

## A Single Clinic Blood Pressure Measurement Is Inadequate for Clinical Decision Making in Hypertension

Powers BJ, Olsen MK, Smith VA, et al. Measuring blood pressure for decision making and quality reporting: where and how many measures? *Ann Intern Med* 2011;154:781–8.

### Study Overview

**Objective** To compare systolic blood pressure (SBP) measurements taken in different settings (home, clinic, and research) and estimate the certainty to which each measurement strategy can classify hypertensive patients as in or out of control.

**Design.** Secondary data analysis of a randomized controlled trial (Hypertension Intervention Nurse Telemedicine Study) that examined the effect of an 18-month self-management intervention administered by a nurse over the telephone, a medication management intervention directed by a physician, or both, compared with usual care. This analysis included only the intervention arms because the usual care arm did not have home blood pressure monitoring.

**Setting and participants.** Veterans attending primary clinics affiliated with Durham VA Medical Center in North Carolina with a previous diagnosis of hypertension and a history of inadequate blood pressure control in the year before enrollment. Excluded were patients who resided in nursing homes or had received home health care, had a history of dementia, metastatic cancer, renal insufficiency on hemodialysis, or recent history of stroke or heart attack.

**Main outcome measure.** Estimates of true blood pressure, variance, and measurement error using a random effects model. Out of control blood pressure was defined according to guideline recommendations (SBP  $\geq$  140 for clinic and research measurements and SBP  $\geq$  135 for home measurements). Clinic blood pressures were measured at varying intervals as a part of patient's routine clinic visits by trained nurses according to standards maintained by the VA. Measurements were done with automated devices. Home blood pressures were obtained by a digital home blood pressure monitor. Participants were asked to provide at least 3 measurements per week through a telemedicine device that transmits the measurements automatically. Research blood pressure measurements were done at baseline and at 6-month intervals thereafter for 18 months. These were taken when the patient was seated, and 2 resting blood pressure measurements were obtained 5 minutes apart. These were also done with automated devices and the devices were inspected quarterly to ensure accuracy.

**Main results.** 444 patients were included in the sample. Mean age was 64 years (SD 10), 92% were male, and 48% were black. A total of 3218, 7121, and 100,842 blood pressure measurements were taken in

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the research, clinic, and home settings respectively over 18 months. In the first 30 days, 28% of patients were categorized as in control according to clinic measurement, 47% were in control according to home measurement, and 68% according to research measurement. 52% of patients had a mean home SBP 10 mm Hg lower than their mean clinic SBP. Increasing the number of measurements decreased the within-patient variance across all 3 measurement strategies. The probability of correctly identifying a patient a having SBP out of control improved with increasing number of measurements. Of note, a single measurement from 120 to 157 mm Hg was unable to identify whether a patient was in or out of control with 80% or greater certainty. The blood pressure measurements were modeled in 30-day and 90-day intervals for home and clinic blood pressure respectively; changing the time frame of modeling did not substantially change the results.

**Conclusion.** A single blood pressure measurement, regardless of measurement setting, was inadequate to categorize whether a patient has SBP in or out of control. Averaging several measurements may increase the certainty in correctly classifying status of blood pressure control.

### **Commentary**

Hypertension is a common condition that is a major reason for physician visits. Reducing blood pressure among hypertensive patients can improve health outcomes, such as decreasing risk for cardiovascular events and renal failure. For physicians, accurate blood pressure measurement in the office is important for ensuring safe and appropriate patient treatment. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment Of High Blood Pressure (JNC-7) has outlined the recommended blood pressure measurement method in the clinic setting: an auscultatory method using a properly calibrated device on patients who have been seated quietly for at least 5 minutes in a chair with feet on the ground and arm supported at heart level; at least 2 measurements should be made [1].

This current study adds to what is known about blood pressure measurements. Other studies have documented that averaging several readings across several visits yields a more precise measurement. Powers and

colleague measured blood pressures in multiple settings (home, clinic and research), estimating the variance in blood pressure measurements over time and the certainty with which a patient's control can be classified. They found that several measurements of blood pressure are needed for correctly classifying a patient as in or out of control with at least 80% certainty.

The study has implications for the use of blood pressure control as a quality measure, and also increasingly, the use of clinical reminders and decision support tools through electronic clinical information systems. A single blood pressure measurement may be inadequate as a quality measure, and when used for clinical decision making, may lead to inadequate or overly aggressive treatment of hypertension, thereby exposing patients to the risks of both under- and over-treatment. This study also provides support for the use of home blood pressure monitoring devices. Multiple measurements can be obtained without the need for repeated clinic visits.

Several other issues also warrant mention. In this study, blood pressure measurements were taken using automated devices, in contrary to JNC-7 recommendations. Automated devices may be less accurate than manual devices, particularly in hypertensive patients [2]. Including manual blood pressure measurements for comparison with other measurements may further enhance our understanding of the variability of measurements, particularly since many physicians measure blood pressure through manual devices. Moreover, within-patient variance may be different among the the study's mostly male veteran population as compared with the general population. Of note, persons with dementia and those in nursing homes and receiving home care services (and thus likely to have functional impairment) were excluded in this study. This population is likely more frail than the general population and may have more or less within-patient variance in SBP. Since this population may be more susceptible to the effects of overly aggressive treatment of hypertension due to frailty, inclusion of this population is necessary to understand how the variance in blood pressure over time affects this population. Furthermore, it is still not clear exactly how many measurements are needed, and what strategy of blood pressure measurements over time is best correlated with improved patient outcomes. Further studies are needed to answer these important questions.

**Applications for Clinical Practice**

This study suggests that a single blood pressure measurement is inadequate in monitoring patients with hypertension and is not a meaningful quality measure. Several measurements are needed to assess the status of blood pressure control. Further work is needed to identify the best strategy in blood pressure measurements in order to maximize patient outcomes.

—Review by William Hung, MD, MPH

**References**

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2. Skirton H, Chamberlain W, Lawson C, et al. A systematic review of variability and reliability of manual and automated blood pressure readings. *J Clin Nurs* 2011;20:602–14.

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