Accurate Blood Pressure Measurement: What It Is, Why It's Important, and How to Ensure Reliable Results

Similar to the pressure created by water flowing through a garden hose, blood pressure refers to the force exerted by circulating blood on the walls of our arteries and blood vessels. Blood pressure is commonly measured by inflating a cuff on the upper arm and watching the pressure indicated by a blood pressure gauge while listening to the Korotkoff sounds at the brachial artery with a stethoscope. The cuff must first be inflated enough to stop all the blood from flowing through the artery. Then, as the pressure in the cuff is gradually released with a valve, the occlusion of the artery is reduced. The point at which blood begins to flow again is signaled by the first Korotkoff sound. This is an indication of the peak blood pressure in the arteries and is referred to as systolic blood pressure. Continued reduction of the pressure in the cuff eventually allows the blood to flow completely unobstructed again. This point is signaled by the disappearance of the Korotkoff sounds and is considered a reliable indication of diastolic blood pressure.

Typical values for a resting, healthy adult human are approximately 120 mmHg systolic and 80 mmHg diastolic (written as 120/80 mmHg, and spoken as "one twenty over eighty"). Blood pressure varies throughout the day as part of our natural circadian rhythm. Factors such as smoking, stress, drugs, disease, and nutrition also affect blood pressure. Hypertension refers to sustained blood pressure being abnormally high. Hypotension refers to sustained blood pressure that is abnormally low.

In the early 1900s, physicians determined that high blood pressure was a risk factor associated with early death due to coronary heart disease (CHD). Soon afterwards, insurance companies began to require that candidates for life insurance have their blood pressure screened by a physician. In time, taking blood pressure became a routine, vital signs measurement along with temperature and weight.

The New England Journal of Medicine published an interesting paper on blood pressure in its January 6, 2000, edition [1]. This study tracked the blood pressure measurements of 12,031 healthy men in six regions of the world for over 25 years. During the study, 1,291 of the subjects died from CHD. Researchers found that the relative increase in 25-year mortality from CHD for a given increase in blood pressure was similar among all the populations when adjustments were made for age, serum total cholesterol, and smoking. For an increase of 10 mmHg in systolic blood pressure, the relative risk of death from CHD rose by 28%. A 5-mmHg increase in diastolic blood pressure had a similar effect. These results closely match the outcomes of other 10-year studies from different regions of the world. They highlight the impact of even small increases in blood pressure, and therefore the prerequisite of accurate blood pressure measurement.

Unfortunately, measuring blood pressure accurately is not so easy. The accuracy of measurement devices varies widely [2]. The American Heart Association (AHA) continues to recommend the mercury manometer as the instrument of choice for blood pressure measurement [3]. However, even with a perfectly calibrated manometer, the AHA cautions practitioners about common sources of manual measurement error (see Table 1).

With all of these potential obstacles to an accurate manual blood pressure measurement, one might think that an automated device would be preferred. But that is not always the case. Certification of medical devices in the United States is the responsibility of the Food and Drug Association (FDA). For blood pressure devices, the FDA relies upon voluntary compliance by manufacturers to a standard developed by the Association for the Advancement of Medical Instruments (AAMI). However, lack of this designation does not prevent the sale of non-certified blood pressure instruments to hospitals, clinics, or individuals. Currently, no regulatory agency requires the use of AAMI-validated instruments. In fact, some of the most common automated blood pressure measuring devices have never passed AAMI certification [2]. Furthermore, the accuracy problems with inexpensive blood pressure devices, such as some used for home monitoring, are well-documented [4].

Today, most hospitals use automated blood pressure monitors to collect readings but keep a manual sphygmomanometer available for those times that a reading cannot be obtained or for those times when a reading is in doubt. Physician's offices are more likely to use manual sphygmomanometers but are increasingly adopting automated devices in the interest of efficiency. A device that combined the best of both worlds – the speed and automated technique of a monitor with the reliability and accuracy of the mercury manometer – would be an ideal product.

The ADC® ADView® 2 Modular Diagnostic Station is just such a product. It is a fully automated, AAMI-validated blood pressure device with a manual back up mode that allows the user to take traditional blood pressure readings with a stethoscope if needed. Add optional "plug and play" temperature and Sp02 modules and the ADView 2 can be expanded into a full diagnostic station.

The ADView 2 features a modern, compact design that's self-standing for desktop or tabletop use, with desktop caddy, wall mounting, and mobile stand solutions also available.

References

1 van den Hoogen PC, Feskens EJ, Nagelkerke NJ, Menotti A, Nissinen A, Kromhout D. The relation between blood pressure and mortality due to coronary heart disease among men in different parts of the world. Seven Countries Study Research Group. New Engl J Med. 2000 Jan 6; 342(1):1-8. 2 Jones DW, Appel LJ, Sheps SG, Roccella EJ, Lenfant C. Measuring blood pressure accurately: new and persistent challenges. JAMA. 2003 Feb 26; 289(8): 1027-30. 3 Perloff D, Grim C, Flack J, Frohlich ED, Hill M, McDonald M, Morgenstern BZ. Human blood pressure determination by sphygmomanometry. Circulation. 1993; 88:2460-2470. 4 James GD, Pickering TG, Yee LS, Harshfield GA, Riva S, Laragh JH. The reproducibility of average ambulatory, home, and clinic pressures. Hypertension. 1988 Jun; 11(6 Pt 1): 545-9.

Table 1

Common Problems in Measuring Blood Pressure

Problem	Result	Recommendation
Equipment		
Stethoscope ear pieces plugged	Poor sound transmission	Clean ear pieces
Ear pieces poorly fitting	Distorted sounds	Angle ear pieces forward
Bell or diaphragm cracked	Distorted sounds	Replace equipment
Tubing too long	Distorted sounds	Length from ear pieces to bell should be 12 to 15 in (30 to 38 cm)
Mercury manometer		
Meniscus not at 0 at rest	Inaccurate reading	Replace or remove mercury
Column not vertical	Inaccurate reading	Place manometer on level surface
Bouncing of mercury with inflation/deflation	Inaccurate reading	Clean tubing and air vent, replace mercury
Aneroid manometer		
Needle not at 0 at rest	Inaccurate reading	Recalibrate
Bladder/cuff		
Too narrow for arm	Blood pressure too high	Use cuff length 80% of circumference
Too wide for arm	Unable to fit on arm	Use regular but longer cuff
Inflation system		
Faulty valves	Inaccurate reading Difficulty inflating and deflating bladder	Replace equipment
Leaky tubing or bulb	Inaccurate reading	Replace equipment
Observer		
Digit preference	Inaccurate reading	Be aware of tendency; record blood pressure to nearest 2 mm Hg
Cut-off bias	Inaccurate reading	Record to nearest 2 mm Hg
Direction bias	Inaccurate reading	Record to nearest 2 mm Hg
Fatigue or poor memory	Inaccurate reading	Write down reading immediately
Subject		
Arm below heart level	Reading too high	Place patient with midpoint of upper arm at heart level
Arm above heart level	Reading too low	Place patient with midpoint of upper arm at heart level
Back unsupported	Blood pressure too high	Avoid isometric exercise during measurement
Legs dangling	Blood pressure too high	Avoid isometric exercise during measurement
Arrhythmia	Blood pressure level variable	Make multiple measurements and average
Large or muscular arm	Blood pressure reading high	Use appropriate cuff size
Calcified arteries	Blood pressure reading high	Note presence of positive Osler sign in record
Technique		
Cuff		
Wrapped too loosely	Blood pressure reading too high	Rewrap more snugly
Applied over clothing	Inaccurate reading	Remove arm from sleeve
Manometer		
Below eye level	Blood pressure reading too low	Place manometer at eye level
Above eye level	Blood pressure reading too high	Place manometer at eye level
Stethoscope head		
Not in contact with skin	Extraneous noise	Place head correctly
Applied too firmly	Diastolic reading too low	Place head correctly
Not over artery	Sounds not well heard	Place head over palpated artery
Touching tubing or cuff	Extraneous noise	Place below edge of cuff
Palpatory pressure omitted	Danger of missing auscultatory gap Underestimation of systolic pressure	Routinely check systolic pressure by palpation first
Inflation level too high	Patient discomfort	Inflate to 30 mm Hg above palpatory blood pressure
Inflation level too low	Underestimation of systolic pressure	Inflate to 30 mm Hg above palpatory blood pressure
Inflation rate too slow	Patient discomfort Diastolic pressure too high	Inflate at even rate
Deflation rate too fast	Systolic pressure too low Diastolic pressure too high	Deflate at 2 mm Hg/s or 2 mm Hg per beat Deflate at 2 mm Hg/s or 2 mm Hg per beat
Deflation rate too slow	Forearm congestion Diastolic pressure too high	Deflate at 2 mm Hg/s or 2 mm Hg per beat Completely deflate cuff at end of measurement