Self-Monitoring of Blood Pressure: A Pilot Study

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The purpose of this study was to evaluate the applicability of the sensory detection method (SDM) in patient self-monitoring of blood pressure. The SDM involves the use of a blood pressure cuff alone and represents an easy, simple blood pressure recording method. In a sample of 116 ambulatory patients visiting the Eastern Carolina Family Practice Center, only 59 percent of the patients were able to measure their systolic blood pressure, and 54 percent were able to measure diastolic blood pressure. Of those patients who could sense their blood pressure, no significant mean systolic difference between SDM and indirect method (IDM) was detected. Mean diastolic measurements were significantly different. The correlations between IDM and SDM systolic blood pressures and diastolic blood pressures suggested a moderate relationship. Further analysis suggested that education was positively related to ability to accurately measure blood pressure using SDM. No relationship was detected between obesity, age, sex, or ethnicity and ability to measure blood pressure.

The measurement of arterial blood pressure in humans began with the crude intra-arterial cannulation of Reverend Stephen Hales,[1] but did not become practical until the introduction of the auscultatory method of Korotkoff in 1905.[2] Several studies exist that demonstrate the correlation of the auscultatory indirect blood pressure measurement with direct intra-arterial manometric measurements.[3-7] Particularly relevant to this study is the controversy regarding the correlation of Korotkoff with direct diastolic measurements. Using disappearance (Korotkoff stage 5) Roberts et al[4] found mean measurement of diastolic pressure to be 7 mmHg lower than direct measurement. However, using muffling (Korotkoff stage 4), they found mean measurement of diastolic pressure to be 3 to 4 mmHg higher than direct

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measurement. Of their 47 measurements, 31 percent of systolic and 9 percent of diastolic varied by more than 20 mmHg between direct and indirect methods. London and London,[6] on the other hand, found phase 4 to be absent in 37 percent of measurements, and when present, it was 12 to 20 mmHg above direct measurements.

In addition to the errors of measurement inherent in the indirect detection method, there is considerable variability within subjects when pressures are measured on multiple occasions. Armitage et al[8] found random differences between two occasions for individual subjects to be 9.1 mmHg for systolic pressure and 7.2 mmHg for diastolic (phase 4). The significance of this is borne out by their study in which 35 percent of the subjects would have been falsely classified as hypertensive if only their initial pressure had been used as the criterion.

Another significant source of possible measurement error is interobserver variability. Wilcox[9] found considerable variability among 390 nurses using paired simultaneous measurements. Lowe and McKeown[10] further demonstrate this variability among physicians, pointing out the well-known tendency for even-digit preference. The magnitude of interobserver variability is not well quantified in the literature. Wilcox pointed out that no personal or professional characteristic seemed to predict measurement variability.

A key factor associated with the success of a treatment regimen is patient compliance. Noncompliance is recognized as a problem in the treatment of any chronic disease, including hypertension. Unfortunately, the asymptomatic nature of high blood pressure and the necessity for long-term treatment exacerbates the ordinary compliance difficulties.[11] Determinants of noncompliance include the complexity of the medication regimen, patient denial of disease, and characteristics of the physician-patient interaction.[11,12] Barsky[13] suggests that optimum management of a chronic disease and the best therapeutic outcome require the active involvement of the patient in his or her medical care. Therefore, improvement of compliance may involve the active participation of the patient with emphasis on modifying the multiple factors believed to be influencing nonadherence.

Some authorities suggest that patients should monitor their own blood pressure at home,[14] while others advise against it.[15] Several studies provide evidence suggesting that patients can measure their own blood pressure reliably.[16,17] Haynes et al[18] found that an intervention package containing self-monitoring of blood pressure was effective in raising compliance rates from a mean of 44 percent to 66 percent. Laughlin et al[14] found that after one month, clinically significant decreases in blood pressure resulted from home blood pressure readings. Carnahan and Nugent[19] and Johnson et al[20] found that technique ineffective in increasing compliance or in reducing blood pressure. However, Vidt[21] notes that the positive benefits of home blood pressure monitoring are that it (1) serves as a reminder to the patient under a long-term treatment program, (2) gives the patient a feeling of active participation in his own care, and (3) makes available serial blood pressure measurements. Recently Gelman and Nemati[22] evaluated a new method of self-recording of blood pressure, the sensory detection method, that requires only a blood pressure cuff. All but 15 percent of the patients in their study were able to use this procedure. They suggest that the simplicity of the method may increase patient vigilance in home blood pressure monitoring and, subsequently, adherence to their antihypertensive regimen.

The objectives of this study were to determine whether ambulatory patients are able to use the sensory detection method (SDM) and to determine their accuracy using SDM compared with standard indirect detection method (IDM) measurements of blood pressure.

Methods

A consecutive sample of 116 ambulatory patient volunteers visiting the Eastern Carolina Family Practice Center during the months of November and December (1981) were included in this study. The East Carolina University Family Medicine Program is a residency training program offering medical services to patients residing in Pitt County and the surrounding area. Approximately 14,000 patients are registered with the practice, with an average daily visiting rate of between 100 and 120 patients. The demographic characteristics of the sample are reported in Table 1. The average age of

Table 1. Demographic Characteristics of the 116 Ambulatory Study Patients Attending Eastern Carolina Family Practice Center, November-December, 1981

	No. (%)
Race	
White	74 (63.8)
Black	42 (36.2)
Sex	
Male	41 (35.3)
Female	75 (64.7)
Education	
Grade school	19 (19.8)
High school	47 (48.9)
>High school	30 (31.3)

the study participants was 46 years with a range in ages from 18 to 82 years. Of the 116 patients, 63.8 percent were white and 64.7 percent were female. Approximately 49 percent reported a high school education, while 31.3 percent reported education past high school.

Nurses instructed patients enrolled in the study in blood pressure measurement using the sensory detection method. The SDM consists of inflating the blood pressure cuff to a point greater than presumed systolic pressure, then slowly releasing it until the patient begins to feel a throbbing rhythmic pulsation in the arm under the inflated blood pressure cuff. The point at which the patient first begins to feel this pulsation is recorded as the systolic pressure. The cuff is slowly let down to the point where the patient no longer feels this pulsation, and this pressure is recorded as the diastolic pressure. The systolic and diastolic blood pressures are recorded by sensing the appearance and disappearance, respectively, of the pulsatile throbbing sensation in the artery under pressure.

Following instruction in SDM, the patient was requested to measure his or her own systolic and diastolic blood pressure. The nurse simultaneously evaluated the patient's blood pressure using the routine indirect method (IDM). Patients were unaware of the nurse's specific blood pressure measurements, resulting in a single-blind protocol.

After evaluating the patient's blood pressure and recording the measurements, the nurses asked for and recorded the patient's self-measurement. Information concerning patient characteristics was obtained from the patient's medical records by a research assistant. All blood pressure recordings were made during November and December in 1981.

Statistical analysis of the collected data was accomplished using t tests for paired observations and Pearson-product moment correlations. The .05 level of significance was used for all statistical tests.

Results

Of first concern within the study was to determine whether ambulatory patients were able to use the sensory detection method in measuring their blood pressure. Using the sensory detection method, 58.6 percent of the patients were able to measure their systolic blood pressure. The most common reason volunteered by the unsuccessful patients was that they "felt nothing." In addition, no significant relationship was detected between any patient demographic characteristic, including obesity, that was related to the ability to make blood pressure measurements using SDM. The remainder of the results apply only to those individuals who proved able to use SDM.

The descriptive statistics for the systolic and diastolic blood pressure measurements for the SDM and IDM are summarized in Table 2. The mean systolic blood pressure recorded by the nurses was 132.2 mmHg, while the patient's self-recording was 130.8 mmHg. The standard deviations were comparable for SDM and IDM, at 24.7 mmHg and 22.1 mmHg, respectively. Of those patients who could sense their blood pressure, no significant difference in mean systolic blood pressure measurement between SDM and IDM was detected ($t = .925$, 67 df, $P > .05$). Mean diastolic blood pressure measurements were significantly different ($t = 3.97$, 61 df, $P < .001$). The average difference between SDM and IDM diastolic blood pressure measurements was 4.42 mmHg. The mean diastolic blood pressure using SDM was 76.3

Table 2. Sensory Detection Method (SDM) and Indirect Method (IDM) Systolic and Diastolic Blood Pressure Measurements (mmHg)

Blood Pressure	Mean	SD	Median	Range
SDM systolic (n=68)	130.8	24.7	130.0	80-200
SDM diastolic (n=62)	76.3	14.1	79.7	40-110
IDM systolic (n=116)	132.2	22.1	128.5	98-220
IDM diastolic (n=116)	80.3	13.2	80.0	40-120

Table 3. Correlations Between Sensory Detection Method (SDM) and Indirect Method (IDM) Blood Pressure Measurements

	IDM Systolic	IDM Diastolic	SDM Systolic	SDM Diastolic
IDM systolic	1.0			
IDM diastolic	.73 (116)	1.0		
SDM systolic	.79 (68)	.65 (68)	1.0	
SDM systolic	.67 (62)	.76 (62)	.60 (60)	1.0

Note: Sample size in parenthesis. All correlations are significant at $P < .01$

mmHg and using IDM, 80.3 mmHg.

The Pearson-product moment correlations between the SDM and IDM diastolic and systolic blood pressure measurements are included in Table 3. The correlations between IDM and SDM systolic and diastolic blood pressure were .73 and .76, respectively. Both correlations are significantly different from zero ($P < .001$). Although these correlations are positive and moderate in magnitude, considerable measurement error is suggested. Only about 53 to 58 percent of the variance in SDM and IDM blood pressure measurements can be explained.

Further analysis suggested that education was significantly related to ability to accurately measure systolic blood pressure using SDM ($r = -.25$, $P < .05$). This suggests that patients with higher educational levels tend to measure their blood pressure more accurately. No relationship was detected between obesity and ability to accurately measure blood pressure. Similarly, there were no significant correlations between patient's sex, race, or weight and accuracy of blood pressure measurements. The correlation between age and blood pressure measurement accuracy approached statistical significance ($r = .18$, $P < .07$), suggesting that the older the patient, the less accurate the systolic SDM blood pressure measurements.

Discussion

In this sample, 41.4 percent of the patients were unable to utilize the SDM because of inability to detect pulsations. Gelman and Nemati's series[22] estimated this to be 15 percent. They suggested obesity as a possible reason, but no relationship was found in the present study. Of the variables age, race, sex, weight, and education level, only education level could be documented to significantly correlate with the ability to accurately sense one's own blood pressure. This would suggest the possibility that further patient education in SDM technique might improve accuracy.

For those patients able to sense pulsations, it would appear that systolic blood pressure can be accurately measured using SDM. Diastolic measurements differed significantly, although the mean SDM diastolic was less than IDM by only 4 mmHg. Several possibilities could explain this discrepancy. First, 4 mmHg is well within the range of magnitude of differences noted between direct and indirect measurements. Also considerable controversy exists in the literature over which point in Korotkoff's phases correlates best with direct measurements and by what factor a systematic error occurs.[4,6] Phase 5 was used for this study. It has also been noted that individual pressures vary between occasions and observers. This study controlled for occasions by simultaneous measurement of IDM and SDM. Four different nurses were involved in IDM measurements, which introduces a variable that needs further study. Multiple measurements of SDM pressures by individuals might also improve accuracy.

Also suggested are further studies that would examine the impact on compliance of using SDM home measurements by hypertensive patients selected for ability to accurately measure their own blood pressure.

Finally, a comment on the inaccuracies of using traditional indirect measurement in making therapeutic decisions that significantly affect the lives of thousands of patients. Physicians should be reminded that this is only an approximation of actual intra-arterial measurements, and there exists some controversy as to its accuracy. Physicians' office measurements of blood pressures in patients with borderline hypertension have recently been shown to poorly correlate with average 24-hour pressure.[23] The ease of obtaining multiple measures in multiple environments using the SDM might outweigh some of its inaccuracies.

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