VIDEOS IN CLINICAL MEDICINE

Blood-Pressure Measurement

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INDICATIONS

Blood-pressure measurement is indicated in any situation that requires assessment of cardiovascular health, including screening for hypertension and monitoring the effectiveness of treatment in patients with hypertension. In the routine outpatient setting, blood-pressure measurement is obtained indirectly. Proper techniques are important to ensure consistent and reliable measurements.

CONTRAINDICATIONS

Measurement of blood pressure at the brachial artery is a generally benign procedure. However, there are some circumstances in which obtaining readings from a particular arm may not be appropriate; such circumstances include the presence of an arterial–venous shunt, recent axillary node dissection, or any deformity or surgical history that interferes with proper access or blood flow to the upper arm. If these relative contraindications are present, blood pressure should be assessed in the opposite arm. There may also be pre-existing conditions that can interfere with the accuracy or interpretation of readings, such as aortic coarctation, arterial–venous malformation, occlusive arterial disease, or the presence of an antecubital bruit. If neither arm can be used, then measurement of blood pressure in a leg may be indicated.

EQUIPMENT

Figure 1. Equipment used in blood-pressure measurement.

The essential equipment for blood-pressure measurement includes a stethoscope and a sphygmomanometer. The stethoscope tubing should be long enough to permit the practitioner to auscultate Korotkoff sounds while viewing the manometer at eye level. Use of the bell side of the stethoscope chestpiece facilitates auscultation of the low-frequency Korotkoff sounds. The sphygmomanometer consists of a blood-pressure cuff containing a distensible bladder, a rubber bulb with an adjustable valve for inflation, tubing that connects the cuff to the bladder, and a manometer (Fig. 1). Regular inspection and calibration of the equipment are important to ensure that it is in proper working order. For accurate measurement, calibrations are recommended every 6 months.[1,2]

Many institutions have removed mercury manometers from clinical settings and replaced them with aneroid manometers. The steps required for accurate blood-pressure measurement with an aneroid or a mercury manometer are identical.

PREPARATION

The examination room should be quiet, with a comfortable ambient temperature. Ideally, blood pressure should not be measured if the patient has engaged in recent physical activity, used tobacco, ingested caffeine, or eaten within the past 30 minutes.[3]

Positioning of the Patient

Correct positioning of the patient is essential for accurate measurement. The patient's back and legs should be supported, with the legs uncrossed and the feet resting on a firm surface.

The arm in which blood pressure will be measured should be bare to the shoulder, and the garment sleeve, if raised, should be loose, so that it does not interfere with blood flow or with proper positioning of the blood-pressure cuff. The arm should be supported and level with the heart. The manometer should be positioned at the health care practitioner's eye level.

Arm Measurement

A common error in measuring blood pressure is the use of an improperly fitted cuff. Undersized cuffs will result in overestimation of blood pressure. Selection of an appropriately sized cuff requires assessment of the patient's arm circumference at the midpoint of the upper arm. One half the distance between the acromion and the olecranon processes determines the midpoint of the arm (Fig. 2). The circumference is then measured at the midpoint.

Figure 2. Arm measurements for assessing cuff size.

Cuff Sizing

Cuffs are typically marked with line indicators intended to facilitate proper fitting. The index line runs perpendicular to the length of the cuff, and the range line runs parallel to the length of the cuff. Once the cuff has been wrapped around the arm, the index line should fall within the range-line limits, and the midpoint of the bladder should sit over the brachial artery.

In addition to index and range lines, cuffs will often indicate size or size ranges (e.g., adult or large adult). The sizes marked on the cuff should correspond to the appropriate arm circumference (Table 1). Although these may be helpful guides, it is most important to use a cuff size that is based on the arm measurement and on the match between the index and range lines once the cuff is placed on the patient. A cuff that is too small may contribute to a falsely elevated blood-pressure measurement.

Figure 3. Proper positioning of the blood-pressure cuff.

Cuff Placement

The cuff should be placed on a bare arm, approximately 2 cm above the elbow crease, with the midline of the bladder (usually indicated by the manufacturer) directly over the brachial artery (Fig. 3). It should fit snugly but should still allow for two fingers to slide under the cuff.

Table 1. Blood-Pressure Cuff Sizing.

Arm Circumference	Bladder Dimensions	Cuff Size
centimeters		
22 to 26	12×22	Small adult arm
27 to 34	16×30	Adult arm
35 to 44	16×36	Large adult arm
45 to 52	16×42	Adult thigh

Pulse-Obliteration Pressure

Inflating the cuff to an arbitrary level runs the risk of overinflation and undue patient discomfort or of underestimation of systolic blood pressure. To avoid underestimation of blood pressure due to an auscultatory gap, determine the pulse-obliteration pressure, which can be used to estimate an appropriate initial cuff-inflation pressure. An auscultatory gap is present when there is intermittent disappearance of the initial Korotkoff sounds after their first appearance. It is more likely to be present in older hypertensive patients and can lead to underestimation of systolic blood pressure.[4] Estimating systolic blood pressure by first measuring pulse-obliteration pressure helps to avoid an incorrect measurement of systolic blood pressure.

To determine the pulse-obliteration pressure, palpate the radial pulse while rapidly inflating the cuff to approximately 80 mm Hg. Then slow the inflation rate to approximately 10 mm Hg every 2 to 3 seconds, taking note of the reading at which the pulse disappears. After the pulse has disappeared, deflate the cuff at a rate of 2 mm Hg per second, noting when the pulse reappears, which confirms the obliteration pressure.

BLOOD-PRESSURE MEASUREMENT

Place the bell of the stethoscope over the brachial artery, using sufficient pressure to provide good sound transmission without over-compressing the artery. To avoid extraneous noise during cuff deflation, ensure that the stethoscope is not in contact with the patient's clothing or with the blood-pressure cuff.

Once the pulse-obliteration pressure is determined, initiate the auscultatory blood-pressure measurement by rapidly inflating the cuff to a level 20 to 30 mm Hg above the pulse-obliteration pressure. Then deflate the cuff at a rate of 2 mm Hg per second while listening for the Korotkoff sounds.

KOROTKOFF SOUNDS

As the cuff is deflated, turbulent blood flow through the brachial artery generates a series of sounds. Classically, these have been described according to five phases. Phase 1 is characterized by a clear, repetitive tapping sound, coinciding with reappearance of a palpable pulse. The initial appearance of phase 1 sounds is equal to the systolic blood pressure. During phase 2, audible murmurs in the tapping sounds are heard. In phases 3 and 4, muted changes in the tapping sounds occur (usually within 10 mm Hg of the true diastolic pressure) as the pressure measurement approaches the diastolic pressure. Phase 5 is not really a sound; it indicates the disappearance of sounds and equates to the diastolic blood pressure.

To ensure that diastole has been reached, continue to deflate the cuff pressure for an additional 10 mm Hg beyond the fifth Korotkoff sound.

Obtain a minimum of two blood-pressure measurements at intervals of at least 1 minute.[1] Record the average of the measurements as the blood pressure.

BLOOD-PRESSURE CLASSIFICATION

Normal adult blood pressure is defined as a systolic pressure less than 120 mm Hg and a diastolic pressure less than 80 mm Hg. Higher blood pressures are considered to indicate prehypertension and hypertension, which is also divided into stages (Table 2).[1]

OBSERVER ERROR

A common error in blood-pressure measurement is the introduction of observer bias, which occurs in two forms. The first occurs when practitioners show terminal-digit preference, and the second occurs when practitioners round the terminal

Table 2. Blood-Pressure Classification.

Classification*	Systolic	Diastolic
	mm Hg	
Normal	<120	<80
Prehypertension	120–139	80–89
Stage I hypertension	140–159	90–99
Stage II hypertension	≥160	≥100

* For classification of blood pressure as normal, the requirements for both systolic and diastolic pressure must be met; for the remaining categories, either the systolic or the diastolic requirement must be met.

digits, as when recorded blood-pressure levels are rounded to a 0 or a 5.[1] Manometer scales are generally scored in 2-mm increments, so a terminal digit of 5 cannot be read and the terminal digit 0 should occur only 20% of the time. Use of an appropriate deflation rate and careful recording of the appearance and disappearance of Korotkoff sounds generally facilitates precise measurement.

A parallax error may occur when mercury manometers are used if the observer is not at eye level with the mercury column. Such misalignment between the eye and the mercury meniscus may cause the meniscus to be read as higher or lower than the actual position.

SPECIAL CIRCUMSTANCES

Certain clinical conditions may complicate blood-pressure measurement or its interpretation. In the case of arrhythmias and dysrhythmias, irregularity in the timing of Korotkoff sounds (e.g., atrial fibrillation) can decrease the accuracy of a measurement. Accuracy can be improved by decreasing the deflation rate and by taking an average of several measurements.

Atherosclerotic vascular disease can result in the persistence of audible Korotkoff sounds (prolonged Korotkoff phase 4 or absence of phase 5) despite deflation to 0 mm Hg. This is called persistent systole and may occur in older patients and during pregnancy. In this situation, diastole should be estimated by noting the appearance of the fourth Korotkoff sound.

Occasionally, a patient with an exceptionally large arm circumference requires a cuff size that cannot be adequately positioned between the antecubital fossa and the upper arm. This can lead to patient discomfort and inadequate compression of the brachial artery. If an appropriate cuff cannot be fitted above the brachial artery, then it may be better to place a cuff on the forearm with auscultation of Korotkoff sounds at the radial artery. Care should be taken to ensure that the forearm is supported level with the heart. If the forearm is below heart level, a false elevation in pressure may occur, owing to increased hydrostatic forces.

Normal blood pressure fluctuates over a 24-hour period. In some situations, it may be prudent to obtain measurements at different times during the day, particularly when diagnosing or monitoring hypertension. It is also important to consider the timing and type of antihypertensive medications used when interpreting blood-pressure measurements in hypertensive patients.

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