

AACN Practice Alert

Obtaining Accurate Noninvasive Blood Pressure Measurements in Adults

Scope and Impact of the Problem

Blood pressure (BP) is measured in virtually all patients receiving health care. Accurate measurement of BP is essential to guide management decisions and prevent adverse outcomes. Noninvasive BP (NIBP) monitoring is considered a safe practice; however, complications can occur. Bruising and skin irritation from compression are the most commonly occurring complications.¹ Prolonged periods of frequent NIBP measurements have been associated with rare complications, including pain, limb edema,² phlebitis,³ compartment syndrome, peripheral neuropathy, thrombophlebitis, venous stasis, ecchymosis, and petechiae.^{2,3} Conditions that place patients at high risk for complications include diabetes,^{4,5} arterial or venous insufficiency, preexisting peripheral neuropathies, decreased limb perfusion, thrombolytic therapy, anticoagulation therapy,² increased arm activity (eg, seizures, shivering), irregular cardiac rhythms, and decreased level of consciousness.³

Expected Practice

1. Measure BP in the upper arm (between the shoulder and the elbow) using the oscillatory or auscultatory method. [level D]
2. Use appropriate-size BP cuff and follow instructions for fit and placement per manufacturer's recommendations. [level D]

AACN Levels of Evidence

- Level A** Meta-analysis of quantitative studies or metasynthesis of qualitative studies with results that consistently support a specific action, intervention, or treatment (including systematic review of randomized controlled trials)
- 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 reviews, systematic reviews, or randomized controlled trials with inconsistent results
- Level D** Peer-reviewed professional and organizational standards with the support of clinical study 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

- a. If upper arms cannot be used for BP measurement or if the maximum size BP cuff does not fit the upper arm, BP may be measured in the forearm.
- b. Consider use of thigh and calf for BP measurement if the upper arms and forearms cannot be used.
3. Measure baseline BP in both upper arms. For clinically significant differences in BP (>10 mm Hg), use the arm with the higher pressure. [level D]
4. Positioning of patient: The appropriate reference level for NIBP measurement is the heart. [level D]
 - a. Patient should be seated with back and arms supported, feet on floor, and legs

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uncrossed with upper arm at heart level (phlebostatic axis: 4th intercostal space, halfway between the anterior and posterior diameter of the chest; Figure 1).

- b. 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.
5. The patient and the caregiver should not speak while BP is being measured. [level B]
6. Minimize complications by using the maximum (least frequent) NIBP cycle time for the shortest time period and by ensuring proper cuff placement. [level E]

Supporting Evidence

Use of NIBP Monitoring

1. Studies comparing oscillatory BPs with intra-arterial^{6,7} and/or auscultatory BPs⁸⁻¹⁵ were reviewed. Each manufacturer of automatic oscillatory devices has its own algorithm for deriving systolic and diastolic pressures from the detected mean arterial pressure; readings from one device may differ from readings from another. Thus, comparison between studies is difficult if different oscillometric devices and data collection procedures are used.
2. To promote accuracy, nurses should use oscillatory devices that meet the Association for the Advancement of Medical Instrumentation standards (mean difference, ± 5 mm Hg and standard deviation ≤ 8 mm Hg when compared with auscultatory method)¹⁶ and the appropriate size cuff.
3. Stiffness of the arteries, particularly in older patients, also influences amplitude of the oscillations and may cause underestimation of mean arterial pressure.^{8,15} Accuracy of the automated device may also be limited if patients are hypertensive,⁸ hypotensive,¹⁰ and/or have cardiac dysrhythmia.¹⁷
4. With beat-to-beat variation in BP in patients with atrial fibrillation, both auscultation and oscillatory BP measurements may vary, and there are recommendations to perform 3 consecutive measurements in outpatient settings.¹⁸ Studies are limited, with marked heterogeneity, and have



Figure 1 Correct cuff and arm positioning in sitting patient. Used with permission from Cristiana Hospital, Newark, DE.



Figure 2 Correct cuff and arm positioning in supine patient. Used with permission from Cristiana Hospital, Newark, DE.



Figure 3 Correct cuff and arm positioning with head of bed elevated. Used with permission from Cristiana Hospital, Newark, DE.

yielded varied results to either recommend or not recommend the use of oscillatory BP measurement in patients with atrial fibrillation.^{17,19}

Cuff Size and Placement

1. Selection of a BP cuff of the appropriate size is necessary for accurate measurement of BP. Studies have shown that the use of a cuff that is too narrow results in an overestimation of BP, and a cuff that is too wide yields underestimates of BP. A falsely high pressure reading may result when the cuff is too small relative to the patient's 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.^{16,20-22} If the thigh or calf is used, the same attention to selection of proper cuff size is necessary.
2. Research has shown that BP measurements in the forearm and upper arm are not interchangeable. If the forearm is used, selection of the proper cuff size and positioning of the forearm at the level of the heart are necessary.²³⁻³⁰
3. Results of comparisons of automatic, NIBP measurements in the upper arm and calf of 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.³¹⁻³³ 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.³⁴ In adults, calf BPs should be used only if the upper arm or forearm are not accessible^{31,35} or if the appropriate size cuff is not available.
4. Although no evidence-based research is available, multiple guidelines and patient education sources state reasons why an extremity may not be suitable for BP measurement. Reasons include deep vein thrombosis, grafts, ischemic changes, arteriovenous fistula, arteriovenous grafts, and peripherally inserted central catheters or midline catheters.³³⁻⁴⁰ For patients who have had a mastectomy or lumpectomy, do not use the involved arm(s) for BP measurements if lymphedema is present.^{20,41}
5. Wrap cuff snugly around upper arm so that the end of the cuff is 2 to 3 cm above the antecubital fossa to allow room for placement of the stethoscope for manual BP measurement.²⁰ Align the cuff to ensure that the mark on the cuff for artery is placed over the artery.
6. 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 2.5 cm 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 3 cm above the popliteal fossa.^{31,35}
7. Calf BP measurement is also referred to as an ankle BP. If a stethoscope is used, Korotkoff sounds are auscultated over either the dorsalis pedis or posterior tibial artery (for calf BP) or the popliteal artery (for thigh BP).
8. 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 BP between the 2 arms.^{21,22} Additionally, research has shown that up to 20% to 40% of persons without the just-listed conditions may also have a measurable difference of 10 to 20 mm Hg in systolic and diastolic BP between the left and right arms.²⁰⁻²² Research methods included oscillatory or auscultatory BP measurements, with both methods yielding similar findings. Age was a factor in one study²¹ 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.²⁰

Positioning of Patients

1. Body position and arm position influence the measurement of BP.^{20,42,43} With the arm placed at heart level and the patient supine, the systolic BP readings are approximately 8 mm Hg higher than with the patient sitting.^{20,44,45} 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 mean BP difference of up to 10 mm Hg when the arm is not at heart level is attributed to the effects of hydrostatic pressure.^{20,44,45}

2. For calf BP measurements, position the patient supine.^{29,30} Place the patient prone for thigh BP measurements. If the patient cannot be placed prone, position the patient supine with knee slightly bent.^{29,30}
3. Systolic and diastolic BPs of hypertensive and normotensive patients increase with talking.⁴⁵

Patient Safety

1. To minimize complications, ensure proper cuff placement. The cuff should not be placed over a bony prominence, superficial nerve,⁴⁶ or joint. Use the maximum (least frequent) NIBP cycle time for the shortest time period possible. During prolonged monitoring, inspect the cuff site and extremity^{3,47} and consider alternating between limbs.² Consider arterial pressure monitoring for prolonged surgery, severe hypotension, and shock.³

Actions for Nursing Practice

Determine the best site and method of NIBP measurement for your patient.

Use the appropriate size cuff for the patient's size and the extremity to ensure the best results.

Follow your facility's procedures for BP measurement, including documentation of site and interarm differences.

Promptly report any BP monitoring equipment or cuffs that are not working properly and take them out of service until they can be inspected by the biomedical department.

Ensure appropriate positioning of patients during BP measurement.

Compare acquired values with the actual assessment of the patient and his or her clinical condition.

Evaluate skin at the site and circulation in the extremity being used for BP measurement.

Make sure that all personnel are competent in use of the types of equipment available on your unit.

Need More Information or Help?

1. Contact a clinical practice specialist for additional information: go to www.aacn.org/practice-resource-network.

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