

NONINVASIVE BLOOD PRESSURE MONITORING

Expected Practice:

- ☑ Measure blood pressure (BP) in the upper arm using the oscillatory or auscultatory method.
 - 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 measure 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.
- ☑ Measure baseline BP in both upper arms. For significant differences in BP, use the arm with the higher pressure.
- ☑ Position patient:
 - 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.

Supporting Evidence:

- Studies comparing oscillatory BPs to intra-arterial^{1,2} and/or auscultatory BPs³⁻¹¹ were reviewed. Each manufacturer of automatic oscillatory devices has its own algorithm for deriving



Figure 1



Figure 2



Figure 3

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. To promote accuracy, nurses should use oscillatory devices that meet the Association for the Advancement of Medical Instrumentation standards (mean difference \pm 5mm Hg and standard deviation \leq 8mm Hg) when compared to auscultatory method¹² 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.^{3,10} Accuracy of the automated device may also be limited if patients are hypertensive,³ hypotensive,⁵ and/or have cardiac dysrhythmia.¹³ 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.^{5,8} (Level IV)
- Research has shown 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.¹³⁻¹⁷ (Level VI)
- 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.^{18,19}
- 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.¹⁸ Place the patient in the prone position for thigh BP measurements. If the patient cannot be place prone, position the patient supine with knee slightly bent.¹⁹ Normally, thigh pressures are higher than upper arm pressures though no research was found to substantiate this.¹⁹ (Level II) Research has demonstrated that calf pressures are not interchangeable with upper arm pressures.^{20,21} (Level IV)

- 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 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.²⁰⁻²² (Level V) 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.²¹ In adults, calf BPs should be used only if the upper arm is not accessible²⁰ 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.²³⁻²⁵ 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.²³ BP measurements should not be taken in extremities with peripheral IV while an infusion is running²⁶ 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.^{13,27} (Level II)
- 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.¹³ 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 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 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.^{13,23,28-30} If the thigh or calf is used, the same attention to selection of proper cuff size is necessary. (Level VI)
- 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.³¹ 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.³²⁻³⁶ 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.³² (Level V)
- Body position and arm position influence the measurement of BP.^{13,37,38} 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.^{13,39,40} 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.^{13,39,40} (Level VI)
- Systolic and diastolic BPs of hypertensive and normotensive patients increase with talking.^{13,41-43} (Level V)

What You Should Do:

- Ensure that your units have a written practice document such as policy, procedure, or standard of care for BP measurement that includes documentation of site and inter-arm differences.
- Ensure proper size cuffs are readily available.
- Provide routine training and retraining of healthcare providers in BP measurement and equipment use.

AACN Grading Level of Evidence

Level I:	Manufacturer's recommendations only
Level II:	Theory based, no research data to support recommendations; recommendations from expert consensus group may exist
Level III:	Laboratory data, no clinical data to support recommendations
Level IV:	Limited clinical studies to support recommendations
Level V:	Clinical studies in more than 1 or 2 patient populations and situations to support recommendations
Level VI:	Clinical studies in a variety of patient populations and situations to support recommendations

Need More Information or Help?

- Talk with a clinical practice specialist for additional information / assistance at www.aacn.org then select PRN.

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