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Blood Pressure Measurement

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Overview

The term blood pressure (BP) describes lateral pressures produced by blood upon vessel walls. BP is a vital sign obtained routinely in hospital and outpatient settings, and is one of the most common tests performed around the world. It can be determined directly with the intra-arterial catheter or by indirect method, which is a non-invasive, safe, easily reproducible, and thus most used technique. One of the most important applications of BP measurements is the screening, diagnosis, and monitoring of hypertension, a condition that affects almost one third of the U.S. adult population and is one of the leading causes of the cardiovascular disease.

BP can be measured automatically by oscillometry or manually by auscultation utilizing a sphygmomanometer, a device with an inflatable cuff to collapse the artery and a manometer to measure the pressure. Determination of the pulse-obliterating pressure by palpation is done prior to auscultation to give a rough estimate of the target systolic pressure. Next, the examiner places a stethoscope over the brachial artery of the patient, inflates the cuff above the expected systolic pressure, and then auscultates while deflating the cuff and observing the manometer readings. When the pressure in the cuff falls below the pressure in the brachial artery, the turbulent blood flow in a partially-squeezed artery produces Korotkoff audible sounds **(Figure 1).** The first audible Korotkoff sound signifies the maximum arterial pressure during systole. When the pressure in the cuff is reduced further and falls below the minimal arterial pressure (during diastole), the Korotkoff sounds become no longer audible. The reading at this point signifies diastolic blood pressure **(Figure 1).** The blood pressure is measured in mmHg and recorded as a fraction (systolic BP/ diastolic BP).

The equipment needed for indirect measurement of blood pressure by auscultatory method is a stethoscope and a sphygmomanometer. The sphygmomanometer consists of a BP cuff containing a distensible bladder, a rubber bulb with an adjustable valve for inflating the cuff and releasing the pressure, tubing connecting the cuff to the bulb, and a manometer to indicate the cuff's pressure.

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In most instances, the vital signs are initially measured by a health care assistant or registered nurse (RN). The physician may choose to repeat the vital signs and blood pressure measurement after completion of the patient interview. Repeated measurement of blood pressure is especially important given the potential measurement errors and blood pressure variations.

Procedure

1. Preparation for exam.

1.1 Assess for any contraindications to BP measurement in the upper arm including arteriovenous fistula, history of axillary lymph node dissection, or evident lymphedema.

1.2 Make sure the patient has changed into a gown and rested for at least 5 min prior to obtaining blood pressure and other vital signs.

1.3 Have the patient sit comfortably with their feet uncrossed and resting on the floor.

1.4 Have the stethoscope and sphygmomanometer ready.

1.5 Confirm proper sizing of the BP cuff (when wrapped around the limb the index line on the cuff should fall within the marked arm circumference range limits). A small cuff may falsely elevate the readings and potentially lead to misdiagnosis.

2. Determination of pulse-obliterating pressure by palpation.

Obtaining the pulse-obliterating pressure prior to measurement of blood pressure by auscultation allows to avoid measurement error due to the auscultatory gap. An auscultatory gap is an intermittent disappearance of Korotkoff sounds after their initial appearance before the true diastole, which may seriously underestimate the systolic pressure or overestimate the diastolic pressure.

2.1 Place the cuff on the patient's arm about 2.5 cm above the antecubital fossa.

2.2 Make sure the patient's arm is free of clothing and resting at their side with the brachial artery at the level of the heart.

2.3 Identify the radial pulse with your index and middle fingers.

2.4 Close the valve on the pressure bulb (by turning it clockwise with your thumb) and inflate the cuff by squeezing the pressure bulb rapidly.

2.5 Inflate the cuff until the radial pulse cannot be felt anymore and note the measurement on the manometer.

2.6 Continue to inflate the cuff until the pressure increases for an additional 30 mmHg. This is done to avoid over-inflation of the cuff on subsequent readings.

2.7 Open the valve slowly by rotating it counterclockwise with your thumb.

2.8 Deflate the cuff at 2 mmHg/sec until the radial pulse returns.

2.9 Record the manometer reading when the radial pulse reappears (obliterating pressure) on the vital signs flow sheet.

3. Obtaining blood pressure with auscultation.

3.1 Place the stethoscope over the brachial artery (medial aspect of antecubital fossa).

3.2 Inflate the cuff again at a level of 30 mmHg above pulse-obliterating pressure and make sure no sounds are present.

3.3 Slowly deflate the cuff at a rate of 2 mmHg/sec.

3.4 Note the value on the manometer when the Korotkoff sound, indicated by the first two consecutive beats, can be heard. The manometer reading at that moment corresponds to the systolic blood pressure.

3.5 Continue slowly deflating the cuff while listening for the sounds to completely disappear, which signifies the diastolic blood pressure.

3.6 Make sure to deflate the cuff entirely so as not to miss the diastolic pressure.

3.7 Record the systolic and diastolic blood pressure measurements on the vital signs sheet. Systolic and diastolic blood pressures are recorded as numerator and denominator and are measured in mmHg (for example, normal values of blood pressure are 120/80 mmHg).

3.8 Repeat the process in both arms (unless contraindicated).

4. Testing for pulsus paradoxus.

Normally, the systolic blood pressure is lower on inspiration due to decreased intrathoracic pressure. An abnormally large fall (more than 10 mmHg) in systolic blood pressure on inspiration is defined as pulsus paradoxus and is most commonly associated with cardiac tamponade or severe chronic obstructive pulmonary disease**.**

4.1 Inflate the cuff to 30 mmHg higher than the systolic pressure determined during blood pressure measurement.

4.2 Deflate at 2 mmHg/sec until the first Korotkoff sound is audible on expiration (sound should be intermittent rather than every heartbeat, corresponding to higher blood pressure on expiration). Note the measurement.

4.3 Continue to deflate the cuff at 2 mmHg/sec until the Korotkoff sounds are audible on both expiration and inspiration (every heartbeat). Lower blood pressure on inspiration is due to a decrease in intrathoracic pressure.

4.4 Calculate the difference between systolic blood pressure on expiration and inspiration.

5. Orthostatic or Postural blood pressure measuring.

An orthostatic hypotension is an abnormal decrease in systolic blood pressure of 20 mmHg or a decrease in diastolic blood pressure of 10 mmHg within 3 min of standing compared with blood pressure in supine or sitting position. This can result from compromised venous return and subsequent decrease in cardiac output. Orthostatic hypotension can happen transiently in people of all ages, but occurs most commonly in elderly patients. Some potential causes include blood loss, medications, and disease of the autonomic nervous system.

5.1 Place the patient in a supine position. Wait for a minimum of 5 min before obtaining the reading.

5.2 Obtain a blood pressure measurement as described.

5.3 Record the measurement on the vital signs sheet. Make sure to note the position of the patient.

5.4 Have the patient stand and repeat the BP measurement after 3 min of standing.

5.5 Calculate the difference in pressures. If there is a decrease of 20 mmHg or greater in the systolic pressure, or 10 mmHg or greater in the diastolic pressure, the patient has orthostatic hypotension.

Summary

An accurate measurement of blood pressure is essential for timely diagnosis and treatment of abnormal BP. Although patients can sustain higher blood pressure (hypertension) for a longer period of time, which is a key factor in developing cardiovascular disease or stroke, a drastically low (hypotensive) or decreasing blood pressure can be fatal if not treated in time. Despite being a simple and non-invasive measurement, obtaining accurate BP is a skill that requires practice, and correct interpretation of the findings requires good understanding of physiology and pathophysiology behind the principle of this procedure.

An examiner should be aware of common pitfalls in blood pressure measurement, including improper technique, examiner bias, and faulty equipment. In addition, certain clinical scenarios might interfere with establishing blood pressure levels, including arrhythmia (atrial fibrillation) and “white coat hypertension”, an elevation of blood pressure only during the office visits.

Figures and Legends

Figure 1. Principle of the blood pressure measurement by auscultation.

Comment [DM2]: We don’t have rights, Anna’s asked if we can reproduce something similar.

The effects of the inflatable cuff on blood flow with relation to arterial pulse tracing and auscultatory findings.

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