

Agreement and Digit Preference of Blood Pressure Measurements Between pairs of Random-Zero Sphygmomanometer, Digit Automatic Device and Regular Mercury Sphygmomanometer on Hypertensive Urban Young African-American Men

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Introduction

Blood pressure is normally variable physiologic phenomena(Clement, 1979 ; del Arco-Galan, Suarez-Fernandez, & Gabriel-Sanchez, 1994) which is more variable than other measurements and not as easily measured(Klah, et al., 1993). It is important as a health outcome and as a process or mediating variable that affects other health outcomes such as cardiac and renal function. The gold standard for the most valid and reliable assessment of blood pressure is direct intra-arterial measurement. Indirect measurement methods are widely used in clinical practice and research because they are less invasive and expensive well qs more practical and generalizable. However, indirect measurement presents methodological challenges because of numerous factors they effect blood pressure values : characteristics of the device and the bias(Martin, 1993 ; Reeves, Leenen,

& Joyner, 1992 ; Taylor, Lillis, & Lemone, 1994). Observer bias may arise from handling the equipment, interpretation of Korotokoff sounds(Imal, et al., 1994), or from an interaction between subject and observer which actually alters the level of blood pressure(Rose, Blackburn, Gillum, & prineas, 1982 ; Rose, 1965), such "Whitecoat or office Hypertension". In addition, biologic variability can be minimized by averaging several readings(Pickering, James, & Harshfield, 1988 ; Reeves, Leenen, & Joyner, 1992 ; White, Lund-Johansen, & Omvik, 1990). To minimize these sources of bias, investigators have to be familiar with various measurement methods and select the one that will assure the most reliable high quality data possible.

In order to determine which method should be used, it is important to compare the relative merit of measurements in chinal and research setting. These are many studies of accuracy and val-

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idity of blood pressure. A standard mercury sphygmomanometer (Imal, et al., 1994; O'Brien, et al., 1990; Van Egmond, Lenders, Weermink, & Thien, 1993) and RZS (Klag, et al., 1993; Reeves, Leenen, & Joyner, 1992) are commonly used as reference standards. But measurement of blood pressure by the mercury sphygmomanometer is prone to error due to observer bias and digit preference (Wright, & Dore, 1970) and RZS may underestimate diastolic blood pressure (DBP) (O'Brien, et al., 1990). The automatic digit device is a powerful research tool, but its clinical role has been difficult to define and the values underestimate than other measurement (Martin, 1993; Stason, & Appel, 1993; Zachariah, & Summer, 1993).

Even small differences in blood pressure can be important in research and clinical practice distorting the results of large-scale surveys and leading to erroneous conclusions (Wright, & Dore, 1970) including false-positive trials, regression to the mean, and over diagnosis and treatment of patients (Stason, & Apple, 1993). For example, in a series of 110 patients, 67% were defined as being hypertensive if 90 mmHg was used as the diagnostic criterion. However, if 91 mmHg was used as the criterion, the percentage defined as hypertensive was 30% (Martin, 1993). In comparison, blood pressures recorded on the same individuals by nurses met the criterion 15% and 10% respectively and blood pressures assessed by ambulatory blood pressure monitoring met the criteria 5% and 4% respectively (Martin, 1993).

In an ongoing 12 month study of hypertensive inner city African American men ages 18-49 years we had the opportunity to examine the agreement between blood pressure levels measured by methods, digital automatic device (DAD) and Hawksley random zero sphygmomanometer (RZS) and in a subset of the sample to also compare RZS and DAD with regular mercury sphygmomanometer readings (RMS). Additionally, observer bias was examined by reviewing distribution of point (digit) preference.

Methods

Two hundred inner city African American men

were enrolled in a 12 month study based upon age, gender, residence and blood pressure eligibility criteria: systolic blood pressure (SBP) ≥ 90 mmHg or on antihypertensive medication). Blood pressure eligibility was first assessed in care settings and secondly in the Outpatient Clinical Research Center by trained observers both by the Critikon automated digital device and the Hawksley Random Zero sphygmomanometer. Standard mercury sphygmomanometer blood pressures also were recorded for 36 men. To reduce error, sequential same arm measurements were taken at one minute intervals with subjects resting five minutes, the correct cuff size, and the bare arm supported on a table at heart level. (NIH, 1993; O'Brien, et al., 1990; Taylor, Lillis, & Lemone, 1994; Van Egmond, Lenders)

Statistical analysis

The mean and standard deviation were calculated for each type of method comparison. To assess point or digit preference for the two methods measurement the distribution of SBP and DBP were reviewed. The individual BP values obtained using the two differences at a given BP level as described by Bland and Altman (Bland, & Altman, 1986; O'Brien, et al., 1990).

Findings

In the 200 subjects, SBP and DBP distributions and measures of central tendency were examined for DAD and RZS measurements. The mean SBPs obtained by the two measures were 149.2 ± 16.6 mmHg and 151.6 ± 16.8 mmHg for the DAD and RZS respectively. The mean DBPs obtained by the two measures were 95.1 ± 12.5 mmHg and 98.5 ± 10.4 mmHg for the DAD and RZS respectively. The mean differences in BP were 2.4 ± 7.2 mmHg and 3.4 ± 8.7 mmHg.

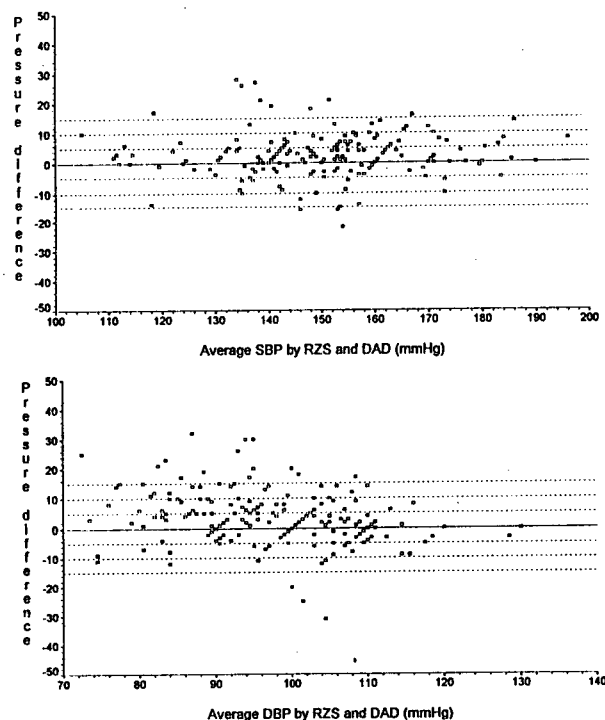
In the 36 subjects, SBP and DBP distributions and measures of central tendency were examined for DAD, RZS and RMS measurements. The mean SBPs obtained by the three measures were 149.6 ± 19.0 mmHg, 153.5 ± 16.7 and 152.4 ± 16.4 mmHg for the

DAD, RZS and RMS respectively. The mean DBPs obtained by the three measures were 96.3 ± 12.8 mmHg, 98.0 ± 9.8 mmHg and 100.5 ± 10.4 mmHg for the DAD, RZS and RMS respectively, The mean differences in SBP and DBP between DAD and RZS were 3.9 ± 10.0 mmHg and 1.7 ± 10.4 mmHg. The mean differences in SBP and DBP between RMS and RZS were 1.1 ± 6.6 mmHg. -2.4 ± 7.0 mmHg. To assess point or digit preference for the two methods measurement the distribution of end numbers 0 or 9 of SBP and DBP were reviewed. In the 200 subjects, SBPs were recored to the nearest zero for 16.5% of RZS measurements and 42.0% of DAD measurements. DBPs were recored to the nearest zero for 21.5% of RZS measurements and 50.0% of DAD. The distribution of SBP and DBP was dispersed indiscriminantly. The modal DAD DBP of the

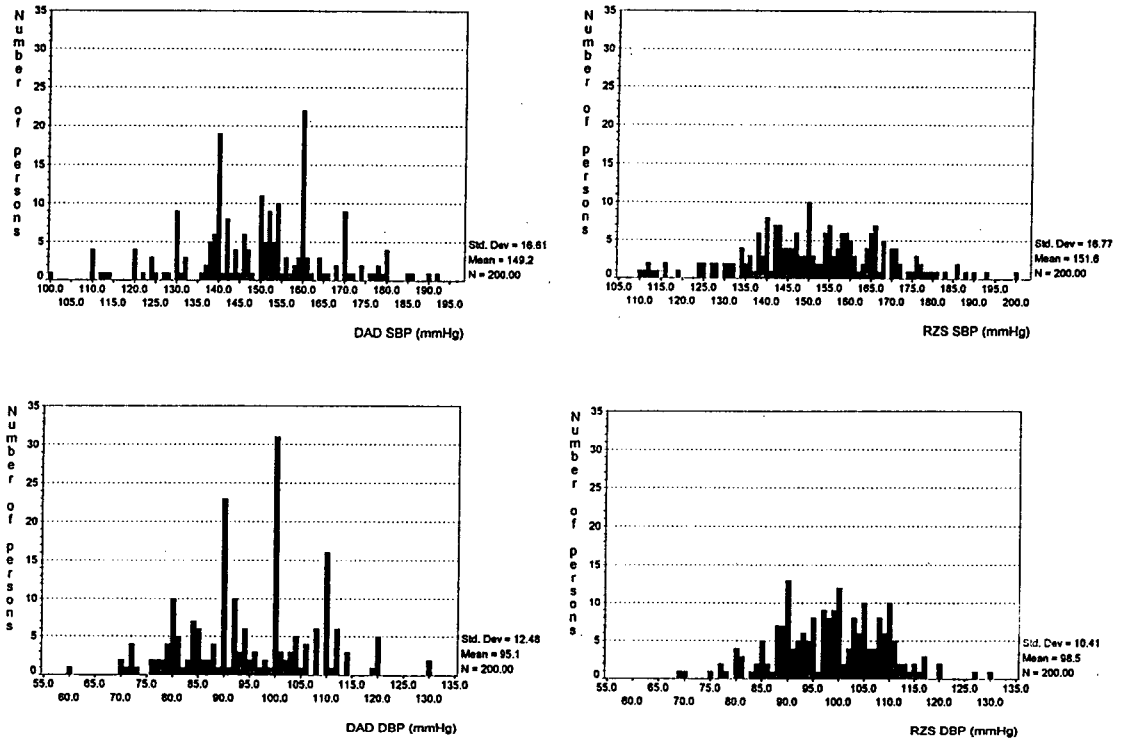
200 subjects was 100mmHg which was recored for 31 subjects(15.5%) of the sample(Figure 2).

The individual differences in BP determined by RZS and by the DAD or the RMS were shown in Figure 3. The scattergram distributed more widely around the level in DAD than RMS.

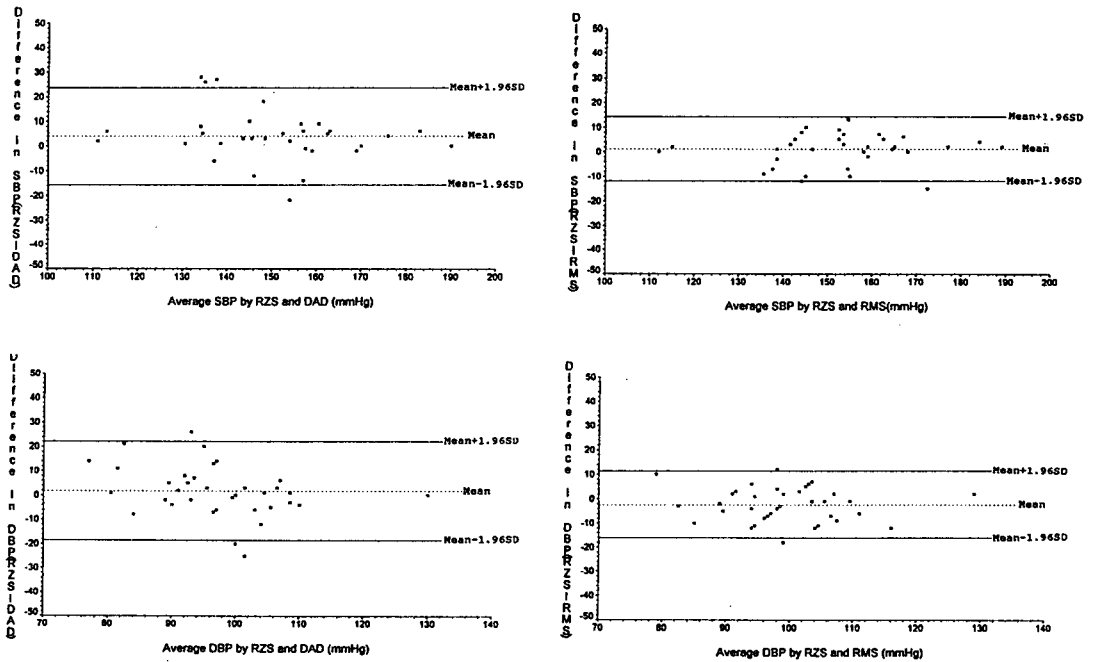
When the 36 pairs of RZS or DAD values were compared to standard mercury sphygmomanometer values important patterns of digit preference were evident. SBPs were recored to the nearest zero for 19.4% of RZS, 52.8% of DAD and 44.4% RMS. DBPs were recored to the nearest zero for 16.7% of RZS, 52.8% of DAD and 8% of RMS(different zero point of RMS and DAD see Figure 4). The modal RMS DBP of the subjects was 100mmHg which was recored for 11 subjctets(30.6) of the sample(Figure 4).



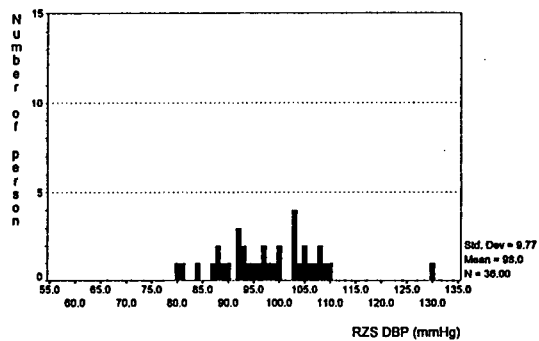
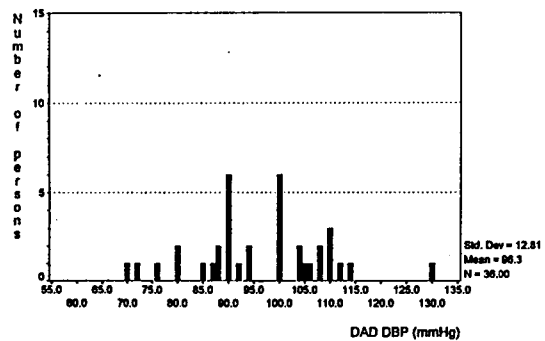
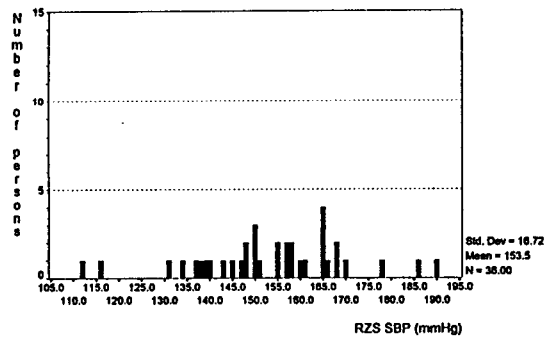
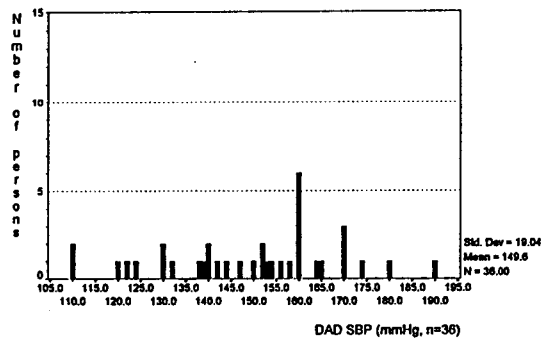
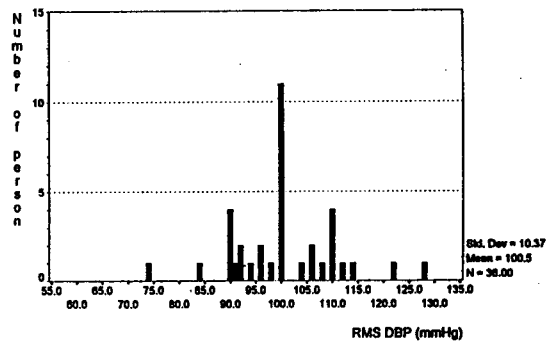
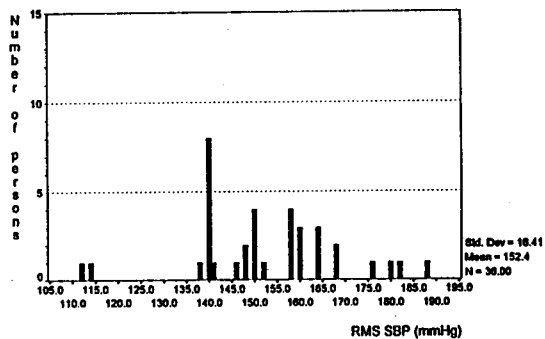
<Figure 1> Plot of pressure difference and mean pressure for RZS and DAD 200 subjects for systolic blood pressure(SBP) and diastoloc blood pressure(DBP). Reference lines for 0, ± 5 , ± 10 and ± 15 mmHg differences are shown.



<Figure 2> Distribution of digit preference of DAD and RZS of SBP and DBP in 200 subjects.



<Figure 3> Individual differences between RZS and DAD measurement methods and RMS in 36 subjects for systolic blood pressure(SBP) and diastolic blood pressure(DBP).



<Figure 4> Distribution of digit preference of DAD, RZS and RMS of SBP and DBP in 36 subjects.

Discussion

At present, automatic or semiautomatic devices for BP measurements are validated according to the criteria of the AAMI (Association for the Advancement of Medical Instrumentation, 1987). These criteria permit a mean difference of ± 5 mmHg and standard deviation within ± 8 mmHg. For clinical purposes, however, these AAMI criteria may be regarded as somewhat too lenient (Imai, et al., 1994; O'Brien, et al., 1990). The BHS Working Party on Blood Pressure Measurement recently proposed criteria that are more strict, whereby the degree of agreement with measurement recently obtained by the auscultation method is graded from A to D (O'Brien, et al., 1990).

The value of examining data visually

This study demonstrated rather poor agreement between RZS and DAD for DBP by AAMI (Association for the Advancement of Medical Instrumentation, 1987) criteria and BHS guidelines (O'Brien, et al., 1990) (see Figure 1). The range of absolute differences between the two methods DBP was larger than the SBP. DAD SBP and DBP underestimated RZS, as other study (Martin, 1993).

In the 36 samples, the scattergram distributed more widely around the mean level in agreement between RZS and DAD than between RZS and RMS.

In our experience, which is similar to others, we found digit preference for DAD (Martin, 1993) and RMS, particularly as measured by regular sphygmomanometer, to be quite common with many values rounded off to the nearest zero.

These findings indicate that RZS measurement is most suitable for research purposes. RZS and alternative blood pressure measurement methods necessitate careful training of observers, retraining and concurrent monitoring of data.

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주요개념 : 혈압측정방법의 일치도

도시지역 고혈압을 가진 젊은 흑인 남성들의 Random- Zero Sphygmomanometer, Digit Automatic Device 와 Regular Mercury Sphygmom- anometer 사이의 혈압측정 방법에 의한 일치도와 점(숫자)선호도

박 경 민*

신체의 활력을 측정하는 혈압은 다른 어느 측정치보다 변동이 심하고 정상적으로 변할 수 있는 생리적 현상이어서 정확하게 측정하기란 쉽지 않다. 1 mmHg 차이의 혈압일지라도, 특히 큰 집단일 경우, 연구목적에서 그 결과를 크게 왜곡 시킬 수 있다 (Wright & dore, 1970).

혈압 측정에는 직접적 방법과 간접적 방법이 있다. 이 중 간접적 방법은 임상분야와 연구분야에서 실제로 넓게 사용되고 있을 뿐만 아니라 신체로의 직접적 침투하는 방법도 아니고 가격 또한 비싸지 않다. 그러나, 간접적 측정 방법은 혈압에 영향을 끼치는 많은 요인들인 관찰자 편견, 확장기음의 청취음 선택, 관찰자와 환자 사이의 상호관계(Whitecoat or office hypertension) 때문에 방법론적으로 문제제기가 되기도 한다.

이런 요인을 최소화하기 위하여 가장 타당도가 높은 측정도구의 선택이 필요하다.

도시지역의(Ease Baltimore) 고혈압을 가진 젊은 흑인 남성(연령별/성별/종족별/거주지역) 중 수축기 혈압이 140mmHg 이고 확장기 혈압이 90mmHg인 사람, 또는 확장기 혈압이 90mmHg인 사람, 또는 혈압하강제를 먹고 있는 사람 200명을 대상으로 훈련받은 community health worker(CHW)에 의해 Random-Zero Sphygmomanometer(RZS)와 Digit Automatic Device(DAD)로 혈압을 측정하게 하였다. 이 중 36명을 무작위 추출하여 regular Mercury Sphygmomanometer(RMS)로 혈압을 측정하게 했다.

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Bland 와 Altman에 의해 제기된 두측정값의 차이에 대한 scattergram(일치도 검증법)과 AAMI(Association for the Advancement of Medical Instrument) 기준, BHS 기준, Central Tendency와 숫자 선호도로 검증되었다.

AAMI와 BHS 기준에 의하면 확장기 혈압에서 RZS와 DAD 의 일치도가 평균을 중심으로 더 넓게 퍼져있어 낮은 일치도를 보였으며 또 DAD와 RMS의

혈압치는 숫자 선호도를 볼 수 있는데 특히 RMS는 더 뚜렷하게 나타났는데 확장기 혈압의 최빈치(30.6)는 100mmHg이었다. 혈압치들이 가장 가까이 "0"점으로 치우쳐져 있었다.

RZS의 Central tendency는 DAD와 RMS보다 뚜렷하였다.

결론적으로 RZS는 이 연구목적으로 가장 적절함을 보여준다.