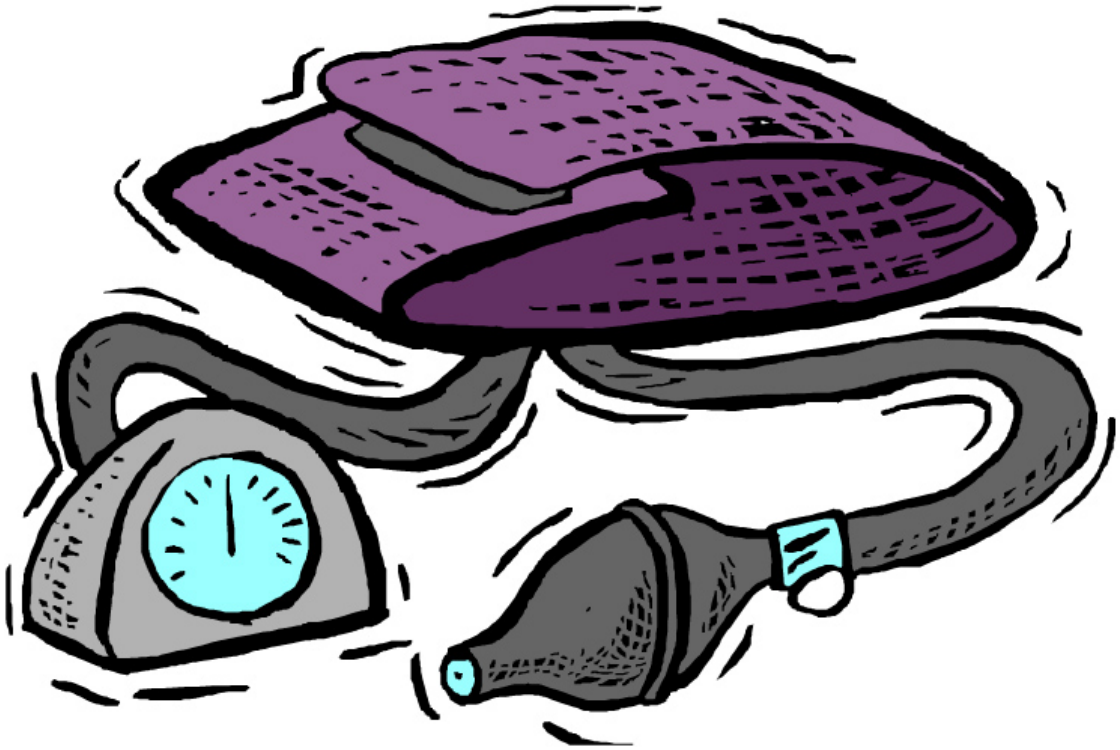
Blood Pressure Measurement

Standardization Protocol



HEART DISEASE &
STROKE PREVENTION PROGRAM
UTAH DEPARTMENT OF HEALTH

www. hearthighway.org
801-538-6141

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Table of Contents

1. What is Blood Pressure? 2
2. Hypertension Overview 4
3. Non-Modifiable Risk Factors 5
4. Modifiable Risk Factors 6
5. Importance of Accuracy 8
6. Knowing the Equipment 9
7. Automated Blood Pressure Cuffs 11
8. Mercury Manometers 12
9. Pulse Obliteration Technique 13
10. Treatment and Referral for Adults 19
11. Treatment and Referral for Individuals over age 60 21
12. Treatment and Referral for Children 23
13. References 26

Appendices

A: Following the DASH Diet

B: Weigh In For Better Health

C: Algorithm for Treatment of Hypertension

D: Blood Pressure Levels by Gender, Age and Height Percentile

E: CDC Growth Chart for Boys

F: CDC Growth Chart for Girls

G: Blood Pressure Management Quiz

H: Blood Pressure Practicum

What is Blood Pressure?

Key Abbreviations

BP- Blood Pressure
SBP- Systolic Blood Pressure
DBP- Diastolic Blood Pressure
JNC7- Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation and Treatment of High Blood Pressure
CVD- Cardiovascular Disease
BMI- Body Mass Index
ABPM- Ambulatory Blood Pressure Monitoring
ACE- Angiotensin-converting enzyme
β-blockers- Beta-blockers
LVH- Left Ventricular Hypertrophy

Definitions

Blood Pressure- measurement of the force exerted by blood against the walls of the arteries.

Systolic Blood Pressure- measurement of the pressure when the heart is contracted (systole)[13]. The systolic pressure indicates the maximum amount of work/force the heart has to perform with each stroke in order to move blood through the arteries [13]. It also may indicate how compliant the arteries are in order to accommodate blood; it indicates how "elastic" they are [13, 18].

Diastolic Blood Pressure- the pressure in the large arteries during the relaxation of the left ventricle (heart) [17]. The diastolic pressure indicates the amount of pressure the heart must overcome in order to generate the next beat [13]. Two thirds of the time in the cardiac cycle is spent in diastole. This generates the equation for mean arterial blood pressure. Mean arterial blood pressure = (SBP- DBP)/ 3 + DBP.

Hypertension- PERSISTENT elevation of either diastolic or systolic blood pressure [24].

Essential (Primary) Hypertension - high blood pressure with no identifiable cause [24].

Secondary Hypertension – high blood pressure with a known cause [23].
Identifiable causes [23]

- Sleep apnea
- Drug-induced or related causes
- Chronic kidney disease
- Primary aldosteronism- excessive aldosterone hormone in the blood [25]
- Renovascular disease- disease of the blood vessels of the kidneys [25]
- Chronic steroid therapy and Cushing's Syndrome
- Pheochromocytoma- a tumor in the medulla of the adrenal glands [25]

- Coarctation of the aorta- narrowing of the aorta [25]
- Thyroid or parathyroid disease

Korotkoff Sounds - Distinct blood pressure sounds were first described by a Russian physician named Korotkoff. He identified the following five phases in blood pressure:

- First Phase- a clear tapping sound [30]. The onset of the sound of two consecutive beats is considered systolic blood pressure [15, 30].
- Second Phase- a tapping sound, followed by a murmur [30]. Usually 10 - 15 mm Hg below first phase and lasting for 14 - 20 mm Hg. In some instances, such as when the cuff is inflated too slowly, part or all of the sounds of this phase may be absent, resulting in a period of silence known as an auscultatory gap [30].
- Third Phase- a loud, crisp tapping sound.
- Fourth Phase- abrupt, distinct muffling of sound, gradually decreasing in intensity [30].
- Fifth Phase- the disappearance of sound, considered diastolic blood pressure [28, 39]. This is defined as 2 points below where the last sound was heard through the stethoscope.

Hypertension Overview

Importance of Hypertension

- Hypertension is a major contributing factor in 68% of all first heart attacks and 75% of all first strokes [11]. Almost one third (28%) of Utah deaths are due to heart disease and stroke [40].
    - The primary risk factors for heart disease and stroke are [38]:
        - Smoking
        - High Blood Cholesterol
        - Hypertension (high blood pressure)
        - Obesity
        - Sedentary Lifestyle

Characteristics of Hypertension

- There are no characteristic signs or symptoms of hypertension [24].
- There is no cure for hypertension, unless a specific cause is found and corrected. Medical therapy and/or lifestyle modification can control hypertension and in many cases prevent complications [24].
- The major consequences of uncontrolled high blood pressure are target organ damage to [38]:
    - Heart
    - Brain
    - Kidneys
    - Eyes
- High blood pressure can only be detected by ACCURATE BLOOD PRESSURE MEASUREMENT [38].
- Individuals with pre-hypertension (those in the range of 130-139/80-89 mm Hg) are at twice the risk to develop hypertension as those with lower values [38].
- In the U.S., 30% of the population are unaware they have hypertension.
- The higher the blood pressure, the greater the chance of heart attack, heart failure, stroke and kidney disease.
- For individuals 40-70 years of age a blood pressure increase of 20 mm Hg in systole or 10 mm Hg in diastole, doubles the risk of CVD.
- The Framingham Heart Study showed that individuals who are normotensive (within normal blood pressure ranges) at age 55 have a 90% lifetime risk for developing hypertension later in life [38].
- Anti-hypertensive therapy has been associated with reductions in stroke incidence averaging 35-40%; heart attack incidence averaging 20-25%; and more than 50% for heart failure [38].

Non- Modifiable Risk Factors

Family History

Studies show that the tendency to develop high blood pressure runs in families. People who have parents, siblings, or close relatives (aunts, uncles and grandparents) with hypertension are at greater risk of developing the disease. The chances of getting hypertension are about twice as high if either parent or a sibling has hypertension.

Increasing Age

As people get older they are at greater risk to develop hypertension due to:

- Increased weight
- Reduced elasticity of arteries
- Reduced competence of the kidneys

Race

Racial and ethnic minorities are at greater risk than Caucasians for developing hypertension and for uncontrolled blood pressure. The prevalence of hypertension in the African American population is almost twice that in the white population and control rates are the lowest in Mexican American and Native American groups.

Diabetes

The prevalence of high blood pressure among adults with diabetes is about twice that of all adults. Blood pressure levels should be maintained at less than 130/80 mm Hg in persons with diabetes.

Gender

Hypertension more commonly occurs in males until about age 50. From the ages of 50 to 60 the occurrence of hypertension is about equal in males and females. After age 60, hypertension more commonly occurs in females.

Modifiable Risk Factors

Overweight and Obesity

There is a positive correlation between elevated body mass index (BMI) and blood pressure. However, not all obese people have high blood pressure and not all persons with hypertension are obese. Individuals who are overweight are more prone to develop severe complications of high blood pressure than those who are not overweight. Obesity (BMI $\geq$ 30 kg/m^2) is an increasingly prevalent risk factor for the development of hypertension and cardiovascular disease (CVD). For information on overweight and obesity see Appendix B.

Metabolic Syndrome

Individuals with metabolic syndrome are at an increased risk for coronary heart diseases and diabetes [1]. Metabolic syndrome is defined as the presence or three or more of the following conditions:

- Elevated waist circumference (men equal to or greater than 40 inches; women equal to or greater than 35 inches) [1]
- Elevated triglycerides (equal to or greater than 150 mg/dL) [1]
- Reduced HDL cholesterol (men less than 40 mg/dL; women less than 50 mg/dL [1]
- Elevated blood pressure (equal to or greater than 130/85 mmHg) [1]
- Elevated fasting glucose (equal to or greater than 100 mg/dL) [1]

Physical Activity

Some evidence exists that blood pressure may be lowered by increasing physical fitness. It is recommended that all healthy adults engage in moderate physical activity (aerobic activity) such as walking, running, bicycling and swimming for 30 minutes on most days of the week.

Sodium Intake

Studies have shown that diets containing excessive sodium can produce hypertension in genetically predisposed animals and probably people. Low sodium diets have been known to lower blood pressure in some hypertensive patients.

About 50% of our sodium intake comes from salt because table salt is 40% sodium. It is recommended that no more than two grams (2,000 milligrams) of sodium or five grams (5,000 milligrams) of salt be consumed daily. On average, Americans eat 5-6 times that amount.

Did you know?

- One "Quarter Pounder" from McDonald's has 690 mg sodium.
- One banana has 1 mg sodium.
- One baked potato has 4 mg sodium.
- One large dill pickle has 1,928 mg sodium.

Also, be-ware of "hidden sodium", sodium in commonly eaten foods that we may not think of as having lots of sodium. Some examples of these foods are:

- Sodium erythorbate in hot dogs
- Sodium citrate in jelly or luncheon meat

- Sodium caseinate in whipped topping
- Sodium propionate in cheese or bread
- Sodium benzoate in condiments
- Sodium bicarbonate in breads or cakes
- Sodium alginate in ice cream or chocolate milk

DASH Diet (Dietary Approaches to Stop Hypertension)

An eating plan low in saturated fat, total fat and cholesterol, rich in fruits, vegetables and low fat dairy products, has been found to help lower elevated blood pressure. This eating plan is rich in calcium, potassium and magnesium as well as protein and fiber (see Appendix A).

Use Alcohol in Moderation

High alcohol intake may also contribute to the development of hypertension. Men should limit their intake to no more than 2 drinks per day and women or lighter men should limit their intake to no more than 1 drink per day. One drink is considered 12 ounces of beer, 5 ounces of wine or 1.5 ounces of 80-proof whiskey.

Oral Contraceptives

Most women taking oral contraceptives experience a small but detectable increase in both SBP and DBP, usually within normal range. Hypertension has been reported to be two to three times more common in women taking oral contraceptive pills for five years or longer than women not taking oral contraceptives. The risk appears to increase with age, duration of use and perhaps body mass. Risk of stroke greatly increases if a woman smokes and takes oral contraceptives. Women taking oral contraception should have their blood pressure checked regularly. Oral contraceptives cause evident hypertension in 5% of the women who take them [17].

Stress Management

Stress does not actually cause hypertension, but prolonged and intense stress may contribute to its development. Any emotionally stimulating activity will temporarily raise blood pressure. According to an article in the Journal of Human Stress, "there is limited evidence of a potential relationship between stress and some types of hypertension" . . . "evidence is fragmented and inconclusive yet certainly suggestive." However, even the most relaxed person can have high blood pressure.

Smoking

Smoking is the most important preventable cause of premature death in the United States [2]. Smoking increases blood pressure and leads to coronary heart disease [2]. A blood pressure should never be taken on a client who has smoked in the last 30 minutes, as the reading will be elevated. It is recommended that a patient never smoke and if they do currently smoke to quit. A patient can be referred to the Utah Tobacco Quit Line at 1-888-567-TRUTH for help in quitting.

Importance of Accuracy

Blood pressure values are used for diagnosis, determination of prognosis and for initiating, evaluating and discontinuing treatment. With such widespread interest in and reliance on the procedure of blood pressure measurement, standardization of all personnel and equipment is necessary to minimize the major sources of error that contribute to variation in blood pressure measurement, and may adversely influence clinical treatment decisions. This standardization should include: selection of quality blood pressure measuring equipment, proper maintenance of equipment, accuracy checks (calibration) and instruction and accreditation in the measurement techniques of all personnel directly involved in blood pressure measurement as recommended by the American Heart Association and The National High Blood Pressure Coordinating Committee [31, 3].

Community or Screening Setting

- Organize the clinical area to be conducive to accurate blood pressure measurement.
- Allow adequate space for registration, a five-minute rest period for the client, and a place to wait for repeat measurements.
- Ensure the room is quiet, so the blood pressure sounds can be heard.
- Ensure the measurement area and equipment are arranged to enable correct body positions and an unobstructed view of the measurement gauge.
- Ensure that health education is provided based on the current readings.

Emergency or Acute Care Setting

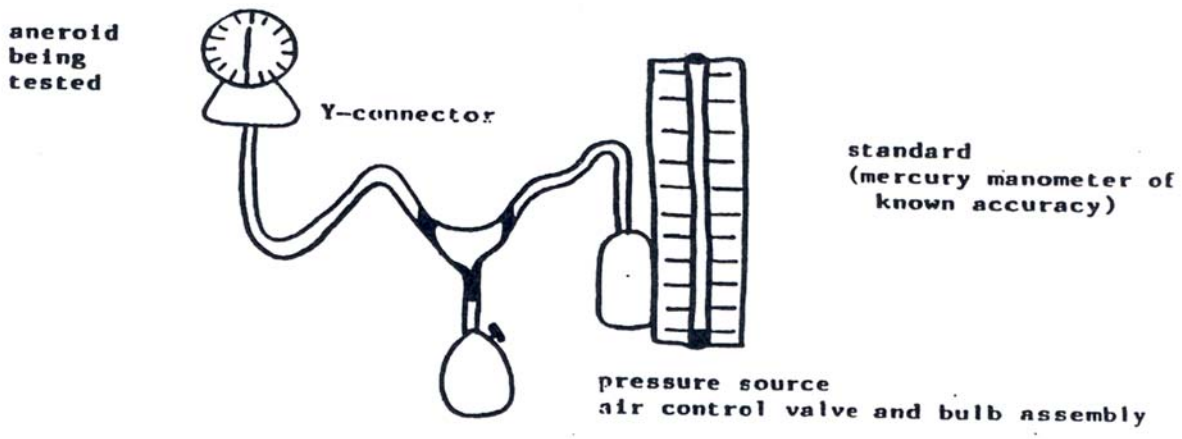
- Blood pressure is a common diagnostic measurement. The first sitting blood pressure measurement taken and recorded as a baseline must be accurate and repeatable. All subsequent blood pressures are evaluated against it.
- A severe elevation in Blood Pressure can lead to a hypertensive urgency or emergency.
    - Hypertensive urgency is a rise in blood pressure usually $\geq$ 180/120 mmHg that is for the most part asymptomatic, the patient may have a headache [22]. There are also no signs of end-organ damage in hypertensive urgency [22].
    - Hypertensive emergency is an acute, life-threatening increase in blood pressure, usually $\geq$ 180/120 mmHg [14]. Some things that would be considered hypertensive emergencies are hypertensive encelopathy, retinal hemorrhages, papilledema and acute renal failure [22]. Patients with a hypertensive emergency are treated more aggressively than patients with hypertensive urgency [22].
- An abnormally low reading can be due to shock or hemorrhage.
- Pulse pressure is the difference between the systolic and the diastolic readings. An increased pulse pressure can be caused by fever, anemia, hot weather, exercise, or anxiety. It is normally found in children and young adults [21]. A decreased pulse pressure can be caused by shock, heart failure, lung or aortic obstruction, or antihypertensive medications. It is not a common observation in normal persons.

Knowing the Equipment

Sphygmomanometer

A standard mercury sphygmomanometer or a properly calibrated aneroid sphygmomanometer may be used. Equipment should be calibrated and standardized every six months.

How to calibrate an aneroid sphygmomanometer using a y-connector tube:



- The air control valve and the bulb assembly serve as the pressure source. A mercury manometer of known accuracy is used as a standard. (Top of the meniscus should be at 0.)
- Pump the pressure to 250 mm Hg.
- Deflate stopping at 10 mm Hg intervals over the entire range.
- Readings should be the same on both instruments at all levels [10, 40].
- Differences at any pressure level should not be greater than ±3 mmHg according to the National Bureau of Standards [43].
- A validated electronic device can be used. Finger and wrist monitors are inaccurate. (See page 12).

Blood Pressure Cuff

Recommended Bladder Dimensions for Blood Pressure Cuff

Cuff Name	Arm Circumference at Midpoint (cm)	Bladder Width (cm)	Bladder Length (cm)
Newborn	5-7.5	2.5-4.0	5-9
Infant	7.5-13	4-6	11.5-18
Child	13-20	7.5-9	17-19
Adult	17-32	11.5-13	22-26
Large Adult	32-42	14-15	30.5-33
Adult Thigh	42-50+	18-19	36-38

1. A selection of appropriate sphygmomanometer cuff sizes is necessary to correspond to size of limb. This is of critical importance if accurate measurements are to be obtained. Cuff size should be selected according to build and weight not age [33, 37].

2. The bladder within the cuff should be wide enough to cover 80% of the upper arm (between the top of the shoulder and the elbow).
3. Midpoint of arm is defined as half the distance from the shoulder (acromion) to the elbow (olecranon).
4. If the cuff is too small for persons with very large limbs, the blood pressure should be measured in the leg or forearm by a health professional familiar with the correct procedure for this measurement.
5. If the cuff is too short the reading will be erroneously high and if the cuff is too wide the reading will be erroneously low [17].

Special Note: The right arm should be used for measurement as a way to standardize all blood pressures. Sphygmomanometers are designed for right arm measurements [42]. Brachial artery pressure may normally differ between left and right arm measurements by as much as 10 mm Hg and is usually higher in the right arm [6]. Use of right arm for standardization and consistency of readings is recommended. In certain circumstances the left arm may need to be used. These include: amputation, mastectomy on the right side, intravenous infusion, breast or auxiliary surgery on that side, arteriovenous shunt, or injured or diseased limb.

Stethoscope

The diaphragm or the bell of the stethoscope can be used to listen for the sounds of the blood pressure. The earpieces on the stethoscope should point forward and fit comfortably in the ears, so that the person can listen without hearing any other noises that could interfere with the accuracy of the measurement.

Automated Blood Pressure Cuffs

Most automated blood pressure devices are now accurate enough for use in the clinical setting [27]. Automated blood pressure cuffs are sometimes preferred in physicians' offices because they can eliminate some of the human errors that can occur, such as when the person taking the blood pressure cannot hear the sounds.

Automated Blood Pressure Cuffs work in three different ways:

1. Detection of arterial blood flow by ultrasound [28]
2. Detection of arterial blood flow by the Oscillometric Method [28]
3. Detection of Korotkoff sounds by microphone [28]

The most common of these is the Oscillometric Method. The cuff is inflated above the systolic pressure. During deflation, a sensor in the monitor detects air pressure changes that correspond to arterial volume changes. Based on the oscillations, the machine calculates the systolic and diastolic pressures [4].

Each automated blood pressure device is different. Before using any automated cuff be sure to read the instruction manual and follow the manufacturer's advice on cuff placement and use of the machine. When reading the instructions remember to use the proper technique and placement of the cuff (i.e. use the right arm, don't allow the cuff to touch any clothing, use the correct cuff size, etc.)

Mercury Manometers

There is a lot of debate in the medical community regarding the use of mercury manometers. Traditionally, the mercury manometer has been the "Gold Standard" because it is easier to calibrate and thus, more accurate than aneroid manometers. However, recently there has been discussion on the safety of patients and providers who could be exposed to mercury poisoning, if a manometer should break. Hospitals seeking Joint Council on Accreditation of Healthcare Organizations (JCAHO) certification must dispose of their mercury instruments and purchase other options.

The cost of disposing of mercury is much higher than the cost of purchasing alternatives to mercury manometers even if the alternatives need to be calibrated more frequently. For more information on a cost comparison see: *Eliminating Mercury in Hospitals: Environmental Best Practices for Health Care Facilities, JACHO Environment of Care Standards 1.3, 2.3, 4.0,* November 2002 page 9 [16].

If your clinic does use mercury manometers it is important that a mercury spill clean up kit be kept in the office at all times and that all staff members receive training on procedures in the event of a mercury spill.

Pulse Obliteration Technique

TECHNIQUE	RATIONALE
Patient should be seated for five minutes. Patient should refrain from smoking or ingesting caffeine during the 30 minutes prior to the measurement [31, 32].	Vasoconstrictive substances such as nicotine and caffeine may increase the blood pressure [32, 15].
Patient should be sitting up straight with both feet flat on the floor as the procedure is explained and conducted.	Crossing the legs can increase blood pressure. Alteration of body position alters blood pressure. Slouching will elevate both systolic and diastolic levels [8].
Expose the upper right arm by rolling up the sleeve. Jackets or sweaters should be removed. Use the left arm only if there are right arm injuries, trauma, or severe dermatitis.	Sphygmomanometers are designed for right arm measurements [42]. Brachial artery pressure may normally differ between left and right arm measurements by as much as 10 mm Hg and is usually higher in the right arm [6]. Use of right arm for standardization and consistency of readings is recommended. In clinical assessment situations, baseline measurements of both arm pressures are recommended. If a shirt sleeve has been rolled up it can occlude the blood flow in the arm resulting in an erroneously low blood pressure reading. Also, if the stethoscope rubs against the clothing it can create sounds which make it harder to hear the actual blood pressure reading. For the most accurate reading remove clothing from the arm. If the clothing when rolled up the arm is too tight have the patient remove their shirt.
Make certain the center of the upper right arm is at heart level, (approximately the 4th intercostal space) elbow slightly flexed, forearm with the palm facing upwards and supported on a flat surface.	If brachial artery in the upper arm is lower than heart level, blood pressure could increase by as much as 10 mm Hg in both systolic and diastolic readings [31, 26]. If higher than heart level, blood pressure measurement will be as much as 10 mm Hg lower.
The blood pressure cuff should be applied so the cuff is one-inch (about the width of two fingers) above the natural crease (antecubital fossa). The inflatable bladder is centered over the brachial artery (cuffs are usually marked appropriately). Do not place the stethoscope under the cuff.	This space allows proper placement of the stethoscope. If a portion of the head of the stethoscope is placed under the cuff, it may cause uneven cuff pressure and distort the reading [18]. Proper cuff placement also reduces the possibility of bumping the tubing or the cuff.

TECHNIQUE	RATIONALE
Wrap the cuff snugly around the upper arm area.	The bladder of a loosely wrapped cuff will balloon and decrease the effective width causing an elevated reading [8].
Be certain you are using the proper size cuff. Many cuffs are marked inside with a range to ensure appropriate cuff size. When the cuff is applied to the arm, the end of the cuff should fall within the range marked on the cuff. If the cuff does not fit within the range, select a larger size.	If the cuff is too short the reading will be erroneously high and if the cuff is too wide the reading will be erroneously low [17].
Attach cuff to the sphygmomanometer.	
Locate the brachial artery.	
Inflate cuff while palpating the radial artery pulse until the pulse is obliterated [31]. Make a mental note of the pulse obliteration level. This level will closely approximate the systolic blood pressure.	This method eliminates the problem of an auscultatory gap, the temporary disappearance of second phase blood pressure sounds. Phase One Korotkoff sounds are heard over the brachial artery when cuff pressure is high and disappear as pressure is reduced (Phase Two), reappearing at a lower level (Phase Three). If the screener does not know how high to properly inflate the cuff, it is possible the first sounds heard could be the reappearance of sounds in the third phase, not the first phase. This could result in underestimation of systolic blood pressure by as much as 40 mm Hg [31, 5]. The pulse obliteration technique also alerts the screener to irregularities of heart rate which would affect interpretation of blood pressure readings.
	Over-inflation of the cuff may cause a spasm of the vessels, resulting in increased blood pressure peripheral resistance (the resistance by the arterioles to the flow of blood), which creates increased myocardial taxation (work load of the heart) resulting in increased blood pressure[18]. Unnecessary elevations of cuff pressure may also cause pain to the client, resulting in a stress response and an elevated reading [11, 19].

TECHNIQUE	RATIONALE
Calculate peak inflation by adding 30 mm Hg to the level at which the radial pulse is obliterated. Deflate the cuff fully, wait 30 seconds and then re-inflate to the peak inflation level. Example: Pulse Obliteration point 124 mm Hg + 30 Peak Inflation Level 154 mm Hg	The peak inflation rate is 30 mm Hg above the level at which the radial pulse is obliterated in adults and 20 mm Hg above the level at which the radial pulse is obliterated in children.
Allow at least 30 seconds between pulse obliteration and auditory measurement. Instead of deflating the cuff fully and then reinflating after 30 seconds, people who have had more experience and are able to control the valve so that no air escapes from the cuff after pulse obliteration can immediately continue to inflate the cuff to the peak inflation level. This takes some practice to learn how to control the valve so no air escapes.	This will allow for the release of blood that is trapped in the veins [31].
Place the stethoscope over the brachial artery. Avoid allowing the stethoscope to bump the cuff or tubing. Make sure the entire surface of the stethoscope is against the surface of the arm. Apply as little pressure on the head of the stethoscope as possible.	Careful placement of the stethoscope improves hearing the brachial arterial sounds [29]. Heavy pressure distorts the artery and produces sounds heard below diastolic pressure, or may obliterate the sounds entirely [31].
Rapidly inflate the cuff to peak inflation level (with small quick puffs).	An auscultatory gap is more likely to occur if the blood pressure cuff is inflated too slowly [7].
Deflate the cuff by 2 mmHg per second.	If deflation is slower than 2 mm Hg/second venous congestion develops and diastolic reading could be elevated [8]. If deflation is more rapid than 2 mm Hg per second the observer may err in identifying faint sounds either at onset or disappearance of sounds.

TECHNIQUE	RATIONALE
Avoid re-inflating the cuff after deflation has begun.	Venous return will engorge the forearm with blood and produce a loss of clarity of diastolic endpoint [7]. It may also result in a falsely low systolic and elevated diastolic pressure. It may also produce an auscultatory gap, or create spasms [8]. If the cardiac rhythm is irregular, rapid deflation of the cuff upon initial disappearance of sound may result in an elevated diastolic reading [34].
Listen for the onset and disappearance of Korotkoff sounds. Do not be confused by bounces in the column of mercury or of the needle on the aneroid dial – note auditory sounds not visual cues. To make certain the sound is not from an outside source, at least two consecutive beats should be heard as the pressure falls. Continue the deflation at this rate to 10 mm Hg past the disappearance of sound, then deflate rapidly.	

TECHNIQUE	**RATIONALE**
If sounds were faint: ❑ Inflate cuff more rapidly ❑ Recheck the placement of the stethoscope ❑ Eliminate extraneous noise ❑ Ask client to elevate his or her arm for 10-15 seconds then rapidly inflate the cuff to peak inflation level while the arm is elevated, then lower arm and proceed with measurement [30] ❑ Have the patient open and close their fist 8-10 times after the pressure cuff has been inflated above systolic level. In some patients sounds will be heard to 0 mm Hg. This can be caused by several things: ❑ Anemia ❑ Vigorous exercise immedietly prior to measurement ❑ Heavy pressure on the stethoscope If sounds were heard to 0 mmHg the blood pressure should be charted as: Systolic/4th Korotkoff phase/0 Example: 120/90/0 mm Hg	
Record the onset of sound and the disappearance of sound on the appropriate form [32].	
record <u>limb</u>: Rt. (Right arm) L. (Left arm) Record <u>body position</u>: Lying, sitting, standing Record <u>other than standard cuff:</u> child, large adult, thigh etc.	Blood pressure measurements can vary as much as 10 mm Hg between the right and left arm. Also, measurements are altered by body position and cuff size. Accurate recording allows the next person taking the blood pressure to understand how the baseline was determined.

TECHNIQUE	RATIONALE
If the blood pressure is elevated the screener should consider other factors that may increase blood pressure, e.g., climate, diet, antihistamines, or other medications, a full bladder, recent exposure to high altitude, current or recent stress [31]. The patient should not have exercised or smoked for at least 30 minutes prior to the blood pressure measurement.	Cold climates may cause vasoconstriction and increase blood pressure. Increased physiological demand, as with high altitudes, may increase blood pressure [31]. Physiological and emotional stress stimulate the "flight or fight" response and elevate blood pressure by the following mechanism: ▪ vasodilation in muscle ▪ vasoconstriction in skin and intestines ▪ increase in heart rate ▪ increase in cerebral blood flow ▪ increase in cardiac output A full urinary bladder produces a fairly generalized vasoconstriction reflex through the spinal cord [29].

Treatment and Referral for Adults

Recommendations for Follow-up
Based on Initial Blood Pressure Measurements for Adults [36]

Classification	Initial Systolic Blood Pressure, in mm Hg	Initial Diastolic Blood Pressure, mm Hg	Recommendation
Normal	<120	<80	Recheck in 2 years
Prehypertensive	120-139	80-89	Recheck in 1 year
Stage 1 Hypertension	140-159	90-99	Confirm within 2 months
Stage 2 Hypertension	>160	≥ 100	See physician within 1 month. If pressure is >180/110 mm Hg, see physician immediately

An elevation in either diastolic or systolic is considered an elevated reading.

Two or more readings separated by 5 minutes should be averaged [8]. If the first 2 readings differ by more than 5 mm Hg, additional readings should be obtained and averaged.

When systolic and diastolic blood pressures fall into different categories, the higher category should be selected to classify the individual's blood pressure status.

Determine appropriate follow up based on the average of 2 or more readings taken at each of 3 visits, including the initial screening. This is to prevent over referral. It will also eliminate false positives and provide the physician with a series of measurements over a period of time, which can help in treatment decisions.

Education/Counseling

Normal Reading and Not Taking Antihypertensive Medication

1. Define blood pressure (i.e. Blood pressure is the force of the blood against the walls of the blood vessels).
2. Inform the patient of the numerical value of his or her current reading.
3. Explain elevated, average, and low normal blood pressure readings and where his or her reading fits into the range, (i.e. elevated is a systolic of 140 or greater or a diastolic of 90 or greater).
4. Inform the patient that he or she is within the normal range. Recheck in two years.
5. If the patient has a family history of hypertension, recommend an annual recheck.
6. Review appropriate lifestyle modification for preventing high blood pressure and heart disease.
7. Answer any questions.

Elevated Reading and No Anti-Hypertensive Medication

1. Define blood pressure.
2. Inform the patient of the numerical value of his or her current reading.
3. Explain elevated, average, and low normal and where the patient's reading fits into the range.
4. Inform the patient that his or her present averaged reading is elevated, but that one averaged elevated reading does not necessarily indicate hypertension since blood pressure normally increases with emotion, pain, cold, exercise, eating, smoking cigarettes, drinking coffee, a full bladder. Medications and drugs such as diet pills, decongestants, birth control pills, caffeine, estrogen, antihistamines, etc can also raise blood pressure. Therefore, blood pressure measurement should be repeated within a month.
5. Explain that uncontrolled high blood pressure can result in damage to the blood vessels of the heart, kidney, brain and eyes. High blood pressure can also ultimately result in stroke, heart disease, kidney failure, and blindness.
6. Make an appointment for a recheck within one to two months based on stage of hypertension.
7. Discuss lifestyle modifications (i.e. maintaining ideal body weight, smoking cessation, regular physical activity, and appropriate dietary recommendations).
8. If a doctor's referral is indicated explain the need to seek antihypertensive therapy.
9. Emphasize that there are no characteristic symptoms.
10. Explain that persons with high blood pressure usually have to follow a treatment plan for the rest of their lives.

Patient Controlled with Antihypertensive Medication

1. Explain normal blood pressure values.
2. Explain the action of the drug.
3. Explain how the drug should be taken.
4. Assess for side effects.
5. Reinforce the medication regimen prescribed by the physician and the importance of medication compliance.
6. Make an appointment for a quarterly follow-up or as recommended by the physician.

Treatment and Referral for Individuals over age 60

Overview

- More than half of all Americans over age 60 have high blood pressure.
- More than 75% of individuals age 70 and older have uncontrolled hypertension.
- Isolated systolic hypertension (ISH) is the most common type of hypertension among those age 60 and over.
- After age 60, more women than men have hypertension.
- Hypertension is especially common and severe among African American elderly.
- The elderly typically have higher systolic blood pressure due to less compliant arteries.

Definitions

- **Isolated Systolic Hypertension (ISH)**: elevated systolic blood pressure with normal diastolic blood pressure. (SBP >140 and DBP <90 mmHg)
- **Pseudo hypertension**: falsely high blood pressure readings, caused by calcified arteries that do not collapse under the blood pressure cuff.
- **Osler's Maneuver**: the cuff cannot adequately occlude the vessels, therefore the radial pulse remains palpable after the cuff is inflated above the systolic pressure.
- **Orthostatic Hypotension**: a decline of 20 mm Hg or more in the systolic blood pressure or 10 mm Hg or more in the diastolic blood pressure when the patient stands up right. This may result from an excessive reduction in blood volume when the patient is upright or from the heart being unable to compensate for the decline in cardiac pre-load that is associated with standing upright.

  Medications which may cause orthostatic hypotension include: phenothiazine, tricyclic antidepressants, antianxiety agents, levodopa, diuretics, and antihypertensive medications with central nervous system effects (such as methyldopa and clonidine) as well as those with peripheral actions (prazosin, hydralazine, and quanethidine).

Measurement Technique

Because elderly hypertensive patients may experience postural decreases in blood pressure that tend to be greater in the supine (sitting) position, the following steps and considerations should also be taken:

- Measure the blood pressure on both arms initially. If there is more than 10 mm Hg difference refer to their physician. The difference between the left and right arm may indicate arterial obstruction on the side that has the lower pressure.
- Take blood pressure in the following three positions to check the effect of medications and to check for orthostatic hypotension.
  - Sitting (after 5 minutes)

- Standing (immediately)
- Standing up for 2 minutes

Patients with postural falls in blood pressure greater than 20 mm Hg may need protection against further reductions. If the standing blood pressure is consistently lower (more than 20 mm Hg), refer to physician.

The pediatric size cuff is not recommended for measurement on older clients, even when they have thin arms. The pediatric cuff bladder width of 8 cm doesn't adequately meet the adult requirement of 11 - 13 cm.

Antihypertensive Therapy

Nonpharmacological Therapy

- The elderly appear to be more "sodium sensitive" and often show significant response to moderate dietary sodium restriction or low doses of a diuretic agent.
- The same nonpharmacologic therapies recommended for younger patients should be used for the elderly, including weight loss if overweight; sodium restriction to less than 2,400 mg/day; eat a balanced diet, high in fruits, vegetables, and low or nonfat dairy products, reduction in intake of foods high in saturated fat and cholesterol; engage in regular moderate physical activity, 30-45 minutes on most days of the week; limit alcohol consumption to no more than one ounce of ethenoyl alcohol (12 ounces of beer, 5 ounces of wine or 1.5 ounces of 80-proof whiskey) a day; stop smoking or use of other tobacco products.

Pharmacological Therapy

Physicians and other heath care providers should keep in mind the following considerations when initiating drug therapy:

- Start with small doses of one medication.
- Keep the numbers of pills and daily doses to a minimum using once-per day, slow releasing formulations if possible.
- Monitor for side effects weekly and for blood pressure response every 2 weeks.
- Avoid childproof lids, and insist on written instructions using a large type for elderly patients
- Encourage continued lifestyle modifications.

Treatment and Referral for Children

Overview

- Blood pressure increases with age during the pre-adult years.
- Elevated blood pressure in childhood often correlates with hypertension in early adulthood.
- Larger children (heavier and/or taller) tend to have higher blood pressures than smaller children of the same age.
- Obese children tend to have higher blood pressures than lean children.
- Measuring and interpreting blood pressures in infants and children is difficult because of the following factors:
    1. Various arm sizes require the availability and selection of an appropriate sized cuff.
    2. Accurate readings and interpretations are difficult to obtain in anxious or restless infants and children.
    3. Errors are easily generated in Korotkoff sounds by heavy pressure on the stethoscope held in the antecubital fossa.
    4. Blood pressure changes in association with growth and development.

Recommendations

1. Normal Blood Pressure: systolic and diastolic blood pressure below the 90th percentile for age and gender.
2. High Normal Blood Pressure: average systolic or diastolic blood pressure greater than or equal to the 90th percentile but less than the 95th percentile for age and gender.
    a. Recheck within 1 - 4 weeks.
3. If the blood pressure reading is high normal for age, but can be accounted for by excess height for age or excess lean body mass for age, such children are considered to have normal blood pressure.
4. High Blood Pressure (Hypertension): average systolic or diastolic blood pressure greater than or equal to the 95th percentile for age and gender measured on at least three separate occasions.
5. The findings of a single elevated reading does not constitute a diagnosis of hypertension, but does indicate the need for further evaluation, including three repeated measurements on separate occasions. Children with severely elevated readings should be evaluated immediately.

Measurement Technique

- The pulse obliteration technique should be used on pediatric patients the same way that it is done on adult patients. It is important to use the correct blood pressure cuff size (see page 9).
- **Blood Pressure Measurement on Lower Extremities:** This measurement is indicated in children who have certain types of obstructive aortic disease, coarctation of aorta or arm amputation. Use a large cuff for infants and children. The patient should be laying face down, the cuff applied with the center of the inflatable bladder over the posterior aspect of the midthigh. The head of the stethoscope is placed over the popliteal fossa (area behind the knee). Monitor the Korotkoff sounds as the pressure in the bladder is lowered

just as is done in the arm. In a situation where the subject is unable to lie face down, a measurement can be taken with the subject lying on their side or back with their knee slightly flexed so that the stethoscope can be placed over the popliteal pulse. While diastolic pressure in the legs is generally similar to that in the arms, systolic pressure may be 20 to 30 mm Hg higher.

- In children the fourth and fifth Korotkoff phases frequently occur simultaneously and often there is no fifth phase at all with sounds audible to zero [33, 20, 35]. This is recorded as 1st phase/4th phase/5th phase (absence of sound). Example: 110/80/60 or 11/70/0 [31, 35].

Other Considerations

- Environmental and biological factors alter the blood pressure [9, 12].
- Vasoconstrictive substances, those that narrow the blood vessels, may increase blood pressure.

  Consider the following environmental and biological factors:
  - Room temperature
  - Noise level
  - Level of rest
  - Smoking, caffeine, alcohol or drug use (birth control pills, decongestants, or diet pills)
  - Non-threatening vs. threatening atmosphere
  - Confidentiality
  - Time of day
  - Previous activity
  - Emotional state
  - Pubescent females
  - Age of a child

Classification of Blood Pressure for Children 2-18 Years of Age

Using the 90th and 95th Percentile Chart

1. Determine the child's height (stature) and age.
2. Using the appropriate National Center for Health Care Statistics (NCHS) Percentile Chart for girls or boys find the child's age at the bottom of the chart. See Appendices F and G
3. Follow the age line vertically up the chart to the intersection of the line for the actual height (stature) on the left side of the chart.
4. Determine the height percentile by matching the range with the percentiles listed on the right side of the chart.
5. Measure the child's blood pressure and record the systolic and diastolic pressure (5th Sound).
6. Use the 90th and 95th Percentile Chart appropriate for the child's gender. See Appendices D and E.
7. Find the child's age on the left side of the chart.
8. Find the child's height percentile on the top of the chart.
9. Find the intersection of the height percentile and age.
10. This value will help you determine if the child's systolic blood pressure is above the 90th or 95th percentile.
11. Diastolic values are located to the right of the systolic. Repeat the same process.
12. Determine blood pressure classification of child. Make appropriate recommendation for follow-up measurements.

Example: The blood pressure measurement of a 10-year-old female is 90/62 mm/Hg. She is 55 inches tall. Her height percentile using the NCHS Chart is at the 50th percentile. Next, using the 90th and 95th Blood Pressure Percentile Chart for girls, the child's age of 10 is found, and her height percentile (in this case, 50th) is located. The value shown on the chart for this age and height percentile is 115 for systolic and 74 for diastolic. Since her blood pressure is 90/60 mmHg, it is well below the 90th percentile. Therefore she would be classified as having Normal Blood Pressure.

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Appendix A

FOLLOWING THE DASH DIET

This table provides a list of daily servings of the various food groups and gives examples.

Food Group	**Daily Servings**	**Serving Sizes**	**Example and Notes**	**Significance of each food group to the DASH eating plan**
Grain and Grain Products	7-8	1 slice bread 1 cup dry cereal 1 /2 cup cooked rice, past or cereal	Whole wheat bread, English muffin, pita bread, bagel, cereals, grits, oatmeal, crackers, unsalted pretzels, and popcorn	Major source of energy and fiber
Vegetables	4-5	1 cup raw leafy vegetable ½ cup cooked vegetable 6 oz 100% vegetable juice	Tomatoes, potatoes, carrots, green peas, squash, broccoli, turnip greens, collards, kale, spinach, artichokes, green beans, lima beans, sweet potatoes	Rich sources of potassium, magnesium and fiber
Fruits	4-5	6 oz 100% fruit juice 1 medium fruit ¼ cup dried fruit ½ cup fresh, frozen or canned fruit	Apricots, bananas, dates, grapes, oranges, orange juice, grapefruit, grapefruit juice, mangoes, melons, peaches, pineapples, prunes, raisins, strawberries, tangerines	Important source of potassium, magnesium, and fiber
Low fat or Fat Free Dairy products	2-3	8 oz milk 1 cup yogurt 1 ½ oz cheese	Fat free (skim) or low fat (1%) milk, fat free or low fat buttermilk, fat free or low fat regular or frozen yogurt, low fat and fat free cheese	Major source of calcium and protein
Meats Poultry and Fish	2 or less	3 oz. Cooked meats, poultry or fish	Select only lean; trim away visible fats; broil roast, or boil instead of frying; remove skin from poultry	Rich sources of protein and magnesium
Nuts, Seeds and Dry Beans	4-5 per week	1/3 cup or 1 ½ oz nuts 2 Tbs or ½ oz seeds ½ cup cooked dry beans	Almonds, filberts, mixed nuts, peanuts, walnuts, sunflower seeds, kidney beans, lentils, peas	Rich sources of energy, magnesium, potassium, protein and fiber
Fats and Oils*	2-3	1 tsp soft margarine 1 Tbsp low fat mayonnaise 2 Tbsp light salad dressing 1 tsp vegetable oil	Soft margarine, low fat mayonnaise, light salad dressing, vegetable oil (such as olive, corn, canola, or safflower)	Besides fats added to foods, remember to choose foods that contain less fat
Sweets	5 per week	1 Tbsp sugar 1 Tbsp jelly or jam ½ oz jelly beans 8 oz lemonade	Maple syrup, sugar, jelly, jam, fruit-flavored gelatin, jelly beans, hard candy, fruit punch, sorbet and ices	Sweets should be low in fat

* Fat content changes serving counts for fats and oils: For example 1 Tbsp of regular salad dressing equals 1 serving; 1 Tbsp of low fat dressing equals ½ serving; 1 Tbsp of a fat free dressing equals 0 servings.

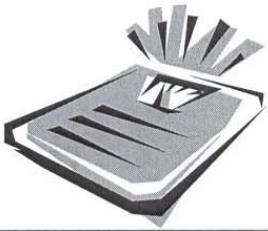
* Another important aspect of the DASH is limiting sodium, or salt in the diet. This is especially important for those watching out for high blood pressure. A sodium intake of 1,500 mg per day provides the greatest reductions.

Appendix B

WEIGH IN FOR BETTER HEALTH

What you weigh is just one factor that affects your health. Where you carry extra weight and whether you have weight-related health problems are also important factors. Follow these steps to determine if weight loss should be in your future.

1 Calculate your body mass index (BMI) from the chart below.
Find your height, follow that row to your weight.
Your BMI is the number at the top of your weight column.



FIND YOUR BMI

	21	22	23	24	25	26	27	28	29	30	31	
5'	107	112	118	123	128	133	138	143	148	153	158	Weight in pounds
5'1"	111	116	122	127	132	137	143	148	153	158	164	
5'2"	115	120	126	131	136	142	147	153	158	164	169	
5'3"	118	124	130	135	141	146	152	158	163	169	175	
5'4"	122	128	134	140	145	151	157	163	169	174	180	
5'5"	126	132	138	144	150	156	162	168	174	180	186	
5'6"	130	136	142	148	155	161	167	173	179	186	192	
5'7"	134	140	146	153	159	166	172	178	185	191	198	
5'8"	138	144	151	158	164	171	177	184	190	197	203	
5'9"	142	149	155	162	169	176	182	189	196	203	209	
5'10"	146	153	160	167	174	181	188	195	202	209	216	
5'11"	150	157	165	172	179	186	193	200	208	215	222	
6'0"	154	162	169	177	184	191	199	206	213	221	228	
6'1"	159	166	174	182	189	197	204	212	219	227	234	
	Acceptable range				Overweight					Obese		

2 Measure your waistline. (Place a tape measure around your waist – just below your rib cage and above your belly button.)

3 Consider whether your weight may be affecting your health. Health problems that may be related to your weight include high blood pressure, type 2 diabetes, high blood cholesterol, gallstones, sleep apnea and arthritis

You should consider losing weight if:

- ***Your BMI is 30 or greater***
- ***Your BMI is 25 to 29 and you have two or more weight-related health problems.***
- ***Your waist circumference exceeds 40 inches (for men) or 35 inches (for women) and you have two or more weight-related health problems***

If your BMI is in the upper 20s or your waist circumference is high – but you don't have weight-related health problems – make an effort not to gain more weight

WEIGHT CONTROL TIPS YOU CAN LIVE WITH

♥ **Be Realistic** – ***Make small changes over time.*** ♥ **Be Adventurous** - ***Expand your tastes to enjoy a wide variety of foods .*** ♥ **Be Flexible** – ***Balance what you eat and do it over several days, if you eat a lot one day, exercise more, etc.*** ♥**Be Sensible** - ***Enjoy all foods, just don't overdo it.***

♥ **Be Active** - ***Try some new activities, and increase the amount of time you spend walking to and from work.***

Appendix C

Algorithm for Treatment of Hypertension

LIFESTYLE MODIFICATIONS

Not at goal blood pressure (>140/90 mmHg)
(>130/80 mmHg for patients with diabetes or chronic kidney disease)

INITIAL DRUG CHOICES

Without Compelling Indications

Stage 1 hypertension
SBP 140-159/ DBP 90-99 mmHg
Thiazide-type diuretics for most. May consider ACEI, ARB, BB, CCB, or combination.

Stage 2 hypertension
SBP ≥ 160 or DBP ≥ 100 mmHg
Two drug combination for most (usually thiazide-type diuretic and ACEI, or ARB, or BB or CCB).

NOT AT GOAL BLOOD PRESSURE

Optimize dosages or add additional drugs until goal blood pressure is achieved. Consider consult with hypertension specialist.

With Compelling Indications

Other antihypertensive drugs (diuretics, ACEI, ARB, BB, CCB) as needed.)

NOT AT GOAL BLOOD PRESSURE

Optimize dosages or add additional drugs until goal blood pressure is achieved. Consider consult with hypertension specialist.

DBP=diastolic blood pressure
SBP= systolic blood pressure
ACEI= angiotensin converting enzyme inhibitor
ARB= angiotensin receptor blocker
BB= beta blocker
CCB= calcium channel blocker

Appendix D

Blood Pressure Levels for Boys by Age and Height Percentile

Age (Year)	BP Percentile ↓	Systolic BP (mmHg) ← Percentile of Height →							Diastolic BP (mmHg) ← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	80	81	83	85	87	88	89	34	35	36	37	38	39	39
	90th	94	95	97	99	100	102	103	49	50	51	52	53	53	54
	95th	98	99	101	103	104	106	106	54	54	55	56	57	58	58
	99th	105	106	108	110	112	113	114	61	62	63	64	65	66	66
2	50th	84	85	87	88	90	92	92	39	40	41	42	43	44	44
	90th	97	99	100	102	104	105	106	54	55	56	57	58	58	59
	95th	101	102	104	106	108	109	110	59	59	60	61	62	63	63
	99th	109	110	111	113	115	117	117	66	67	68	69	70	71	71
3	50th	86	87	89	91	93	94	95	44	44	45	46	47	48	48
	90th	100	101	103	105	107	108	109	59	59	60	61	62	63	63
	95th	104	105	107	109	110	112	113	63	63	64	65	66	67	67
	99th	111	112	114	116	118	119	120	71	71	72	73	74	75	75
4	50th	88	89	91	93	95	96	97	47	48	49	50	51	51	52
	90th	102	103	105	107	109	110	111	62	63	64	65	66	66	67
	95th	106	107	109	111	112	114	115	66	67	68	69	70	71	71
	99th	113	114	116	118	120	121	122	74	75	76	77	78	78	79
5	50th	90	91	93	95	96	98	98	50	51	52	53	54	55	55
	90th	104	105	106	108	110	111	112	65	66	67	68	69	69	70
	95th	108	109	110	112	114	115	116	69	70	71	72	73	74	74
	99th	115	116	118	120	121	123	123	77	78	79	80	81	81	82
6	50th	91	92	94	96	98	99	100	53	53	54	55	56	57	57
	90th	105	106	108	110	111	113	113	68	68	69	70	71	72	72
	95th	109	110	112	114	115	117	117	72	72	73	74	75	76	76
	99th	116	117	119	121	123	124	125	80	80	81	82	83	84	84
7	50th	92	94	95	97	99	100	101	55	55	56	57	58	59	59
	90th	106	107	109	111	113	114	115	70	70	71	72	73	74	74
	95th	110	111	113	115	117	118	119	74	74	75	76	77	78	78
	99th	117	118	120	122	124	125	126	82	82	83	84	85	86	86
8	50th	94	95	97	99	100	102	102	56	57	58	59	60	60	61
	90th	107	109	110	112	114	115	116	71	72	72	73	74	75	76
	95th	111	112	114	116	118	119	120	75	76	77	78	79	79	80
	99th	119	120	122	123	125	127	127	83	84	85	86	87	87	88
9	50th	95	96	98	100	102	103	104	57	58	59	60	61	61	62
	90th	109	110	112	114	115	117	118	72	73	74	75	76	76	77
	95th	113	114	116	118	119	121	121	76	77	78	79	80	81	81
	99th	120	121	123	125	127	128	129	84	85	86	87	88	88	89
10	50th	97	98	100	102	103	105	106	58	59	60	61	61	62	63
	90th	111	112	114	115	117	119	119	73	73	74	75	76	77	78
	95th	115	116	117	119	121	122	123	77	78	79	80	81	81	82
	99th	122	123	125	127	128	130	130	85	86	86	88	88	89	90

Blood Pressure Levels for Boys by Age and Height Percentile (Continued)

Age (Year)	BP Percentile ↓	Systolic BP (mmHg) ← Percentile of Height →							Diastolic BP (mmHg) ← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
11	50th	99	100	102	104	105	107	107	59	59	60	61	62	63	63
	90th	113	114	115	117	119	120	121	74	74	75	76	77	78	78
	95th	117	118	119	121	123	124	125	78	78	79	80	81	82	82
	99th	124	125	127	129	130	132	132	86	86	87	88	89	90	90
12	50th	101	102	104	106	108	109	110	59	60	61	62	63	63	64
	90th	115	116	118	120	121	123	123	74	75	75	76	77	78	79
	95th	119	120	122	123	125	127	127	78	79	80	81	82	82	83
	99th	126	127	129	131	133	134	135	86	87	88	89	90	90	91
13	50th	104	105	106	108	110	111	112	60	60	61	62	63	64	64
	90th	117	118	120	122	124	125	126	75	75	76	77	78	79	79
	95th	121	122	124	126	128	129	130	79	79	80	81	82	83	83
	99th	128	130	131	133	135	136	137	87	87	88	89	90	91	91
14	50th	106	107	109	111	113	114	115	60	61	62	63	64	65	65
	90th	120	121	123	125	126	128	128	75	76	77	78	79	79	80
	95th	124	125	127	128	130	132	132	80	80	81	82	83	84	84
	99th	131	132	134	136	138	139	140	87	88	89	90	91	92	92
15	50th	109	110	112	113	115	117	117	61	62	63	64	65	66	66
	90th	122	124	125	127	129	130	131	76	77	78	79	80	80	81
	95th	126	127	129	131	133	134	135	81	81	82	83	84	85	85
	99th	134	135	136	138	140	142	142	88	89	90	91	92	93	93
16	50th	111	112	114	116	118	119	120	63	63	64	65	66	67	67
	90th	125	126	128	130	131	133	134	78	78	79	80	81	82	82
	95th	129	130	132	134	135	137	137	82	83	83	84	85	86	87
	99th	136	137	139	141	143	144	145	90	90	91	92	93	94	94
17	50th	114	115	116	118	120	121	122	65	66	66	67	68	69	70
	90th	127	128	130	132	134	135	136	80	80	81	82	83	84	84
	95th	131	132	134	136	138	139	140	84	85	86	87	87	88	89
	99th	139	140	141	143	145	146	147	92	93	93	94	95	96	97

BP, blood pressure

* The 90th percentile is 1.28 SD, 95th percentile is 1.645 SD, and the 99th percentile is 2.326 SD over the mean.

For research purposes, the standard deviations in Appendix Table B–1 allow one to compute BP Z-scores and percentiles for boys with height percentiles given in Table 3 (i.e., the 5th,10th, 25th, 50th, 75th, 90th, and 95th percentiles). These height percentiles must be converted to height Z-scores given by (5% = -1.645; 10% = -1.28; 25% = -0.68; 50% = 0; 75% = 0.68; 90% = 1.28%; 95% = 1.645) and then computed according to the methodology in steps 2–4 described in Appendix B. For children with height percentiles other than these, follow steps 1–4 as described in Appendix B.

Blood Pressure Levels for Girls by Age and Height Percentile

Age (Year)	BP Percentile ↓	Systolic BP (mmHg) ← Percentile of Height →							Diastolic BP (mmHg) ← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	83	84	85	86	88	89	90	38	39	39	40	41	41	42
	90th	97	97	98	100	101	102	103	52	53	53	54	55	55	56
	95th	100	101	102	104	105	106	107	56	57	57	58	59	59	60
	99th	108	108	109	111	112	113	114	64	64	65	65	66	67	67
2	50th	85	85	87	88	89	91	91	43	44	44	45	46	46	47
	90th	98	99	100	101	103	104	105	57	58	58	59	60	61	61
	95th	102	103	104	105	107	108	109	61	62	62	63	64	65	65
	99th	109	110	111	112	114	115	116	69	69	70	70	71	72	72
3	50th	86	87	88	89	91	92	93	47	48	48	49	50	50	51
	90th	100	100	102	103	104	106	106	61	62	62	63	64	64	65
	95th	104	104	105	107	108	109	110	65	66	66	67	68	68	69
	99th	111	111	113	114	115	116	117	73	73	74	74	75	76	76
4	50th	88	88	90	91	92	94	94	50	50	51	52	52	53	54
	90th	101	102	103	104	106	107	108	64	64	65	66	67	67	68
	95th	105	106	107	108	110	111	112	68	68	69	70	71	71	72
	99th	112	113	114	115	117	118	119	76	76	76	77	78	79	79
5	50th	89	90	91	93	94	95	96	52	53	53	54	55	55	56
	90th	103	103	105	106	107	109	109	66	67	67	68	69	69	70
	95th	107	107	108	110	111	112	113	70	71	71	72	73	73	74
	99th	114	114	116	117	118	120	120	78	78	79	79	80	81	81
6	50th	91	92	93	94	96	97	98	54	54	55	56	56	57	58
	90th	104	105	106	108	109	110	111	68	68	69	70	70	71	72
	95th	108	109	110	111	113	114	115	72	72	73	74	74	75	76
	99th	115	116	117	119	120	121	122	80	80	80	81	82	83	83
7	50th	93	93	95	96	97	99	99	55	56	56	57	58	58	59
	90th	106	107	108	109	111	112	113	69	70	70	71	72	72	73
	95th	110	111	112	113	115	116	116	73	74	74	75	76	76	77
	99th	117	118	119	120	122	123	124	81	81	82	82	83	84	84
8	50th	95	95	96	98	99	100	101	57	57	57	58	59	60	60
	90th	108	109	110	111	113	114	114	71	71	71	72	73	74	74
	95th	112	112	114	115	116	118	118	75	75	75	76	77	78	78
	99th	119	120	121	122	123	125	125	82	82	83	83	84	85	86
9	50th	96	97	98	100	101	102	103	58	58	58	59	60	61	61
	90th	110	110	112	113	114	116	116	72	72	72	73	74	75	75
	95th	114	114	115	117	118	119	120	76	76	76	77	78	79	79
	99th	121	121	123	124	125	127	127	83	83	84	84	85	86	87
10	50th	98	99	100	102	103	104	105	59	59	59	60	61	62	62
	90th	112	112	114	115	116	118	118	73	73	73	74	75	76	76
	95th	116	116	117	119	120	121	122	77	77	77	78	79	80	80
	99th	123	123	125	126	127	129	129	84	84	85	86	86	87	88

Blood Pressure Levels for Girls by Age and Height Percentile (Continued)

Age (Year)	BP Percentile ↓	Systolic BP (mmHg) ← Percentile of Height →							Diastolic BP (mmHg) ← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
11	50th	100	101	102	103	105	106	107	60	60	60	61	62	63	63
	90th	114	114	116	117	118	119	120	74	74	74	75	76	77	77
	95th	118	118	119	121	122	123	124	78	78	78	79	80	81	81
	99th	125	125	126	128	129	130	131	85	85	86	87	87	88	89
12	50th	102	103	104	105	107	108	109	61	61	61	62	63	64	64
	90th	116	116	117	119	120	121	122	75	75	75	76	77	78	78
	95th	119	120	121	123	124	125	126	79	79	79	80	81	82	82
	99th	127	127	128	130	131	132	133	86	86	87	88	88	89	90
13	50th	104	105	106	107	109	110	110	62	62	62	63	64	65	65
	90th	117	118	119	121	122	123	124	76	76	76	77	78	79	79
	95th	121	122	123	124	126	127	128	80	80	80	81	82	83	83
	99th	128	129	130	132	133	134	135	87	87	88	89	89	90	91
14	50th	106	106	107	109	110	111	112	63	63	63	64	65	66	66
	90th	119	120	121	122	124	125	125	77	77	77	78	79	80	80
	95th	123	123	125	126	127	129	129	81	81	81	82	83	84	84
	99th	130	131	132	133	135	136	136	88	88	89	90	90	91	92
15	50th	107	108	109	110	111	113	113	64	64	64	65	66	67	67
	90th	120	121	122	123	125	126	127	78	78	78	79	80	81	81
	95th	124	125	126	127	129	130	131	82	82	82	83	84	85	85
	99th	131	132	133	134	136	137	138	89	89	90	91	91	92	93
16	50th	108	108	110	111	112	114	114	64	64	65	66	66	67	68
	90th	121	122	123	124	126	127	128	78	78	79	80	81	81	82
	95th	125	126	127	128	130	131	132	82	82	83	84	85	85	86
	99th	132	133	134	135	137	138	139	90	90	90	91	92	93	93
17	50th	108	109	110	111	113	114	115	64	65	65	66	67	67	68
	90th	122	122	123	125	126	127	128	78	79	79	80	81	81	82
	95th	125	126	127	129	130	131	132	82	83	83	84	85	85	86
	99th	133	133	134	136	137	138	139	90	90	91	91	92	93	93

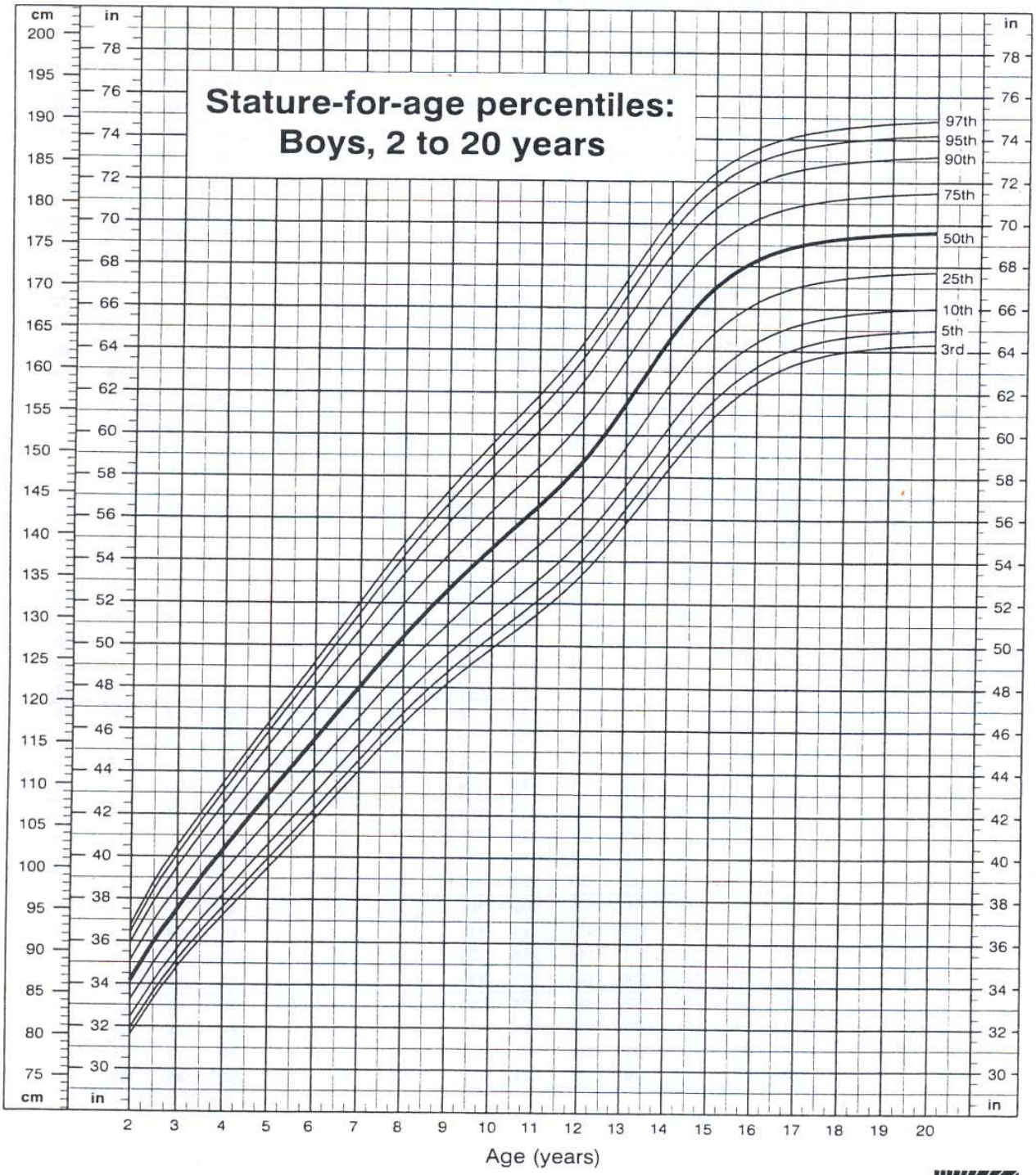
BP, blood pressure

* The 90th percentile is 1.28 SD, 95th percentile is 1.645 SD, and the 99th percentile is 2.326 SD over the mean.

For research purposes, the standard deviations in Appendix Table B–1 allow one to compute BP Z-scores and percentiles for girls with height percentiles given in Table 4 (i.e., the 5th,10th, 25th, 50th, 75th, 90th, and 95th percentiles). These height percentiles must be converted to height Z-scores given by (5% = -1.645; 10% = -1.28; 25% = -0.68; 50% = 0; 75% = 0.68; 90% = 1.28%; 95% = 1.645) and then computed according to the methodology in steps 2–4 described in Appendix B. For children with height percentiles other than these, follow steps 1–4 as described in Appendix B.

Appendix E

CDC Growth Charts: United States



Published May 30, 2000.
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

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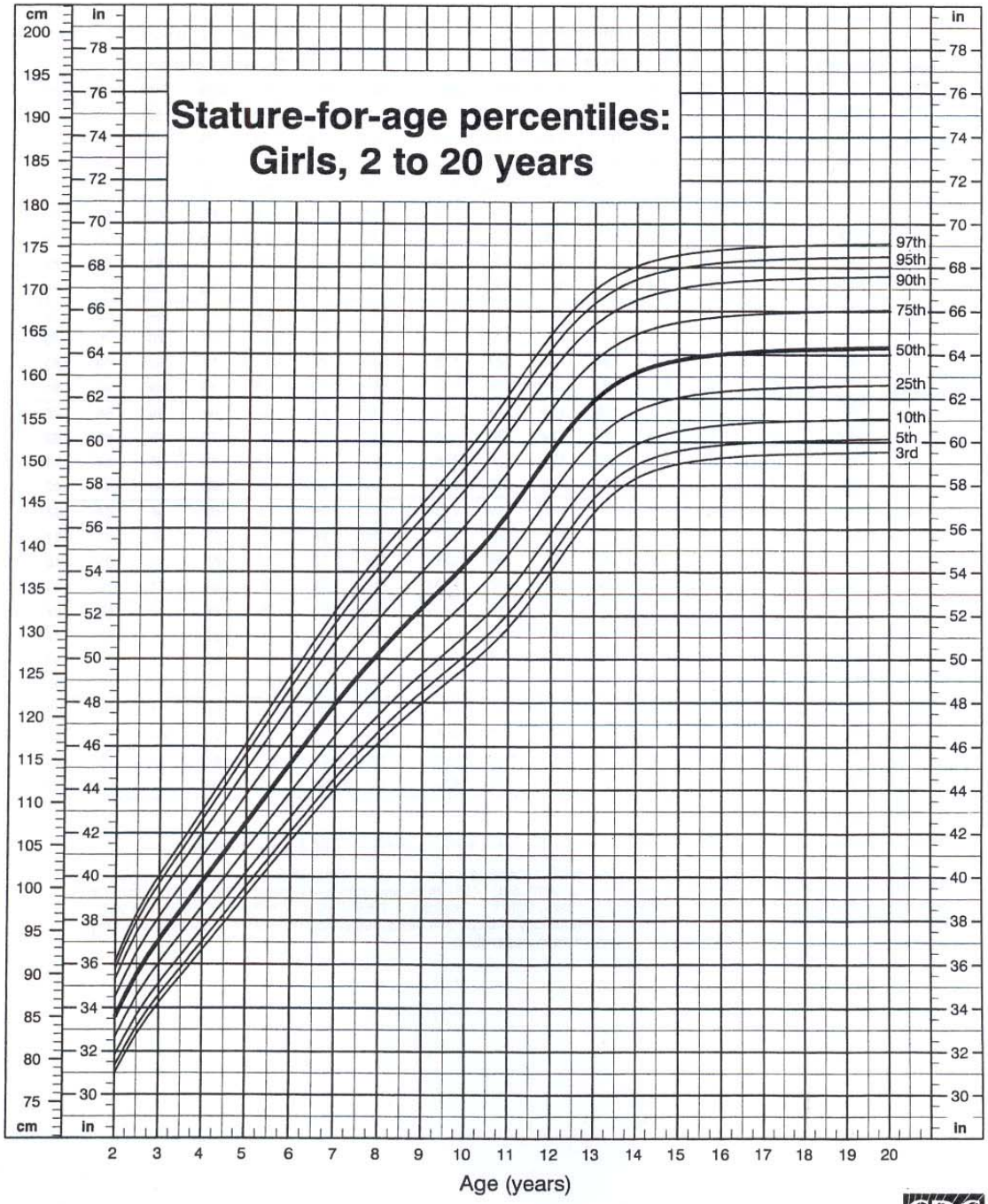
Appendix F

CDC Growth Charts: United States



Published May 30, 2000.
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

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Appendix G

Blood Pressure Measurement Quiz

Multiple Choice (circle the correct answer)

1. Normal blood pressure in adults (age 18 or older) is
    a. 115/75
    b. Below 120/80 mm Hg
    c. Below 160/90 mm Hg
    d. Depends on your age

2. The Korotkoff sound used to determine diastolic pressure in adults is:
    a. The phase when all sounds disappear
    b. The phase when all sounds suddenly become muffled
    c. The last sound heard through the stethoscope

3. Which of the following can cause sounds to be heard down to zero mm Hg?
    a. Anemia
    b. Vigorous exercise
    c. Heavy pressure on the stethoscope
    d. All of the above

4. A cuff with a bladder too small for the patient's arm will result in:
    a. An inaccurately high reading
    b. An inaccurately low reading
    c. Sounds heard down to zero mm Hg

5. If the cuff is applied too loosely, the pressure reading will be
    a. Too low
    b. Too high
    c. Not affected

6. Unless otherwise indicated, measure the blood pressure using the patient's ____ arm.
    a. Right
    b. Left
    c. Either arm is alright

7. Common causes of errors in blood pressure measurement include:
    a. Dirty mercury or dirty glass tube
    b. Cuff applied over clothing
    c. Leaks in the pressure bulb or tubing
    d. Arm above or below heart level
    e. All of the above

8. Some factors that can alter blood pressure are:
    a. Smoking
    b. Anxiety and other emotional states
    c. Talking
    d. Full bladder
    e. All of the above
    f. b & d only

9. When using the Auscultatory-Palpatory technique of blood pressure measurement, the pressure in the cuff should be raised:
    a. 20-30 mm Hg higher than the point where the pulse disappeared
    b. 30 mm Hg higher than the systolic pressure
    c. 20 mm Hg higher than the systolic pressure

10. While taking a blood pressure, the first sound heard through the stethoscope is at 150 mm Hg and sounds are heard from “150” until the last sound is heard at 78 mm Hg. What is the patient’s blood pressure?
    a. 150/78
    b. 148/76
    c. 150/76
    d. 148/78

11. While taking a blood pressure, the screener is not sure if the first sounds were heard at 170 mm Hg. What action should be taken?
    a. Immediately deflate the cuff to “0”, wait 30 seconds and reinflate the cuff.
    b. Immediately reinflate the cuff above 170 mm Hg and listen carefully for the first Korotkoff sounds
    c. Deflate the cuff to “0”. Immediately reinflate the cuff to 30 mm Hg above estimated systolic pressure and listen carefully for the first Korotkoff sounds.

12. When performing the Auscultatory- Palpatory technique of blood pressure measurement, you feel the radial pulse disappear at 175 mm Hg. What should you do next?
    a. Continue to inflate the cuff to 205 mm Hg; place the stethoscope over the brachial artery; slowly deflate the cuff and listen for the Korotkoff sounds.
    b. Place the stethoscope over the brachial artery, slowly deflate the cuff and listen for the Korotkoff sounds.
    c. Deflate the cuff fully; wait 30 seconds; place the stethoscope over the brachial artery; reinflate to 205 mm Hg and listen for the Korotkoff sounds.
    d. A or C dependent on experience

13. Which of the following will increase the loudness of the Korotkoff sounds?
    a. Have the patient open and close their fist 8-10 times after the pressure cuff has been inflated above systolic level.
    b. Rapidly inflate the cuff
    c. Raise the patient’s arm above heart level for several seconds- inflate the cuff above the systolic level while the arm is still elevated- lower the arm and proceed with the blood pressure measurement.
    d. All of the above
    e. A & c only

14. The patient, a 25-year –old white male, has just run up five flights of stairs- what action should be taken?
    a. Have the patient rest 5 minutes and then proceed with measurement
    b. Wait until pulse has returned to normal before measuring blood pressure
    c. Have patient return in 30 minutes for blood pressure check- advise the patient not to do any exercise or other strenuous activity before returning.

True or False (circle the correct answer)

1. To avoid incorrectly assessing the systolic blood pressure due to the auscultatory gap, the auscultatory-palpatory technique of blood pressure measurement should always be used.

   True False
2. A diagnosis of hypertension (high blood pressure) cannot be made from one blood pressure reading.

   True False
3. A high diastolic blood pressure indicates a greater risk for complications (in most people, especially those over age 55) than a high systolic blood pressure.

   True False
4. You shouldn't have your blood pressure checked immediately after smoking.

   True False
5. If the initial blood pressure reading is greater than or equal to 120/80, two or more readings should be taken.

   True False
6. Race: Whites are at a greater risk than Blacks for developing hypertension.

   True False

7. Family History: Studies show that the tendency to develop hypertension runs in families.

   True False
8. Diabetes: Persons with diabetes are at a greater risk for developing hypertension.

   True False
9. Oral Contraceptives: The "pill" raises the blood pressure in almost all of the women who take it.

   True False
10. Stress: Prolonged and intense stress can contribute to the development of hypertension.

    True False
11. Alcohol: Excessive alcohol consumption may be involved with the development of hypertension.

    True False

Answers to Test

Multiple Choice

1. B
2. A
3. D
4. A
5. B
6. A
7. E
8. E
9. A
10. C
11. A
12. D
13. D
14. C

True/False

1. True
2. True
3. False
4. True
5. True
6. False
7. True
8. True
9. True
10. True
11. True

Appendix H

12. BLOOD PRESSURE MEASUREMENT STANDARDIZATION PROGRAM PRACTICUM

Name: _____

Organization: _____

Results (Pass or Fail): _____

PROCEDURE		TEST
1. Preparation for measurement	a. Client has been sitting for five minutes prior to beginning procedure	
	b. If necessary, client's sleeve is rolled up to expose brachial artery and to accommodate cuff	
	c. Arm is supported so brachial artery is at heart level	
	d. If client's feet are crossed, technician reminds him/her to uncross and place flat on floor	
2. Selection and application of cuff	a. Technician selects appropriately sized cuff	
	b. If there are no exceptions, technician selects right arm for test	
	c. Cuff is centered over the brachial artery (most cuffs are marked)	
	d. The cuff is wrapped snugly	
	e. The cuff is 1" above the antecubital fossa	
	f. Technician applies stethoscope earpieces just prior to beginning cuff inflation	
3. Pulse obliteration,determination, and inflation	a. Technician palpates radial pulse and brachial pulse	
	b. Sphygmomanometer is viewed at eye level	
	c. Cuff is inflated smoothly and **rapidly** until radial pulse obliterates	
	d. Technician deflates the cuff fully, waits 30 seconds and then inflates the cuff to 30 mm's higher than pulse obliteration until peak inflation level is reached	
4. Placement of stethoscope and deflation	a. Technician applies diaphragm/bell over brachial artery	
	b. Technician begins deflating cuff at a rate of 2 mm/hg per second	
	c. The cuff valve is opened to allow rapid deflation 10 mm/hg after disappearance of sound is determined	
5. Recording of Blood Pressure	a. Record the systolic and diastolic levels	
	b. Record limb and cuff size used	