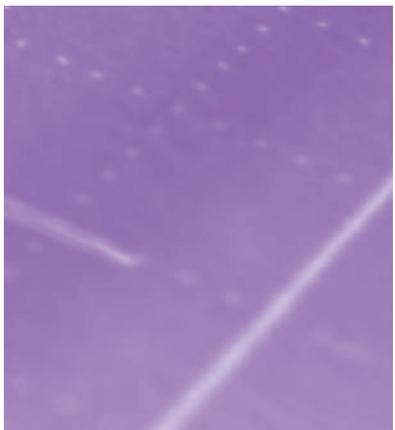
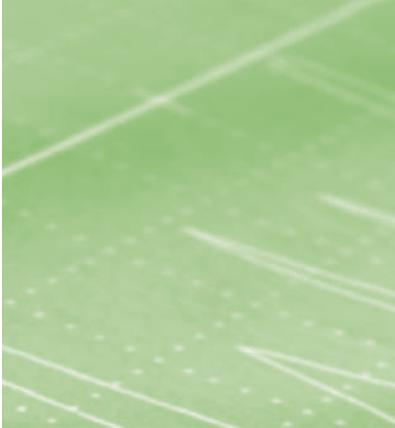


Blood Pressure Measurement Toolkit: Improving Accuracy, Enhancing Care



**Wisconsin Heart Disease and Stroke Prevention Program
Bureau of Community Health Promotion
Division of Public Health
Wisconsin Department of Health Services**

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Dear Health Care Professional:

We are delighted to provide this publication as a toolkit to aid you in your efforts to improve blood pressure measurement accuracy.

Despite effective medications, evidence-based guidelines, and extensive public messaging, uncontrolled hypertension continues to be one of the leading public health issues in the 21st century. We developed this toolkit in the belief that effective blood pressure treatment depends critically on accurate blood pressure measurement.

Accurate blood pressure measurement is within reach of all healthcare providers. The AHA guidelines for blood pressure measurement¹ provide clear, detailed, and compelling guidance to the healthcare professional on all aspects of improving blood pressure measurement. Our objective in this publication is to provide the reader with a “refresher” for the salient elements of those guidelines and to set this in a framework of continuous quality improvement.

It is assumed that the reader has a passing familiarity with the basics of continuous quality improvement, and there are many good sources for this. A few are suggested later in this document. With a basic understanding of quality improvement methods, the reader will see many ways to improve blood pressure measurement in his or her practice.

We hope that you find these materials helpful, and we thank you for your commitment to quality healthcare!

Blood Pressure Measurement Quiz

The following quiz is based on blood pressure measurement guidelines published by the American Heart Association Council for High Blood Pressure Research. This is not an exhaustive test of blood pressure measurement competency. Rather, these questions are intended to help stimulate your thinking about blood pressure measurement and its improvement.

1. How many blood pressure (BP) readings are recommended each time you measure blood pressure?
 - A. one
 - B. at least two
 - C. as many as there is time for
 - D. the same number as taken at the last patient visit
2. Which of the following is true?
 - A. You should never measure blood pressure at the thigh.
 - B. At subsequent visits, it is sufficient to take one blood pressure reading.
 - C. If you take two blood pressure readings and the systolic pressures are 134 and 141, the average should be recorded as the systolic blood pressure.
 - D. At the first visit, blood pressure measurements should be made in both arms.
3. Which of the following patient postures can cause an error of a higher blood pressure reading?
 - A. patient seated on exam table
 - B. arm at heart level
 - C. forearm supported with palm up
 - D. patient's back against chair with feet flat on floor
4. A physician using a mercury column instrument observes a systolic blood pressure reading of 133. Which is the correct recording to make in the patient's chart?
 - A. 130
 - B. 132
 - C. 133
 - D. 134
5. According to evidence-based guidelines, what is the recommended cuff deflation rate for patients who are not bradycardic?
 - A. 2–3 mmHg per second
 - B. 4 mmHg per second
 - C. Accuracy is unaffected by cuff deflation rate.
6. What is the recommended frequency for retraining health care professionals on blood pressure measurement technique?
 - A. every two years
 - B. once per year
 - C. every six months
 - D. up to the discretion of individual clinics

Blood Pressure Measurement Quiz

7. When selecting the correct cuff size, the bladder should be wide enough (the shorter dimension) to encircle at least what percent of the upper arm?
 - A. 30%
 - B. 40%
 - C. 50%
 - D. 80%

8. What is the correct time to wait in between two consecutive blood pressure readings on the same individual?
 - A. not more than 30 seconds
 - B. at least 1 minute
 - C. more than 5 minutes
 - D. no specific time between readings is required

9. Which of the following is false?
 - A. The patient should not talk during the measurement.
 - B. The patient should relax seated for five minutes before the first measurement.
 - C. In the absence of a hard surface to rest her arm, the patient can hold up her arm during blood pressure measurement.
 - D. Urinary bladder distension can cause a significant error in blood pressure measurement.

10. Blood pressure measurement guidelines recommend which of the following?
 - A. use the bell of the stethoscope
 - B. the upper arm should be bare, without constrictive clothing
 - C. inflate the blood pressure cuff to at least 30mmHg above the point where the radial pulse disappears
 - D. all of the above

Blood Pressure Measurement Quiz - Answers

For more details about a specific procedure, refer to the AHA Blood Pressure Measurement Guidelines* on the pages noted.

1. B (Number of Measurements, page 151)
2. D (Subject Preparation, page 149)
3. A (Subject Preparation, page 149)
4. D (Important Points for Clinical Blood Pressure Measurement, page 151)
5. A (Inflation/Deflation System, page 151)
6. C (Retraining, page 153)
7. B (Cuff Size page 150)
8. B (Number of Measurements, page 151)
9. C (Effects of Arm Position, page 150)
10. D (Cuff Placement and Stethoscope and Inflation/Deflation System, page 151)

*Pickering TG, et al. Recommendations for blood pressure measurement in humans experimental animals: a statement for professionals from the Subcommittee of Professional And Public Education Of The American Heart Association Council On High Blood Pressure Research. Hypertension. 2005;Jan:45(1):142-61. Available at: <http://hyper.ahajournals.org/cgi/content/full/45/1/142>

The Need for More Accurate Blood Pressure Measurement

Hypertension (blood pressure > 140/90 mmHg) is the most common primary diagnosis in the United States, affecting nearly 1-in-3 adults.^{2,3} Consider these numbers:

- In 2006, an estimated 25% of the population over age 20 had pre-hypertension, a condition which is estimated to account for nearly 15% of hypertension-related deaths from coronary heart disease.^{3,4}
- There were over 46 million office visits made in 2007 for essential hypertension.²
- The National Health and Nutrition Examination Survey (NHANES) found that only 78% of adults with hypertension were aware of their condition, 68% were receiving treatment and 44% had their blood pressure under control.³
- In the ten years leading up to 2006, the number of deaths due to hypertension increased 48%.⁵

Clearly, hypertension is ubiquitous, silent, and deadly.

Hypertension treatment is linked to clinically significant reduction in cardiovascular risks—a nearly 30-40% reduction in the risk of stroke, 20-25% reduction in myocardial infarction, and more than 50% reduction in heart failure⁶. Although clinical studies show that most people with hypertension can normalize their blood pressure, control rates remain far below the Healthy People 2010 goal of 68%.⁷ A review of clinical literature concludes that regular patient follow-up along with a rigorous, stepped-approach to drug therapy appears to be the most effective approach to controlling blood pressure.⁸ Adhering to evidenced-based practice guidelines, including those for measuring blood pressure, is critical to achieving blood pressure control.

Accurate blood pressure measurement is indispensable for successful detection and management of hypertension.

As a trained healthcare professional you may question the need for a refresher in blood pressure measurement in your practice. You may be thinking, “I have been taking blood pressures correctly for a long time” or “Maybe my reading of blood pressure is off once in a while, but it is the trend that matters.” The fact of the matter is that errors in measuring blood pressure can contribute to inaccurate diagnoses and treatment for millions of people each year. Clinical studies show that 35–60% of healthcare professionals in the United States measure blood pressure incorrectly.^{9,10,11}

For example, a recent study of 373 medical staff found the following:¹²

- 66% never heard of the relevant AHA guidelines.
- 92% never read the guidelines.
- 60% didn’t know how to avoid errors of auscultatory gap.
- 62% did not use the stethoscope bell.
- 35% used Korotkoff Phase 4 as the diastolic reading.
- 48% measured blood pressure with the patient seated on the exam table, which is known to raise diastolic blood pressure by as much as 10 mmHg.

These results beg the question, “What is a negligible error in blood pressure measurement?” and “What difference does being a little off really make?” Clinical studies have attempted to measure the affect of various error modes in blood pressure measurement. The table on the following page is typical and shows that common errors can result in statistically and clinically meaningful inaccuracies in measurement.

A wide range of studies show average blood pressure measurement errors of between 5–15 mmHg.⁹

The Need for More Accurate Blood Pressure Measurement

It's estimated that a 1 mmHg rise in blood pressure above normal on average reduces life expectancy by one year.⁹

Table 1: Factors Affecting Accuracy of Blood Pressure Measurements

Factor	Magnitude of systolic/diastolic blood pressure discrepancy (mmHg)
Talking or active listening	10/10
Distended bladder	15/10
Cuff over clothing	5-50/unknown
Smoking within 30 minutes of measurement	6-20/unknown
Back unsupported	6-10/unknown
Arm unsupported, sitting	1-7/5-11
Arm unsupported, standing	6-8/unknown

Source: http://xnet.kp.org/permanentejournal/sum09/blood_pressure.html

Accurate Blood Pressure Measurement Saves Lives

Surprisingly, even a small difference in measurement can have a considerable impact on the prevalence of cardiovascular events and life expectancy. Researchers approximate that overestimating blood pressure could lead to nearly 30 million Americans receiving inappropriate antihypertensive treatment each year¹³. This would expose individuals unnecessarily to potential adverse side effects and increase healthcare costs. On the other hand, measuring blood pressure 5 mmHg too low in the range of 90–95 mmHg (e.g., when a patient's arm is placed too high or the cuff is too wide) will miss as many as 21 million people with hypertension in the U.S. each year.¹⁴ According to average death rates, about 125,000 of this group are likely to die over a six year period. However, if their hypertension had been diagnosed and effectively treated, 25,000 lives could be saved (about 4,000 lives per year) and an equal number of fatal strokes could be prevented.¹⁵

When blood pressure is measured and treated according to guidelines, even modest reductions can have a clinically significant effect. A meta-analysis of

randomized trials on antihypertensive medications reported that a 5 mmHg reduction in diastolic blood pressure could reduce coronary heart disease by 22% and reduce the incidence of strokes by 41%.¹⁶

Accurate Blood Pressure Measurement Saves Money

Measuring blood pressure accurately can save money, as well. According to data reported by the National Institutes of Health in 2002:

- 60% of renal failure is due to hypertension, with an estimated cost of \$35 billion per year.⁹
- Blood pressure control can delay the onset of renal failure by 4.5 years, saving \$225,000 per person in delayed dialysis.⁹
- Measuring 5 mmHg too high would result in \$1,000 per year to treat each misdiagnosed patient, for a total estimated expenditure of \$27 billion per year.⁹

A history of inaccurately measured high or low blood pressure can affect a patient's eligibility for, or cost of, health, life, or long-term care insurance.

The Need for More Accurate Blood Pressure Measurement

Failure to diagnose hypertension can also lead to malpractice suits. These can be easy cases to lose since accurate measurement of blood pressure is relatively inexpensive and backed by evidence-based guidelines. These types of claims can carry millions of dollars in litigation expense, economic damages, and awards for pain and suffering.

Obviously, improving the accuracy of blood pressure measurement is a simple step toward enhancing care and reducing the clinical and financial toll that measurement errors can have on patients and healthcare professionals.

Improving BP Measurement Can Be Easy

There are many tools available for you to move your organization in the direction of improved blood pressure measurement; many are referenced throughout this toolkit. Many studies demonstrate the feasibility and impact of improving blood pressure measurement. All that is required is the desire to improve, a few tools, and the knowledge to do so.

Accurate blood pressure measurement is an exacting process that requires careful attention and periodic retraining. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC-7) and the American Heart Association (AHA) recommend that those responsible for measuring blood pressure should be trained and regularly retrained, and that all types of equipment should be regularly inspected and validated.^{1,17}

More specifically, the AHA recommends retraining and evaluation on blood pressure measurement technique every six months, including assessment of blood pressure measurement competency through:¹

- Knowledge of proper technique and different types of observer bias
- Awareness of the need for properly maintained and calibrated equipment
- Interpretation of measurements including an understanding of the variability of blood pressure depending on time of day, exercise, and timing of medications
- Demonstration of accurate technique of patient positioning, selection of cuff size, obtaining a valid blood pressure measurement, recording it accurately, and reporting abnormal results.

This toolkit is an easy-to-use guide for retraining healthcare professionals on recommended blood pressure measurement technique or for complementing an existing quality improvement effort. The materials are designed with the busy healthcare and quality improvement professional in mind. They can be used as stand alone resources or as part of a programmatic approach to quality improvement.

- If you are looking for a quick refresher on technique, the table of Common Causes of Blood Pressure Measurement Errors or the Blood Pressure Measurement Procedure may be all you need.
- If you are considering a quality improvement project, you may want to review the various practice guidelines and training programs that are referenced, as well as the section on Developing Quality Improvement.
- If you want to deliver an in-service staff training, you may want to use all of the materials.

Wherever you begin, we hope this resource will provide the information and tools you need to improve blood pressure measurement technique and enhance patient care in your practice.

Obtaining Accurate Blood Pressure Measurements

Blood Pressure Measurement Procedure Patient Preparation

1. Ask if the patient avoided caffeinated beverages and smoking for at least 30 minutes before the examination.
2. Have the patient sit calmly for five minutes with back supported and feet flat on the floor.
3. Patient's upper arm should be bare. Avoid a tourniquet effect if rolling up sleeve.
4. Support the patient's arm on a firm surface at heart level, slightly flexed at the elbow.
5. Both you and the patient should refrain from talking while BP is measured.



Positioning Sphygmomanometer and Cuff

1. Use appropriate cuff size. The inflatable part should be long enough to encircle at least 80% of the arm and wide enough to encircle 40% of the arm at midpoint. When in doubt, select the larger size.

Recommended cuff sizes:

Arm Circumference	Adult Cuff Size
22 to 26 cm	Small adult (12x22 cm)
27 to 34 cm	Adult (16x30 cm)
35 to 44 cm	Large adult (16x36 cm)
45 to 52 cm	Adult thigh (16x42 cm)

Source: American Heart Association Guidelines

2. Wrap the cuff snugly around bare upper arm. The lower edge should be centered two finger widths above the bend of the elbow, and the midline of the bladder should be over the brachial artery pulsation



3. The aneroid dial or mercury column should be clearly visible and facing you.

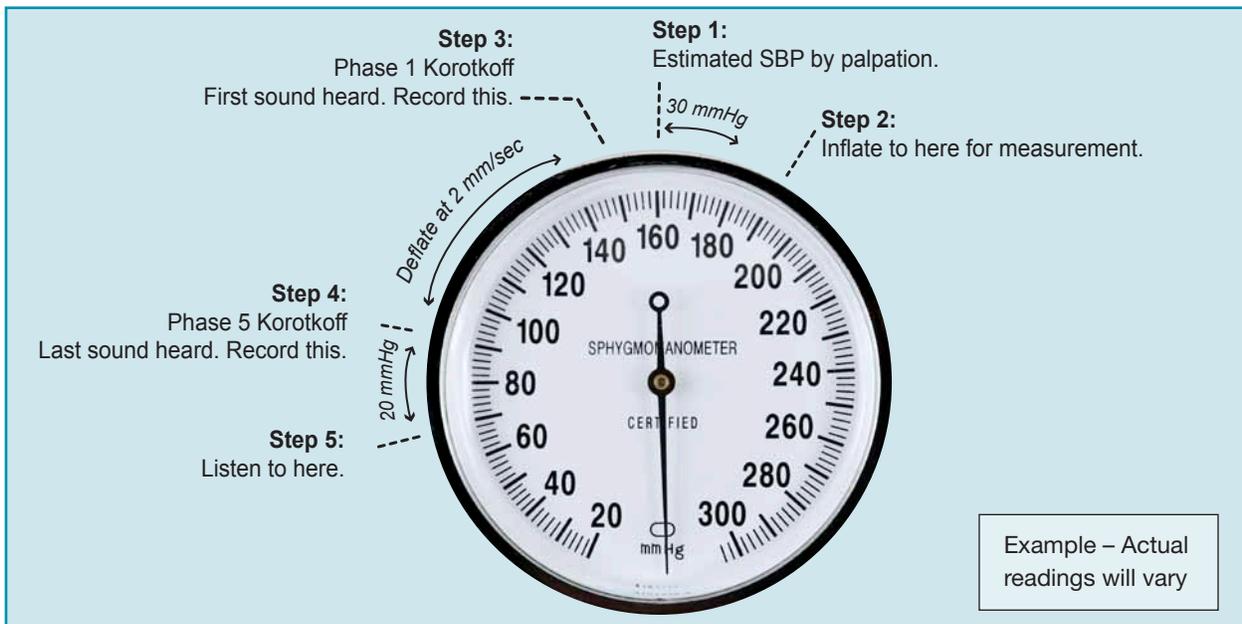


4. Using light pressure, position stethoscope with bell side down over brachial artery and not touching the cuff.

Note: Healthcare providers are encouraged not to rely solely on the manufacturer's markings as to cuff size. Instead, measure the bladder of each cuff before placing it into initial service. Manufacturers differ widely as to what they consider a large, small, etc. size.

Obtaining Accurate Blood Pressure Measurements

Measuring Systolic and Diastolic Pressure



1. Estimate systolic pressure

- Palpate radial artery.
- Inflate the cuff slowly to the point where the pulse disappears. This is the systolic pressure.

2. Blood Pressure Reading

- Rapidly inflate the cuff to 30 mmHg above the estimated systolic pressure.
- Deflate cuff at a steady rate of 2 to 3 mmHg/sec.
- Note the systolic pressure—the first of 2 or more consecutive faint tapping beats (Korotkoff sound phase 1).
- Note diastolic pressure—the last muffled, rhythmic sound (Korotkoff sound phase 5). (The absence of a tapping sound after the initial sound is known as an auscultatory gap. If this occurs, elevate subject's arm overhead for 30 seconds then bring arm to usual supported position to remeasure.)
- Listen for another 10 to 20 mmHg beyond the last sound heard, then quickly deflate cuff to zero.

3. Recheck and Record

- If record system allows, record this BP, rounding up to the nearest 2 mmHg.
- Wait 1 minute and recheck BP. If record system allows, record this BP.
- Average the BP readings and record the average; however, if the first two readings differ by more than 5 mmHg, then take a third measurement and average the three.
- Record blood pressure classification and recommendations for follow-up of patients at various stages of hypertension.
- Communicate to patient verbally and in writing the BP goal for their treatment, their specific BP numbers, and when they should be monitored next. Do not dismiss or minimize to the patient the significance of a borderline reading. If appropriate, discuss medical treatment and lifestyle approaches to preventing and treating high BP.

Pickering TG, et al. Recommendations for blood pressure measurement in humans experimental animals: a statement for professionals from the Subcommittee of Professional And Public Education Of The American Heart Association Council On High Blood Pressure Research. Hypertension. 2005;Jan:45(1):142-61. Available at: <http://hyper.ahajournals.org/cgi/content/full/45/1/142>

Obtaining Accurate Blood Pressure Measurements

Blood Pressure Measurement Procedure Notes

For First Examination

- Obtain 2 readings in each arm, waiting at least 1 minute between readings.
- If the readings consistently differ, the arm with the higher pressure should be used for this and subsequent examinations.

For Subsequent Examinations

- Refer to the patient's chart to determine which arm had the higher reading on the first examination.
- Obtain 2 BP readings in that arm, waiting at least 1 minute between readings.
- If the readings differ by less than or equal to 5 mmHg, then the readings should be averaged and recorded.
- If the readings differ by more than 5 mmHg, then at least one additional reading should be taken and all the readings should be averaged and recorded.

For All Measurements

- Round up to the nearest 2 mmHg.
- Record the average as soon as practical.
- If the charts or electronic health records allow, record the individual measurements and the averages. Also record patient's cuff size, and the position (e.g., standing, seated, supine) and which arm was used.

Table 2: Blood Pressure Classification and Follow-Up in Adults

Blood Pressure Classification	SBP mmHg [◇]	DBP mmHg [*]	Follow-up [†]
Normal	<120	and <80	Recheck in 2 years
Prehypertension	120-139	or 80-89	Recheck in 1 year
Stage 1 Hypertension	140-159	or 90-99	Confirm within 2 months
Stage 2 Hypertension	>160	or >100	Evaluate or refer to source of care within 1 month.

Source: JNC-7, National High Blood Pressure Education Program, National Heart, Lung and Blood Institute, National Institutes of Health, U.S. Department of Health and Human Services, 2003. Publication No. 03-5231.

Classification is based on the average of two or more properly measured, seated blood pressure readings on each of two or more office visits.

* If systolic and diastolic categories fall into different levels of classification, treatment and follow-up should be determined by the highest category (e.g., 132/90 mmHg would be classified as Stage 1 hypertension).

◇ Patients with diabetes or chronic kidney disease should be managed to a blood pressure goal < 130/80 mmHg.

† Modify the scheduling of follow-up according to reliable information about past blood pressure measurements, other cardiovascular risk factors, or target organ disease.

Obtaining Accurate Blood Pressure Measurements

Common Causes of Blood Pressure Measurement Errors

Errors can occur with patient preparation, the equipment, and the observer. Researchers report that observer-related errors are by far the most common; they classify observer errors into one of three categories:

- 1) **Systematic error** is most often due to a lack of concentration or poor hearing. It may result in confusion of auditory and visual cues or misreading of the Korotkoff sounds.
- 2) **Terminal digit preference** refers to the tendency for an observer to record the pressure reading to a convenient digit, such as zero. For example, a reading of 132 is rounded to 130. Several studies have shown bias in favor of the terminal digit zero, which has important implications for decisions about diagnosis and treatment.¹⁷
- 3) **Observer prejudice or bias** implies that an observer adjusts the observed pressure to meet his/her preconceived notion of what the pressure “should be.” This may be expressed as a reluctance to tell a patient s/he has hypertension when the reading is borderline. An observer might record a favorable measurement for a young, healthy man with a borderline increase in pressure, but categorize as hypertensive an obese, middle-aged man with a similar reading.

Table 3: Opportunities for Blood Pressure Measurement Improvement

Equipment Errors	
Problem	Effect and Resolution
Mercury overfilled	Too much mercury may result in a high blood pressure reading. Refer to manufacturer’s information for service.
Mercury under filled	An insufficient amount of mercury may result in an inaccurately low reading. Refer to manufacturer’s information for service.
Occluded diaphragm	The mercury may bounce or stick as it rises, resulting in a faulty reading. Refer to manufacturer’s information for service.
Contaminated mercury or dirty sight tube	The mercury meniscus may be irregularly shaped, impairing the reading. Refer to manufacturer’s information for service.
A leak in the bladder, tubing or pressure bulb; a dirty, worn or broken control valve	Any of these situations may cause the mercury level to drop even when the valve is fully closed, impairing the reading. Contact manufacturer for approved replacement parts, which can usually be replaced without special tools or knowledge.
Sticky control valve	A malfunctioning control valve may inhibit proper deflation, resulting in an inaccurate reading. Contact manufacturer for approved replacement parts, which can usually be replaced without special tools or knowledge.

Obtaining Accurate Blood Pressure Measurements

Table 3: Opportunities for Blood Pressure Measurement Improvement - continued

Patient Preparation Errors	
Problem	Effect and Resolution
Patient not resting for at least 5 minutes prior to measurement	A patient's anxiety may adversely affect blood pressure measurements. Institute rooming policies and procedures to ensure patient rests seated for five minutes before examination.
Patient affected by chemical stimulants	A patient's blood pressure may be affected by recent exposure to nicotine, caffeine, alcohol, etc. Revise rooming procedure to include these questions and make appropriate notations in the patient record. Encourage patient to avoid these substances prior to subsequent examinations.
Patient slumps	If the back is not supported, diastolic pressure can be increased by as much as 6 mmHg. Train examiners to check and correct patient posture prior to measurement. Correct position is seated upright with back supported.
Patient crosses legs or ankles	Crossing the legs or ankles can increase systolic pressure from 2 to 8 mmHg. Train examiners to check and correct patient posture prior to measurement. Correct position is feet flat on floor.
Upper arm considerably below the level of the right atrium	Due to the effects of hydraulic pressure, the reading may be too high. Train examiners to check and correct patient position prior to measurement. Correct position is measurement point on upper arm at about the level of the right atrium.
Upper arm considerably above the level of the right atrium	Due to the effects of hydraulic pressure, the reading may be too low. Train examiners to check and correct patient position prior to measurement. Correct position is measurement point on upper arm at about the level of the right atrium.
Forearm not adequately supported on firm surface	If the patient does not completely rest the arm being measured, then the isometric exercise may raise the blood pressure. Train examiners to check and correct patient position prior to measurement. Correct position is with arm flexed at elbow and the forearm relaxed and resting on a firm, comfortable surface.
Constrictive clothing around arm	Clothing that creates a tourniquet effect may result in an incorrect reading. Train examiners to check and correct patient preparation prior to measurement. Correct condition is with restrictive clothing removed from measured arm.
"Miscuffing" (improper cuff size)	A cuff that is too small will over-estimate blood pressure, and a cuff that is too large will underestimate blood pressure. Provide tape measures at each blood pressure measurement station. Measure and mark all blood pressure cuffs with arm size range prior to first placing into service. Train examiners to correctly measure arm circumference.
Cuff applied too loosely or too tight	When the cuff is not wrapped correctly, it may result in a higher or lower reading. Train examiners to apply the cuff snugly but not too tight. Correct application allows slipping one finger between cuff and arm.
Cuff wrapped over clothing	Measuring blood pressure through clothing can make it difficult to accurately detect Phase I (systolic) and Phase 5 (diastolic) Korotkoff sounds. Train examiners to apply cuff to bare skin.
Bladder misaligned over artery	Blood pressure may read high if the bladder is not over the arterial pulse. Train examiners to palpate for the brachial pulse and to apply the midline of the bladder over that point.

Obtaining Accurate Blood Pressure Measurements

Table 3: Opportunities for Blood Pressure Measurement Improvement - continued

Observer Performance	
Problem	Effect and Resolution
Measuring blood pressure in only one arm at the first examination	Blood pressure can vary considerably between arms and may help to identify aortic coarctation or upper extremity arterial obstruction. Institute rooming policies and procedures to measure blood pressure in both arms at the first examination. Revise patient charts to allow for recording the additional readings.
Taking only one reading at subsequent examinations	The first of a series of blood pressure readings is typically the highest. The average of two or more readings is a better estimation of the true blood pressure. Institute rooming policies and procedures to average two measurements, or three measurements if the first two differ by more than 5 mmHg. Revise patient charts to allow for recording the additional readings.
Inflation rate slow or inconsistent	Slow or inconsistent cuff inflation may cause an auscultatory gap. Elevate the arm overhead for 30 seconds. Bring arm to usual supported position to continue measurement.
Deflation rate too fast	Deflation faster than 2-3 mmHg/second can lead to a significant underestimation of systolic pressure and overestimation of diastolic pressure. Train examiners to deflate the cuff at a rate of 2-3 mmHg/second.
Not estimating SBP—cuff inflated too high	Inflating the cuff too high can be painful to the patient and may cause an incorrect reading. Train examiners to inflate to a point 30 mmHg above the estimated systolic pressure.
Observer-related error (e.g., not measuring to a precision of 2 mmHg, rounding just above or below a particular hypertension category threshold, or a preference for recording zero or some other digit)	Observer-related error hinders determination of blood pressure classification, leading to under- and over-treatment of high blood pressure. Train examiners to record mercury readings to a precision of 2 mmHg rounding upwards. Using the recommended deflation rate also helps to avoid improper estimation and terminal digit bias.
Stethoscope bell placed under cuff or near tubing	Artifact noises can contribute to incorrect readings. Train examiners to place the stethoscope adjacent to but not in contact with the cuff fabric.
Stethoscope applied too firmly	Pulse may be heard below Korotkoff Phase 5, resulting in an incorrect reading. Train examiners to apply the stethoscope with appropriate pressure.
Incorrect, inadequate or incomplete charting	Poor data for clinical decision making and weakened legal defense. Institute policies for record completeness and train examiners. Revise forms and charts to allow for complete recording of blood pressure information.

Maintaining Blood Pressure Measurement Equipment

Poorly maintained equipment may affect blood pressure measurement accuracy. All blood pressure measurement devices—including mercury, aneroid, oscillometric, manual, and automated—should be maintained and calibrated for measurement accuracy at regular intervals. Consult the manufacturer's instructions, specifications, or device labeling for information on the recommended time or number of measurements between calibrations. Follow the manufacturer's instructions on verification or calibration procedure, or refer the device to the manufacturer or a certified testing laboratory for maintenance and service. (The Blood Pressure Measurement Device Maintenance Checklist offers a convenient list of maintenance items). You can find a listing of validated blood pressure measurement devices and calibration services at www.dableducational.com.

Here are some factors to consider that affect blood pressure measurement device accuracy:

Mercury devices

Mercury devices, due to their simple structure, rarely lose calibration. However, increasing concerns about mercury toxicity have caused a shift towards other kinds of blood pressure measuring devices. A mercury manometer is calibrated if the mercury is at "0" on the scale when the device is not under pressure and the mercury is not dirty.

Aneroid devices

Aneroid sphygmomanometers are the most common alternative to mercury devices. However, their mechanical system (bellow and lever) is more susceptible to a loss of calibration due to the bumps and temperature changes of everyday use. These devices can lose accuracy without any obvious signs; although the needle may be at the zero mark without pressure, the instrument will not necessarily provide accurate readings above zero. Consequently, it is recommended that aneroid sphygmomanometers be checked for accuracy against an accurate mercury sphygmomanometer every six months, comparing measurements at a number of points over the complete pressure range.²⁰

Electronic devices

Automated electronic blood measurement devices are growing in popularity, particularly for patient's self-monitoring of blood pressure. Accurate electronic sphygmomanometers offer capabilities such as print-outs of systolic, diastolic, and mean blood pressure; heart rate; the time and date of measurement; and can store data for review later. These devices eliminate errors in interpretation and terminal digit bias. However, automated devices have other limitations. They are based on the oscillometric method that measures mean blood pressure and should not be used in situations such as patients with arrhythmias.¹⁹ In addition, the proprietary algorithms for determining systolic and diastolic pressure vary by manufacturer along with differences in cuff deflation rates. These factors can cause significant variability between different models of electronic blood pressure measurement devices. Since many automated blood pressure measurement devices have not been validated or lack evidence for durability, hypertension experts recommend consulting www.dableducational.com to ensure that specific models are suitable for use.^{18,19,21} All electronic blood pressure measurement devices must also be checked regularly for accuracy against a calibrated manometer.

Maintaining Blood Pressure Measurement Equipment

Recommended Reading: Observer-related and Calibration Errors

1. Niyonsenga T, Vanasse A, Courteau J, Cloutier L. **Impact of terminal digit preference by family physicians and sphygmomanometer calibration errors on blood pressure value: implication for hypertension screening.** *J Clin Hypertens* (Greenwich). 2008 May;10(5):341-7.

The accuracy of blood pressure (BP) measurement is important; systematic small errors can mislabel BP status in many persons. The objective of this study was to assess the impact of 2 types of measurement errors on the evaluation of BP in family medicine: errors associated with terminal digit preference and those associated with calibration errors of sphygmomanometers. Secondary data analyses from 2 different projects were used to derive empiric distributions of terminal digit and BP device errors. Taking into account both types of errors, the proportion of false positives (falsely high BP) and false negatives (falsely normal BP) varied between 0.82% and 5.18% of the population of consulting family physicians. In the United States, false positives and false negatives in patients' BP evaluations might lead to over treating or under treating 1.15 million to 7.25 million patients. Results support the need for the development of systematic interventions for quality control of BP measurements and periodic retraining for health professionals.

2. Turner MJ, Speechly C, Bignell N. **Sphygmomanometer calibration—why, how and how often?** *Aust Fam Physician*. 2007 Oct; 36(10):834-8.

BACKGROUND: Hypertension is the most commonly managed problem in general practice. Systematic errors in blood pressure measurements caused by inadequate sphygmomanometer calibration are a common cause of over- and under identification of hypertension.

OBJECTIVE: This article reviews sphygmomanometer error and makes recommendations regarding in service maintenance and calibration of sphygmomanometers.

DISCUSSION: Most sphygmomanometer surveys report high rates of inadequate calibration and other faults, particularly in aneroid sphygmomanometers. Automatic electronic sphygmomanometers produce systematic errors in some patients. All sphygmomanometers should be checked and calibrated by an accredited laboratory at least annually. Aneroid sphygmomanometers should be calibrated every 6 months. Only properly validated automatic sphygmomanometers should be used. Practices should perform regular in house checks of sphygmomanometers. Good sphygmomanometer maintenance and traceable sphygmomanometer calibration will contribute to reducing the burden of cardiovascular disease and the number of patients over treated for hypertension in Australia.

Maintaining Blood Pressure Measurement Equipment

Blood Pressure Measurement Device Maintenance Checklist

1. Type of Device used: <input type="checkbox"/> Aneroid Manometer <input type="checkbox"/> Mercury Manometer <input type="checkbox"/> Other Serial number of device: _____			
2. Position of the device: <input type="checkbox"/> Wall <input type="checkbox"/> Portable			
	Yes	No	Comments
3. Documentation of last QA check – Date checked:			
4. Integrity of Cuff:			
4.1 Cuff tears			
4.2 Velcro stable at inflating to 220 mmHg:			
4.3 Protruding bladder			
4.4 Line on midline of bladder:			
4.5 Different sized cuffs available: Small, Medium, Large, Thigh, Others			
5. Tubing condition:			
5.1 Cracks or tears			
5.2 Leaks			
5.3 Valve sticks			
6. Device accuracy:			
6.1 Zeroed at 0 pressure:			
6.2 Inflates to 250 mmHg			
6.3 Spontaneous deflation after 30 seconds			

Adapted from: Dickson, B, Hajjar, I. Blood pressure measurement education and evaluation program improves measurement accuracy in community-based nurses: A pilot study. *J Am Acad Nurse Pract.* 2007;Feb:19(2)93-102.

Developing Quality Improvement for Blood Pressure Measurement

While regular retraining and evaluation is an important step toward improving blood pressure measurement accuracy, quality improvement projects can assist healthcare teams to apply recommended guidelines in everyday practice.

Given the many steps in the blood pressure measurement process, it is helpful to think of improving accuracy through a series of small performance improvement projects or rapid improvement cycles. Here are a few examples of common and correctable blood pressure measurement errors to consider as a possible focus for your quality improvement efforts:

- Patient preparation
- Selecting proper cuff size
- Estimating systolic blood pressure
- Recording average blood pressure (instead of a single measurement)
- Eliminating terminal digit bias
- Maintaining and calibrating equipment

Many healthcare professionals are familiar with the Improvement Model, developed by Associates in Process Improvement that is a common framework for healthcare improvement initiatives.²² This model is based on three questions and a Plan-Do-Study-Act (PDSA) cycle to test and apply changes.²³

Improvement Process

The process for designing and implementing a project includes these steps:

Step 1: Plan a change.

- Set the project aim – Draft a written summary of what you hope to achieve. The objective should be specific, measurable, feasible and time-bound.
- Define performance measures – Choose a measure that indicates whether the change led to improvement.
- Choose the change – Identify and implement a change that is likely to produce the desired improvement. For example, if you are trying to improve patient preparation, you might first try to communicate to examiners why posture is important to blood pressure measurement accuracy.

- Plan the change – Draft a procedure for how you will implement the change. Who will be involved and how? When and where will the experiment take place and over what period of time? It is also important to plan how data will be collected and analyzed.

Step 2: Do it on a small scale.

- Do the experiment – Carry out the change and collect the data.

Step 3: Study the results.

- Study the results – Analyze the data according to your plan. What do the results tell you about whether or not the change was an improvement? Was it enough of an improvement?

Step 4: Act to refine or institutionalize the change.

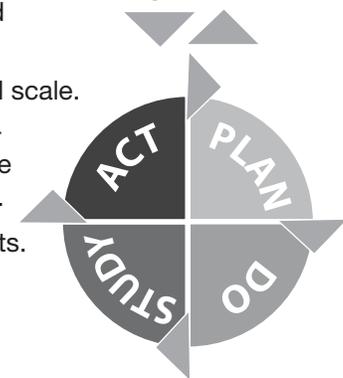
- What next? – If the change was enough of an improvement, decide how you will standardize and institutionalize the change in your organization. How will you communicate this to the organization? What resistance might you encounter? How will you check later on to see if the change is “sticking?” If the change was not enough of an improvement, decide how to modify the experiment. Perhaps you need a different intervention or different conditions under which the experiment takes place. Go back to step 1 and repeat with the re-tuned concept.

For more information on the “how to” of healthcare quality improvement, we suggest visiting the online learning modules at the [Healthcare Improvement Skills Center \(HISC\)](http://www.ihl.org/IHI/Topics/HealthProfessionsEducation/EducationGeneral/Resources/HealthcareImprovementSkillsCenterHISC.htm), <http://www.ihl.org/IHI/Topics/HealthProfessionsEducation/EducationGeneral/Resources/HealthcareImprovementSkillsCenterHISC.htm>, or reviewing the Improvement Map at the [Institute for Healthcare Improvement](http://www.ihl.org/IHI/Programs/ImprovementMap/), <http://www.ihl.org/IHI/Programs/ImprovementMap/>.

What are we trying to accomplish?

How will we know that a change is an improvement?

What changes can we make that will result in improvement?



Developing Quality Improvement for Blood Pressure Measurement

Recommended Reading: Blood Pressure Measurement Quality Improvement

1. Dickson BK, Hajjar I. **Blood Pressure Measurement Education and Evaluation Program (BEEP) Improves Measurement Accuracy in Community-Based Nurses: A Pilot Study.** *J Am Acad Nurse Pract.* 2007;Feb(19) 96.

PURPOSE: Pilot study was developed to determine if a blood pressure measurement training program would improve guideline knowledge and technique in community-based nurses (n= 6). **METHODS:** American Heart Association guidelines were used to develop the Blood Pressure Measurement Education and Evaluation Program (BEEP). Data on guideline knowledge, device quality, measurement technique, terminal digit bias, range of error, and attitude of change were collected prior and after BEEP. **CONCLUSIONS:** BEEP development was feasible and acceptable. The device score was 100%. Knowledge improved but not statistically significant (p= 0.64), as did terminal digit bias. Technique prior to BEEP was poor (T= 15) but improved significantly after BEEP (T= 26 on a scale of 32, p= 0.0006). Range of error decreased but was only significant in the diastolic pressure (p= 0.02). **IMPLICATIONS FOR PRACTICE:** BEEP is feasible. Baseline blood pressure measurement technique is poor in community-based nurses. Our study suggests that this poor technique can benefit from an educational program and result in improved blood pressure measurement accuracy.

2. Stroebel RJ, Broers JK, Houle SK, Scott CG, Naessens JM. **Improving Hypertension Control: A Team Approach in a Primary Care Setting.** *Jt Comm J Qual Improv.* 2000 Nov;26(11):623-32.

BACKGROUND: Blood pressure (BP) control rates in the United States have not improved significantly during the past decade. There has been limited study of improvement efforts

focusing on guideline implementation and changes in the model of care to address hypertension. **METHODS:** Five physician (MD)/registered nurse (RN)/licensed practical nurse (LPN) teams in a large community practice modified their care model in 1997 to manage hypertensive patients as part of guideline implementation efforts. The other 25 MD teams in the same setting practiced in the usual model, but were exposed to the guideline recommendations. BP control rates of patients in each group were assessed monthly. After nine months of testing the new care model, 10 additional teams adopted the model. **RESULTS:** In the pilot group, hypertension control rates showed statistically significant improvement from pre- (33.1%) to post implementation (49.7%). After adjusting for age, this was significantly greater than the improvement in the control group (p = 0.033). Medication changes were more frequent in the pilot group (32.3%) than in the control group (27.6%); however, the differences were not statistically significant. A longitudinal examination of the hypertension patients in the study showed that improved BP control was sustained for at least 12 months. **DISCUSSION:** A change in the model of care for hypertensive patients within a primary care practice resulted in significant, sustainable improvement in BP control rates. These changes are consistent with the chronic care model developed by Wagner; practice redesign appeared to be the most important change.

3. Adair R, Callies L, Lageson J, Hanzel KL, Streitz SM, Gantert SC. **Posting guidelines: a practical and effective way to promote appropriate hypertension treatment.** *Jt Comm J Qual Patient Saf.* 2005;Apr;31(4):227-32.

BACKGROUND: Despite publication and periodic updating of treatment guidelines, hypertension remains undertreated in the United States, and physicians underuse recommended drugs. **METHODS:** Hypertension treatment guidelines were summarized and posted in five places in a

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hospital-based primary care clinic staffed by internists and internal medicine residents. Costs and recommended doses of five commonly used antihypertensive drugs were included. The charts of all 253 patients seen during a four-month period with a diagnosis of hypertension were analyzed. Blood pressures and physician prescribing habits were compared at baseline and at 8, 12, and 16 months after posting the guidelines. RESULTS: The number of patients with blood pressures < 140/90 mm Hg increased from 41% to 58%, $p = .001$. Median (IQR) systolic pressure fell from 143 (119-167) to 137 (116-158) mmHg, $p < .0001$ and diastolic pressure from 78 (65-91) to 77 (64-90) mmHg, $p = .0002$. Physicians prescribed more recommended drugs, more total antihypertensive drugs, larger doses of hydrochlorothiazide and lisinopril, and more inexpensive drugs. The total cost of antihypertensive drugs per patient increased slightly. CONCLUSION: Regular exposure to clinical guidelines, presented in a practical and simple way, can change physician behavior and improve patient care.

4. Choma NN, Huang RL, Dittus RS, Burnham KE, Roumie CL. **Quality improvement initiatives improve hypertension care among veterans.** *Circ Cardiovasc Qual Outcomes* 2009; 2: 392-398.
Veterans Affairs-Tennessee Valley Healthcare System implemented a quality improvement initiative to improve hypertension care among 2 teaching hospitals, 5 community-based outpatient clinics, and 4 contract clinic sites. Goals of the program were to (1) improve measurement and documentation of blood pressure, (2) initiate outpatient patient education, (3) emphasize VA/Department of Defense hypertension treatment algorithms to providers, (4) emphasize external peer review performance goals, and (5) initiate feedback of each clinic's performance. Improvements in blood pressure control were demonstrated in all the research settings are results were sustained 1 year after intervention.

5. Langley GL, Moen R, Nolan KM, Nolan TW, Norman CL, Provost LP. **The Improvement Guide: A Practical Approach to Enhancing Organizational Performance.** San Francisco: Jossey Bass; c2009. Available at: http://www.amazon.com/Improvement-Guide-Organizational-Performance-JOSSEY-BASS/dp/0470192410/ref=sr_1_1?ie=UTF8&s=book&qid=1265601332&sr=8-1
6. Shaw P, Elliot C, Isaacson P, Murphy E. **Quality and performance improvement in healthcare. 3rd edition.** c2009. Available at: http://www.amazon.com/Performance-Improvement-Healthcare-Programmed-Learning/dp/158426165X/ref=sr_1_2?ie=UTF8&s=books&qid=1265601375&sr=1-2
7. Carey RG, Lloyd RC. **Measuring quality improvement in healthcare: a guide to statistical process control applications.** Milwaukee (WI): Quality Press; c2001. Available at: http://www.amazon.com/Measuring-Quality-Improvement-Healthcare-Applications/dp/0527762938/ref=sr_1_2?ie=UTF8&s=books&qid=1265601420&sr=1-2
8. Brassard M, Ritter D. **The Public Health Memory Jogger II: A Pocket Guide for Continuous Improvement and Effective Planning.** Salem (NH) :Goal/QPC, c2007. Available at: http://www.amazon.com/Public-Health-Memory-Jogger-Improvement/dp/1576811018/ref=sr_1_1?ie=UTF8&s=book&qid=1265601541&sr=1-1
9. Parsley K., Corrigan P. **Quality Improvement in Nursing and Healthcare: Putting Evidence into Practice.** Nelson Thornes, c1999. http://www.amazon.com/Quality-Improvement-Nursing-Healthcare-Evidence/dp/0748733558/ref=sr_1_2?ie=UTF8&s=book&qid=1265601578&sr=1-2

Websites on Healthcare Quality Improvement

<http://www.nahq.org/>
<http://www.ahrq.gov/>
<http://www.ihq.org/ihq>
<http://www.ncqa.org/>
<http://www.qualityforum.org/>
<http://www.wahq.org/>
<http://www.wchq.org/>

Developing Quality Improvement for Blood Pressure Measurement

Sample Quality Improvement Project: Terminal Digit Bias (TDB)

Note: This PDSA template offers a detailed plan for implementing a quality improvement project around terminal digit bias. This procedure was designed for use in a particular sample of community health centers; it might require modification for use in your setting.

Objective: This project is designed to improve the accuracy of blood pressure measurements at ABC Community Health Center.

Performance Measure: We previously ascertained that there is evidence of TDB in a sample of blood pressure measurement records. We did this by comparing the frequency of each possible terminal digit to the expected frequency using a chi-square test of significance.

The Change: We will use a staff “brown-bag lunch” to communicate the importance of accurately recording blood pressure measurements.

Plan for Change: We will ask Dr. Smith’s staff to attend a brown-bag presentation given by Nurse Betty. After 30 days, 25 blood pressure measurements will be drawn at random from Dr. Smith’s recent patient records and the data recorded on a special form. A chi-square test of significance will be used to decide if the observed frequency of terminal digits differs from the expected frequency if there were no TDB. The records will be drawn by Dr. Smith’s assistant on a day when Dr. Smith is not seeing patients.

1. Blood Pressure Devices

- a. This project is designed to be run on data collected from manual blood pressure devices. These might be mercury (column) or aneroid (dial) type manometers. A manual device requires you to listen to the Korotkoff sounds and then take a visual reading from the column or dial.
- b. Automated devices do not require the use of a stethoscope or operator judgment about the reading. You simply read and record whatever number you see on the digital display. It is highly unlikely to find problems of TDB when using automated devices.

2. Defining Your Population

- a. You can think of the population as all the patient records that have any non-zero probability of being selected for the sample. For example, your population might be all patients seen in the medical practice. In that case, it is theoretically possible to state the probability of any of these records to be in your sample. If you narrow the population to Dr. Smith’s records, then it is possible to state the probability of any of these records to be in the sample.
- b. Defining the sample is important because what you learn about TDB applies to just that population. In the second example, if you find TDB, then you will be able to say that this problem affects Dr. Smith’s patient records, but you’ll know nothing about Dr. Jones’ patient records.
- c. You might want to think about whether or not to include records for more than one provider, to include records for the dental practice, to exclude records for white patients, or some other design consideration. Here’s one way to ensure that you get the right population definition. Pretend that you find TDB and fill in the blank in this sentence: “There is evidence of terminal digit bias in the patient records of [insert population description].” If you’re unhappy with the scope of the population, change it before you pull records.

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3. Selecting Your Sample

- a. A sample is a portion of the population records that are chosen for analysis. Having a deliberate sampling process is very important. Every analysis method has underlying assumptions. For statistical testing, we often (but not always) have to ensure that the data are selected randomly.
- b. It is often necessary to have a reasonable amount of data to analyze. For this project, we've chosen a sample size of 25 patient records, which gives us 25 systolic and 25 diastolic blood pressure measurements. That's a total of 50 end digits.
- c. IMPORTANT: The project is a lot easier if you choose 25 patient records for a total of 50 BP measurements. If you choose a different number, then here are some things to keep in mind.
 - i. Use a number of records and number of BP measurements equally divisible by 5. This gives you five, equal, whole numbers in the "Expected" column of the data sheet.
 - ii. If you chose some number of patient records other than 25 for your sample, then be sure to represent the correct number in the "Expected" column of the data sheet. The correct number will be the number of BP measurements divided by 5. For example, if you use 30 patient records, and each has a systolic and diastolic pressure for a total of 60 blood pressure measurements, then the correct number in each line of the "Expected" column is 12.
- d. There are many ways of ensuring that you draw a random sample from the population. In the special case of this project, it doesn't matter much how you do it. You could just select the first 25 patient records that meet your selection criteria.

4. Recording the Data

- a. Technically, you could just keep a tally of the terminal digits you find; however, it's a good idea to record the BPs from the patient charts. This allows you to check your work without having to pull the charts again in the event you discover that you made a systematic error in handling the data.
- b. Each of the two pressure readings (systolic, diastolic) count as separate data for the purpose of this project. For example, if the pressure is 120/84, then you get one datum for 120 (end digit = 0) and one datum for 84 (end digit = 4).

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Sample Terminal Digit Bias Data Collection and Analysis Worksheet

ABC Community Health Center

Dr. Smith

Terminal Digit Bias Data for February 1, 2010 through March 2, 2010

BP	End Digit								
134	4	140	0	110	0	148	8	146	6
82	2	84	4	76	6	94	4	82	2
126	6	126	6	120	0	122	2	120	0
90	0	76	6	86	6	84	4	84	4
136	6	130	0	122	2	140	0	140	0
90	0	86	6	80	0	96	6	98	8
150	0	122	2	124	4	130	0	112	2
96	6	88	8	86	6	88	8	74	4
138	8	130	0	130	0	156	6	126	6
80	0	88	8	92	2	92	2	78	8

Tally the End Digit Data

Number of "0" end digits	15
Number of "2" end digits	8
Number of "4" end digits	7
Number of "6" end digits	13
Number of "8" end digits	7

Chi-Square Goodness of Fit Test

A	B	C	D	E	F
End Digit	Expected	Observed	col C – col B	col D x col D	col E ÷ col B
0	10	15	5	25	2.5
2	10	8	-2	4	0.4
4	10	7	-3	9	0.9
6	10	13	3	9	0.9
8	10	7	-3	9	0.9
Total col B				Total col F	5.6

Note: If you collect 25 patient records with 50 blood pressure measurements (one systolic and one diastolic), then fill in "10" for each line of column B. If you collect a different number of patient records and blood pressure measurements, then fill in the total number of blood pressure measurements divided by five. For example, if you collect 25 patient records in the sample that have a total of 60 blood pressure measurements, then fill in "12" for each line of column B ($12 = 60 \div 5$).

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Decision Rule

- If the total of column F is greater than 9.49, then there is evidence of terminal digit bias. Continue with another round of quality improvement.
- If the total of column F is less than or equal to 9.49, then there is no evidence of terminal digit bias. Recheck periodically for quality assurance.

Your Decision

- There is evidence of terminal digit bias in the sample.
- There is no evidence of terminal digit bias in the sample.

Analysis: The results suggest that a brown-bag lunch presentation was sufficient for TDB to be eliminated from Dr. Smith's blood pressure recordings. This project will be expanded to a broader sample of staff and patient records.

Training Tools and Resources

Directory of Blood Pressure Measurement Educational Resources

There are many resources available that provide guidelines and training for accurate blood pressure measurement. We recommend that you review a few of these to determine which will best meet your needs

Evidence-based Practice Guidelines

1. Chobanian AV, et al. Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension* 2003;42:1206-1252. Available at: <http://hyper.ahajournals.org/cgi/content/full/42/6/1206>
2. Pickering TG, et al. Recommendations for blood pressure measurement in humans and experimental animals: a statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. *Hypertension*. 2005;Jan:45(1):142-61. Available at: <http://hyper.ahajournals.org/cgi/content/full/45/1/142>
3. Preventive Cardiovascular Nurses Association. National guidelines and tools for cardiovascular risk reduction: a pocket guide: third edition 2009. Book # #0-000341-03-7. Available at: www.pcna.net/clinical/pocketguide/index.php
4. Williams B, Poulter NR, Brown MJ, Davis M, McInnes GT, Potter JP, Sever PS and Thom SM; The BHS Guidelines Working Party Guidelines for Management of Hypertension: Report of the Fourth Working Party of the British Hypertension Society, 2004 - BHS IV. *J Hum Hypertens* 2004;18:139-185. Available at: http://www.bhsoc.org/Latest_BHS_management_Guidelines.stm
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7. Narkiewicz K. Diagnosis and management of hypertension in obesity. *Obes Rev*. 2006;May;7(2):155-62.
8. National Kidney Foundation. K/DOQI clinical practice guidelines for cardiovascular disease in dialysis patients. *Am J Kidney Dis*. 2005;Apr;45(4 Suppl 3):S1-153. Available at: http://www.kidney.org/professionals/KDOQI/guidelines_bp/index.htm

Training Resources

1. Korotkoff Sounds Video Tutorial (British Hypertension Society). Available from: <http://www.abdn.ac.uk/medical/bhs/tutorial/tutorial.htm>
2. Omron 0405 Duel Head Training Stethoscope. Available from: <http://www.omronhealthcare.com/product/1155-213-stethoscopes-professional-dual-head-training-stethoscope-405>
3. Shared Care Inc. consulting, training, and equipment validation for standardized blood pressure measurement. Available at: <http://sharedcareinc.com/docs/corporate.html>
4. Under Pressure Patient Education Program (Daiichi Sankyo). Available from <http://www.bpunderpressure.com/index.asp>

Training Tools and Resources

Blood Pressure Measurement Observational Assessment

Name _____ Date _____

Observation	Yes	No	Comments
1. Patient in a comfortable position			
2. Observer in a comfortable position			
3. Adequate lighting of the room (Can read number on device when at current distance)			
4. Level of noise in the room (can hear whispers)			
5. Tells patient that blood pressure is going to be read			
6. Asks about factors affecting blood pressure (coffee, exercise, anxiety, smoke in last 30 minutes)			
7. Waiting (5 minutes) prior to reading blood pressure			
8. Midpoint of cuff at heart level			
9. Feet flat on floor, legs uncrossed			
10. Device at eyesight level			
11. Check if zeroed prior to measurement			
12. Measure arm circumference			
13. Select the right size cuff (L80%/W40%)			
14. Palpate the brachial artery at base			
15. Wrap cuff well around bare arm			
16. Place midline of bladder over brachial pulse			
17. Lower edge is at least 1" cm above bend of the elbow			
18. Find the radial pulse in the same arm			
19. Inflate the blood pressure cuff until you can no longer feel the radial pulse (Look at the number on the dial, note it, and pump the cuff another 30 mm Hg beyond number where you could no longer feel the radial pulse = Maximum Inflation Level {MIL})			
20. Use bell of stethoscope			
21. Put bell of stethoscope on the brachial pulse			
22. Deflate the cuff slowly 2 to 3 mmHg/sec. (dial should drop gradually, not quickly)			
23. Hears the first sound (at what number?)			
24. Hears the second sound (last distinct sound) (at what number?)			
25. Let rest of air out rapidly			
26. Deflate completely before re-inflation			
27. Wait at least one minute prior to second reading			
28. Second measurement is initiated			
29. Measure other arm using above steps			
Documentation			
30. Patient position () sitting () lying () standing			
31. Record which arm measured			
32. Writes BP down immediately after measurement			
33. Records average of BP readings: Reading #1: ____/____ Reading #2: ____/____			
34. Tells patient his/her blood pressure measurement			
35. Tells patient what the normal BP range is			

Adapted from: Dickson, B, Hajjar, I. Blood pressure measurement education and evaluation program improves measurement accuracy in community-based nurses: A pilot study. *J Am Acad Nurse Pract.* 2007;Feb:19(2):93-102.

Training Tools and Resources

10 Steps to Improve Blood Pressure Measurement Accuracy

1. Have patient rest five minutes before measuring blood pressure.
2. Patient should be seated in chair with back supported, feet flat on floor, arm supported on firm surface, with midpoint of upper arm at heart level.
3. Select appropriately sized blood pressure cuff by measuring patient's upper arm circumference at the midpoint.
4. Position cuff on arm by centering bladder over brachial artery; lower edge of cuff must be approximately 1 inch above bend in elbow.
5. Deflate 2 mmHg per second. Read pressure to nearest 2 mmHg. Round upwards.
6. Listen for all five phases of Korotkoff sounds including auscultatory gap (if present).
7. After last sound is heard, listen for at least another 10 mmHg. If last sound is heard very early, listen for an additional 40 mmHg.
8. Allow one minute before rechecking pressure in the same arm.
9. Take blood pressure readings in both arms at first examination.
10. Guard against terminal digit bias or adjusting readings based on previous knowledge of the patient.

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Recommended citation:

Wisconsin Department of Health Services, Division of Public Health, Wisconsin Heart Disease and Stroke Prevention Program, *Blood Pressure Measurement Quality Improvement Toolkit: Improving Accuracy, Enhancing Care*, c2010.

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