surgery). Mean changes related to restorative dentistry were 4 mmHg in SBP and 3 mmHg in DBP. Another report concluded that while the actual administration of a local anesthetic agent may produce a transient increase in BP, the BP decreases after the needle is removed from the mouth.

Finally, a systematic review of the literature concluded that, although adverse events may occur in uncontrolled hypertensive patients, the use of epinephrine in local anesthetic agents has minimal effect on BP. However, the BP should be monitored closely if general anesthesia is being administered to hypertensive individuals because of potential wide fluctuations in BP and the risk of hypotension in those receiving antihypertensive drugs.

**Exercise Capacity**
Perioperative risk assessment should also seek to determine the patient’s functional capacity. An assessment of an individual’s capacity to perform a spectrum of common daily tasks has been shown to correlate well with maximum oxygen uptake by treadmill testing, i.e., ergometric exercising. A patient classified as high risk because of known CAD but who is asymptomatic and runs 30 minutes daily, clearly has good functional capacity. In contrast, a patient without a history of cardiovascular disease but poor functional capacity may present a perioperative risk. Functional capacity is expressed in metabolic equivalents (METs).

One MET is defined as baseline oxygen demand by a 40-year-old, 70-kg, man in a resting state (i.e., 3.5 ml of oxygen per kg per minute) without experiencing shortness of breath, diaphoresis, pallor, and tightness in the chest. A person who can climb two flights of stairs has a functional capacity of ≥4 METs, a person who can participate in moderately strenuous recreational activities, e.g., golf, bowling, dancing, or doubles tennis, has a functional capacity of ≥8 METs, while a person who can participate in strenuous recreational activities, e.g., swimming, singles tennis, skiing, football, has a functional capacity >10 METs.

Investigators, starting with the proven premise that functional capacity is a simple and reliable index to estimate cardiac function, evaluated the cardiovascular effects of infiltration anesthesia compared with those produced by ergometric exercising. The hemodynamic effects of infiltration anesthesia with 0.045 mg of epinephrine were found to be less than those produced by ergometric-stress testing at 25 watts in young patients and at 15 watts in older subjects. The workload of ergometric-stress testing at these levels is less than 4 METs.

Based on this report, 4.5 cc of a local dental anesthetic agent with epinephrine 1:100,000 can be administered safely to patients whose functional capacity is equal to or greater than 4 METs. In this study, there were no differences in hemodynamic responses (evaluated by echocardiography) between normotensive and hypertensive patients.

**Preventive Medicine – a Wellness Program in the Oral Healthcare Setting**
To reduce the societal burden of HTN from rising, primary preventive measures should be implemented to reduce or minimize casual factors in the population, particularly in individuals with elevated hypertension. The oral healthcare professional (OHCP) must be
committed to enhancing BP control through (1) reinforcing the message about the risks of HTN, (2) educating patients about lifestyle interventions, and (3) promoting adherence to treatment to achieve goal BP.\textsuperscript{12}

**BP Screening and Follow-up**

The BP is a reliable indicator of cardiovascular function and correlates well with a number of other diseases and conditions (secondary causes). The natural history of HTN is well understood and there is evidence that early intervention reduces the morbidity and mortality associated with HTN. BP screening for HTN in oral healthcare settings should be a systematic and ongoing activity. The BP should be recorded on all new patients at the time of initial appointment and at all subsequent appointments. Minimally, follow-up based on initial BP measurements for adults without acute end-organ damage should be based on the recommendations in Table 6.\textsuperscript{14}

**Lifestyle Modifications**

Beginning with a BP of 115/75 mmHg, cardiovascular disease (CVD) risk doubles for each increased increment of 20/10 mmHg. Those who are normotensive (BP <120/80 mmHg), at age 55 will have a 90% lifetime risk of developing HTN and adoption of a healthy lifestyle is critical to reduce this risk.\textsuperscript{14} Patients with Elevated BP (BP 120-129/<80) are not candidates for drug therapy and should be firmly and unambiguously advised of health-promoting lifestyle modifications to reduce their risk of progressive rise of BP in the future.\textsuperscript{14,18} Table 7 presents recommended lifestyle modifications to reduce the risk of developing HTN.\textsuperscript{14,18} 

**Opportunities and Challenges**

Considering that in 2009, 62\% of adults ages 18-64 and 60\% of adults ages 65 or older visited a dentist, OHCPs are in a unique position to play a pivotal role in a hypertension-related wellness program.\textsuperscript{40} Data from patients seeking dental treatment suggest that patients are willing to participate in medical screening by dentists.\textsuperscript{41,42} The majority of OHCPs consider medical screening in oral healthcare settings important, but report inadequate knowledge and training as barriers to incorporate such activities into practice.\textsuperscript{43}

The Committee on the Future of Dental Education, Institute of Medicine, declared that “oral healthcare is part of comprehensive healthcare” and recommended to “increase the knowledge of dental faculty in clinical medicine so that they...can impart medical knowledge to dental students and serve as role models for them.”\textsuperscript{44} Therefore, it is axiomatic that OHCPs should master the broad scope, not necessarily the depth, of knowledge required of a family physician. The proposition may be viewed as revolutionary. Actualization of this concept, 

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**Table 6. Recommendations for Minimal Follow-up Based on Initial Blood Pressure Measurements for Adults without Acute End-organ Damage.**

<table>
<thead>
<tr>
<th>Initial BP (mmHg)</th>
<th>Follow-up Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal &lt; 120/80</td>
<td>Provide advice about lifestyle modifications and follow-up in 1 year.</td>
</tr>
<tr>
<td>Elevated BP = 120-129/&lt;80</td>
<td>Provide advice about lifestyle modifications and follow-up in 3-6 months.</td>
</tr>
<tr>
<td>Stage 1 HTN = 130-139/80-89</td>
<td>Refer for medical evaluation within 1 month.</td>
</tr>
<tr>
<td>Stage 2 HTN ≥ 140/90</td>
<td>Refer for medical evaluation within 1 month.</td>
</tr>
<tr>
<td>Severely elevated HTN ≥ 180/110</td>
<td>Refer for medical evaluation within 1 week.</td>
</tr>
</tbody>
</table>
however, is inherently evolutionary. The objective can be achieved in accordance with the ethics of the profession and applicable laws.

**Conclusion**

When treating patients with hypertension in the oral health care setting, the goals are to develop and implement timely preventive and therapeutic strategies compatible with the patient's physical and emotional ability to undergo and respond to dental care, the patient's social and psychological needs and desires; and limitations imposed on the clinical process by disease-specific, procedure specific, and functional capacity-related risk factors.

In view of the available data suggesting that blood pressure-related risks associated with

<table>
<thead>
<tr>
<th>Modification</th>
<th>Recommendation</th>
</tr>
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<tbody>
<tr>
<td>Weight Loss</td>
<td>Target ideal body weight. But aim for at least a 1-kg reduction in body weight for most adults who are overweight. Expect about 1 mm Hg for every 1-kg reduction in body weight.</td>
</tr>
<tr>
<td>Healthy diet</td>
<td>Consume a diet rich in fruits, vegetables, whole grains, and low-fat dairy products. Reduce intake saturated and total fat.</td>
</tr>
<tr>
<td>Reduced intake of dietary sodium</td>
<td>Target goal is &lt;1500 mg/d, but aim for at least a 1000-mg/d reduction in most adults.</td>
</tr>
<tr>
<td>Enhanced intake of dietary potassium</td>
<td>Aim for 3500–5000 mg/d, preferably by consumption of a diet rich in potassium.</td>
</tr>
</tbody>
</table>
| Physical activity         | **Aerobic**  
|                           | • 90–150 min/wk  
|                           | • 65%-75% heart rate reserve  
|                           | **Dynamic Resistance**  
|                           | • 90–150 min/wk  
|                           | • 50%-80% 1 rep maximum  
|                           | • 6 exercises, 3 sets/exercise, 10 repetitions/set  
|                           | **Isometric Resistance**  
|                           | • 4 x 2 min (hand grip), 1 min rest between exercises  
|                           | • 30%-40% maximum voluntary contraction, 3 sessions/wk, 8–10 wk |
| Moderation in alcohol intake | In individuals who drink alcohol, reduce alcohol to:  
|                           | • Men: ≤2 drinks daily  
|                           | • Women: ≤1 drink daily  
|                           | One “standard” drink contains roughly 14 g of pure alcohol, which is typically found in 12 oz of regular beer (usually about 5% alcohol), 5 oz of wine (usually about 12% alcohol), and 1.5 oz of distilled spirits (usually about 40% alcohol) |
dental procedures appears to be low or very low, once the need for dental intervention has been established, the assessment of patient-specific factors and the patient’s functional capacity provide the best information for cardiovascular risk stratification. Finally, OHCP are in a unique position to play a pivotal role in a hypertension-related wellness program.
1. Primary HTN appears to be related to heredity modified by environmental factors such as ________.
   A. dietary sodium
   B. obesity
   C. stress
   D. All of the above.

2. All of the following statements relative to secondary HTN are correct EXCEPT which one?
   A. About 5-10% of patients with high BP have secondary HTN.
   B. Secondary HTN has an identifiable and potentially correctable cause.
   C. Alcohol has a beneficial effect on secondary HTN.
   D. Whenever a patient is diagnosed with high BP, one purpose of the initial assessment is to identify possible secondary causes.

3. Which of the following statements about HTN in the U.S. is correct?
   A. More than 103 million people in the U.S., i.e., 46% of adults, have HTN.
   B. New guidelines pertaining to HTN definitions are more conservative than prior guidelines.
   C. About 30% of American adults are aware of their condition.
   D. All of the above.

4. According to the most current guidance, a patient with a SBP ≥160 or DBP ≥100
   ____________.
   A. has stage 2 HTN
   B. has elevated BP
   C. has stage 1 HTN
   D. will not benefit from health-promoting lifestyle modifications to reduce their HTN

5. The basic evaluation for patients with elevated BP includes ____________.
   A. a review of the medical history
   B. physical examination
   C. routine laboratory testing
   D. All of the above.

6. The mercury manometer is the ____________.
   A. most accurate
   B. does not require recalibration
   C. standard for measuring BP
   D. All of the above.

7. All of the following statements about the technique of measuring the BP are correct EXCEPT which one?
   A. The patient's arm should be abducted, slightly flexed, and supported by a smooth, firm surface.
   B. Ideally, the BP should be measured after the patient has rested comfortably for at least 5 minutes.
   C. The brachial artery over which the BP is to be recorded should be at a level with the heart.
   D. SBP is the point at which the first Korotkoff sound is heard (onset of phase 1), and the disappearance of Korotkoff sound (onset of phase 5) is used to define DBP.
8. **All of the following statements are correct relative to the changing patterns of BP with increasing age EXCEPT which one?**
   A. The rise in SBP continues throughout life.
   B. The DBP rises until age 50, then levels off over the next decade, and may remain the same or fall later in life.
   C. DBP is a more potent cardiovascular risk factor than SBP after age 50.
   D. The pulse pressure reflects the numerical difference between SBP and DBP.

9. **Major lifestyle modifications shown to lower BP include __________.**
   A. physical activity
   B. adopting a diet rich in fruits, vegetables, and low-fat dairy products
   C. reduction of dietary sodium
   D. All of the above.

10. **All of the following statements are correct with respect to the pharmacological strategies to treat high BP EXCEPT which one?**
    A. If goal BP is not achieved with lifestyle modification drug therapy is initiated with a thiazide diuretic, a calcium channel blocker, an angiotensin-converting enzyme inhibitor, or an angiotensin receptor blocker.
    B. More than two-thirds of hypertensive individuals cannot be controlled by one drug alone, especially if the BP is 20/10 mmHg above goal.
    C. Once drug therapy is initiated, patients require follow-up and adjustment of medications until the BP is at target
    D. After the BP is at goal and stable, further follow-up visits are not necessary.

11. **According to the ACC/AHA, the preferred perioperative cardiovascular risk assessment of patients about to undergo a noncardiac procedure should be based on __________.**
    A. patient-specific factors
    B. procedure specific factors
    C. exercise (functional) capacity of the patient
    D. All of the above.

12. **Which of the following statements is correct with respect to hypertension-related cardiovascular risk of patients undergoing noncardiac procedures?**
    A. It is well established that BP in the range of 140/90 - 179/109 mmHg is not an independent risk factor for MACE in association with noncardiac procedures.
    B. In association with other recognized minor predictors/markers for cardiovascular disease and the presence of clinical risk factors, an awareness of the patient's elevated BP should lead to a higher suspicion of CAD.
    C. Patients with uncontrolled HTN should be referred for routine medical evaluation and risk modification.
    D. All of the above.

13. **All of the following statements are correct with respect to severely elevated BP EXCEPT which one?**
    A. Patients with severely elevated BP are at increased risk for the development of uncontrolled systemic HTN.
    B. Severely elevated BP is defined as SBP >180 mmHg or DBP >110 mmHg.
    C. When patients present with severely elevated BP, clinicians should defer dental care.
    D. Severely elevated BP tends to develop gradually over days, week, or months.
14. All of the following statements are correct with respect to the asymptomatic patient with severely elevated BP EXCEPT which one?
   A. Routine dental care delivery should be deferred.
   B. The patient is at increased risk for stroke.
   C. The patient must be transported via EMS to the cardiac ICU.
   D. The patient should be evaluated by a physician within 1 week.

15. All of the following statements are correct with respect to the symptomatic patient with severely elevated BP EXCEPT which one?
   A. The patient should not be allowed to drive himself to the hospital.
   B. Patients with signs and symptoms of target organ damage require admission to an intensive care unit within one to two hours for immediate treatment.
   C. In the emergent setting, i.e., the oral healthcare setting, the BP should be acutely lowered while waiting for the EMS to arrive.
   D. Signs and symptoms of target-organ damage include visual disturbances, dyspnea, chest pain, and seizure.

16. All of the following statements are correct with respect to white coat hypertension EXCEPT which one?
   A. WCH is characterized by transient elevation of SBP of up to 20 mmHg and DBP elevations by up to 10 mmHg precipitated by a vigorous sympathetic response to the medical or dental setting.
   B. WCH is noted in about 20-35% of patients diagnosed with HTN.
   C. The risk of major cardiovascular events in patients with WCH is equivocal.
   D. Patients suspected of WCH and no evidence of target organ damage are candidates for ambulatory blood pressure monitoring (ABPM).

17. All of the following statements are correct with respect to orthostatic hypertension EXCEPT which one?
   A. OH is commonly defined as a supine-to standing BP decrease >20 mmHg systolic or >10 mmHg diastolic.
   B. OH is one of the least common medical emergencies in the oral healthcare setting.
   C. Because OH has been shown to be a significant risk factor for syncope, falls, and increased age-adjusted mortality, patients with OH should be referred to physician for focused examination and appropriate risk modification.
   D. Since antihypertensive medications and meals can cause major BP reductions in susceptible patients, it is prudent to schedule dental appointment 30-60 minutes after ingestion of medications and meals.

18. All of the following statements are correct with respect to procedure-specific risk factors EXCEPT which one?
   A. The BP should be monitored closely if general anesthesia is being administered to individuals on antihypertensive medications because of potential wide fluctuation in BP and the risk of a hypertensive crisis.
   B. There are no adequately controlled or randomized clinical trials that help define dental procedure-specific hypertensive or other cardiovascular risks.
   C. There is some evidence that in general the risks associated with dental procedures are comparable to those associated with a spectrum of medical procedures provided in ambulatory settings.
   D. A systematic review of the literature concluded that the use of epinephrine in local anesthetic agents has minimal effect on BP.
19. **All of the following statements are correct with respect exercise capacity EXCEPT which one?**
   A. Exercise (functional) capacity, expressed in METs, is an individual’s capacity to perform a spectrum of common daily tasks.
   B. A person who can climb a flight of stairs, without experiencing shortness of breath, diaphoresis, pallor, or tightness in the chest has a functional capacity of 8 METs.
   C. The hemodynamic effect of infiltration anesthesia with 0.045 mg of epinephrine was found to be equivalent to 4 METs.
   D. 4.5 cc of local anesthetic agent with epinephrine 1:100,000 can be administered safely to a patient whose functional capacity is ≥4 METs.

20. **Within the context of an appropriate follow-up program for BP monitoring, which of the following is appropriate for a patient with an initial BP reading of < 120/80?**
   A. Provide advice about lifestyle modifications and minimally reevaluate BP in two years.
   B. Provide advice about lifestyle modifications and minimally reevaluate BP in one year.
   C. Provide advice about lifestyle modifications and reevaluate BP in two months.
   D. Refer for medical evaluation within one month.
References


**Additional Resources**
- No Additional Resources Available

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