Non-Invasive Blood Pressure Monitoring

Expected Practice:
- Measure blood pressure (BP) in the upper arm using the oscillatory or auscultatory method. [Level D]
  - If upper arms cannot be used for BP measurement or if the maximum size BP cuff does not fit the upper arm, blood pressure may be measured in the forearm.
  - Consider use of thigh and calf for BP measurement if the upper arms and forearms cannot be used.
- Use appropriate size BP cuff and follow instructions for fit and placement per manufacturer’s recommendations. [Level D]
- Measure baseline BP in both upper arms. For significant differences in BP, use the arm with the higher pressure. [Level D]
- Position patient: As with intra-arterial blood pressure monitoring, the appropriate reference level for noninvasive measurement of blood pressure is the heart. [Level D]

- Patient should be seated with back and arms supported, feet on floor, and legs uncrossed with upper arm at heart level (phlebostatic axis: 4th intercostal space, halfway between the anterior and posterior diameter of the chest) (Figure 1)
- If patient cannot be seated, position patient supine (Figure 2) or with head of bed at a comfortable level (Figure 3) and with upper arm supported at heart level.

- The patient and the caregiver should remain quiet throughout the procedure of taking a BP. [Level B]
- Accurate assessment of blood pressure is imperative. Therefore health care providers must be consistent in measuring blood pressure. Blood pressure measurements should be taken in the same arm with the same type of device. [Level B]

- Assess the skin integrity under the cuff on a routine basis.

Scope and Impact of the Problem:
Blood pressure is measured in virtually all patients receiving healthcare. Accurate measurement of blood pressure is essential to guide management decisions. Inaccuracy may lead to over- or under treatment of the patient’s condition, resulting in adverse outcomes.

Supporting Evidence:
- Studies comparing oscillatory BPs to intra-arterial and/or auscultatory BPs were reviewed. Each manufacturer of automatic oscillatory devices has its own algorithm for deriving systolic and diastolic from the detected mean arterial pressure; readings from one device may differ from another. Thus, comparison between studies is difficult if different oscillometric devices and data collection procedures are used. Recent evidence suggests that automated oscillometric devices, as compared to mercury sphygmomanometer, slightly overestimate systolic blood pressure (2.12 mm Hg) and underestimate diastolic blood pressure (2.36 mm Hg). Since these methods to measure blood pressure may not agree they should not be used interchangeably. Consistent use of a method to measure blood pressure should be used.
To promote accuracy, nurses should use oscillatory devices that meet the Association for the Advancement of Medical Instrumentation standards (mean difference ± 5mm Hg and standard deviation ≤ 8mm Hg) when compared to auscultatory method and the appropriate size cuff.

Stiffness of the arteries, particularly in older patients, also influences amplitude of the oscillations and may cause underestimation of mean arterial pressure. Accuracy of the automated device may also be limited if patients are hypertensive, hypotensive, and/or have cardiac dysrhythmia. While some studies showed difference < 5mm Hg between BP measurement methods, other studies demonstrated that individual differences may be > 10mm Hg for some individuals. Vasopressors have shown no significant effect on difference.

Research shows that the forearm and upper arm BPs are not interchangeable. If the forearm is used, selection of the proper cuff size and positioning of forearm at heart level are necessary.

If using the forearm, position the cuff midway between the elbow and the wrist. If using the calf, position the lower edge of the cuff approximately 2.5cm above the malleoli. If using the thigh, position the cuff over the lower third of the thigh so that the lower edge of the cuff is approximately 2 to 3cm above the popliteal fossa.

If the thigh or calf is used for BP measurement, the same attention to selection of proper cuff size is necessary. For calf BP measurements, place the patient in the supine position. Place the patient in the prone position for thigh BP measurements. If the patient cannot be placed in the prone position, position the patient supine with knee slightly bent. Normally, thigh pressures are higher than upper arm pressures though no research was found to substantiate this. Research demonstrates that calf pressures are not interchangeable with upper arm pressures.

Calf BP measurement is also referred to as an ankle BP. If a stethoscope is used, Korotkoff’s sounds are auscultated over either the dorsalis pedis, or the posterior tibial artery (for calf BP), or the popliteal artery (for thigh BP). Results of comparisons of automatic, noninvasive upper arm and calf BPs in adults vary. Overall systolic BP measurements were higher in the calf than the arm in patients undergoing surgery, colonoscopy, and caesarean delivery under spinal anesthesia. Differences in mean BP and diastolic BP were not consistent. Large differences for some individuals make it difficult to devise a predictive formula that would be applicable in all situations.

In adults, calf BPs should be used only if the upper arm is not accessible or if the appropriate size cuff is not available.

Multiple reasons exist why an extremity may not be suitable for BP measurement. BP cuffs should not be used on an extremity with a deep vein thrombosis, grafts, ischemic changes, arteriovenous fistula, or arteriovenous graft. BP cuffs should not be applied over a peripherally inserted central catheter (PICC) or midline catheter site but may be placed distally to the insertion site. BP measurements should not be taken in extremities with peripheral IV while an infusion is running or any trauma/incision. For patients who have had a mastectomy or lumpectomy, do not use the involved arm(s) for BPs if there is lymphedema.

Wrap cuff snugly around upper arm so that the end of the cuff is 2 to 3cm above the antecubital fossa to allow room for placement of the stethoscope for manual B/P measurement. Align the cuff to ensure the mark on the cuff for artery is placed over the artery.

Selection of a BP cuff of the appropriate size is necessary for accurate measurement of BP. Studies show that the use of a cuff that is too narrow results in an overestimation of BP, and a cuff that is too wide underestimates BP. A falsely high pressure reading may result when the cuff is too small relative to the patient arm circumference. If the cuff is too large, falsely low pressure readings can result. A cuff with a bladder of an adequate size capable of going around 80% of the arm is recommended. If the thigh or calf is used, the same attention to selection of proper cuff size is necessary.

Patients with aortic dissection, congenital heart disease, coarctation of the aorta, peripheral vascular disease, and unilateral neurological and musculoskeletal abnormalities may demonstrate a difference in inter-arm BP. Additionally, research has shown that up to 20% to 40% of individuals without the above conditions may also have measurable difference of 10 to 20mm Hg in systolic and diastolic BP between the left and right arms. Research methodology included oscillatory or auscultatory BP measurements with both methods demonstrating similar findings. Age was a factor in one study with higher mean differences in both systolic BP and diastolic BP in older participants. If there is a consistent interarm difference, use the arm with the higher pressure.

Body position and arm position influence the measurement of BP. With the arm placed at heart level and the patient supine, the systolic BP readings are approximately 8mm Hg higher than in the sitting position. Studies also show that if the arm is below the level of the right atrium or heart level, the BP readings will be higher. Conversely, if the arm is above heart level, the BP readings will be lower. This average BP difference of up to 10mm Hg when the arm is not at heart level is attributed to the effects of hydrostatic pressure.

Systolic and diastolic BPs of hypertensive and normotensive patients increase with talking.
Prolonged use of automated devices and frequent blood pressure measurements can cause excessive venous pressures and tissue ischemia. A one-minute gap between repeat inflations of the cuff should be done to avoid venous congestion.

Excessive movement of the patient (shivering or restlessness) can interfere with detection of cardiac oscillations and can lead to erroneous readings.

AACN Evidence Leveling System

Level A  Meta-analysis of quantitative studies or metasynthesis of qualitative studies with results that consistently support a specific action, intervention or treatment.

Level B  Well-designed, controlled studies with results that consistently support a specific action, intervention or treatment.

Level C  Qualitative studies, descriptive or correlational studies, integrative review, systematic reviews, or randomized controlled trials with inconsistent results.

Level D  Peer-reviewed professional organizational standards with clinical studies to support recommendations.

Level E  Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations.

Level M  Manufacturer’s recommendations only.

Actions for Nursing Practice:

- Ensure that your facility has written procedures for BP measurement that include documentation of site and inter-arm differences.
- Ensure proper size cuffs are readily available and that devices meet appropriate standards.
- Provide routine training and retraining of healthcare providers in BP measurement and equipment use.

Need More Information or Help?

- Go to [www.aacn.org/prninfo](http://www.aacn.org/prninfo).

References:


6. Parker SB, Steigerwalk SP. The Dinamap dilemma: inaccuracy of the commonly used Dinamap 8100 compared to simultaneous mercury manometer measurement in hospitalized patients at different levels of blood pressure [abstract]. Am J Hypertens. 2004;17(suppl 1):S52.


