Inaccuracy in Blood Pressure Recordings in Two Primary Health Care Centers in The City of Salta, Argentina

Errores de registro en las mediciones de presión arterial realizadas en dos centros de atención primaria de la salud de la ciudad de Salta, Argentina

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ABSTRACT

Background: The diagnosis of hypertension (HTN) is made by measuring blood pressure (BP) in the physician's office (PO) or nurse station (NS). Rounding BP readings to the nearest multiple of 10 is common and may lead to inaccurate diagnosis and BP control.
Objective: The aim of this study was to determine the number of BP recordings that ended in zero measured in the PO and NS in two primary health care centers in the city of Salta.
Methods: We conducted a descriptive and cross-sectional study from February to December 2018. Blood pressure was measured twice in each patient, first in the NS and then in the PO using an automated BP monitor. The chi square test and the Wilcoxon test were used to analyze data.
Results: A total of 311 subjects were evaluated; 60.77% were women. Mean age was 56.15 ± 13.8 years. The frequency of BP recordings ending in zero was as follows: systolic BP measured in NS 36%; diastolic BP measured in NS, 40.51%; systolic BP measured in PO, 11.58% and diastolic BP measured in PO, 7.72% ($p < 0.0001$). Both systolic and diastolic BP recordings measured ended in zero in 30.87% of the cases in NS and in 0.64% in PO.
Conclusions: Systolic and diastolic BP measured in NS ended in zero with a frequency three and five times greater than those measured in PO, respectively, and the frequency of systolic and diastolic BP concurrently ending in zero was 48 times higher in NS than in PO. These results emphasize the need for ongoing training, to improve BP measurement.

Key Words: Blood pressure - Blood Pressure Determination – Tensiometer - Hypertension

RESUMEN

Introducción: El diagnóstico de hipertensión arterial (HTA) se realiza por la toma de la presión arterial (PA) en el consultorio médico (C) o en enfermería (E). Es frecuente aproximar los valores obtenidos a múltiplos de 10. Esto puede causar imprecisiones en el diagnóstico y el control de la HTA.
Objetivo: Determinar cuántos registros de PA terminaban en cero en las mediciones realizadas en E y en C en dos centros de atención primaria de la salud de la ciudad de Salta.
Material y métodos: Se efectuó un estudio descriptivo, transversal, de febrero a diciembre de 2018. Se utilizó un tensiómetro digital. A cada paciente se le midió la PA dos veces, primero en E y luego en C. Se utilizaron las pruebas de Chi2 y de Wilcoxon.
Resultados: Se estudiaron 311 individuos, 60,77% mujeres. Edad media: $56,15 \pm 13,8$ años. Los registros terminados en cero tuvieron las siguientes frecuencias: PA sistólica en E: 36%; PA diastólica en E: 40,51%; PA sistólica en C: 11,58%; PA diastólica en C: 7,72% ($p < 0,0001$). La PA sistólica y diastólica terminaron simultáneamente en cero en el 30,87% de los casos cuando se midieron en E y en el 0,64% de los casos cuando se midieron en C ($p < 0,0001$).
Conclusiones: La PA sistólica y la PA diastólica terminaron en cero con una frecuencia 3 y 5 veces mayor en E que en C, respectivamente, y la frecuencia de registros de PA sistólica y diastólica coincidentemente terminados en cero fue 48 veces mayor en E que en C. Estos resultados refuerzan la necesidad de una capacitación permanente para mejorar el registro en la medición de la PA.

Palabras clave: Presión sanguínea - Equipos de medición -Tensiómetros - Hipertensión

Abbreviations

NS	nurse station	**HTN**	hypertension
PO	Physician's office	**BP**	blood pressure

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INTRODUCTION

Hypertension (HTN) is the most prevalent disease and one of the main risk factors for cardiovascular disease worldwide. (1) The diagnosis of HTN is made by measuring blood pressure (BP) in the physician's office (PO) or in the nurse station (NS). (2) In many cases, the diagnosis of HTN requires home BP monitoring or 24-hour-ambulatory blood pressure monitoring. (3) Assessment in the PO or NS often involve errors in BP measurement or recording produced by the observer, (4) and is the most critical component of accurate BP measurement. (5) One of the most common sources of error is rounding BP readings to the nearest multiple of 10 mmHg, also known as "rounding to zero end-digit". (6) This may occur in almost 79% of BP measurements made with automated or aneroid devices. (7)

A systematic error of a few mmHg in BP measurement recordings can increase or decrease the diagnosis of HTN by more than 50% and the level of BP control by more than 40%. (8)

This situation leads to under- or over-diagnosis of HTN, with unnecessary treatments and medical visits, or lack of timely treatment (9) and an increased risk of target organ damage due to HTN. (10) Furthermore, the management of hypertensive patients is fundamentally carried out considering baseline BP levels; therefore, accuracy in BP measurement recordings is essential. (11) There is evidence that BP recordings ending in zero are less common with automated devices than with aneroid sphygmomanometers. (12-14) Furthermore, avoiding zero end digit preference of BP recordings allows greater control of hypertensive patients at primary care level. (15)

The aim of this descriptive, cross-sectional study performed between February and December 2018 was to determine the number of BP readings ending in zero, measured in the PO and NS with automated BP monitors in people evaluated in two primary health care centers in the city of Salta, Argentina. We also analyzed if there were statistically significant differences between mean BP levels calculated in NS and PO, the number of hypertensive patients with uncontrolled BP and of people with de novo HTN according to NS and PO, and the type of medication received by patients with HTN.

METHODS

We conducted a descriptive, cross-sectional and prospective study in two primary health care centers in the city of Salta, Argentina, between February and December 2018.

Using nonprobability convenience sampling, the study enrolled individuals of both sexes ≥18 years, who spontaneously visited for any condition (not only because of HTN) the primary health care centers participating in the project. Patients who did not sign the informed consent form and pregnant women were not included in the study.

The presence of previous HTN was defined by the medical interview. Uncontrolled BP was described as systolic BP ≥140 mm Hg or diastolic BP ≥ 90 mm Hg. De novo HTN was considered if the patient had no history of HTN and had systolic BP ≥ 140 mm Hg or diastolic BP ≥ 90 mm Hg.

Blood pressure was measured twice in each patient, first in the NS and then in the PO. Both measurements were performed with an automatic BP monitor Omrom-Hem 7220®.

Blood pressure was measured in the PO following the recommendations of clinical practice guidelines for proper BP measurements in the office (2): the patient should rest for 5 minutes sitting in a chair with his/her feet flat on the floor and back supported; the arm should be bare and positioned at the level of the heart (BP was measured in the dominant arm). The patient was asked if he/she needed to empty his/her bladder and was invited to do so before BP was measured; the cuff was placed two finger breadths above the elbow crease encircling 2/3 of the arm and neither the patient nor the observer should talk during the measurement. Proper BP measurement following clinical practice guidelines was not evaluated when BP was measured in the NS.

Statistical analysis

Data were summarized using measures of central tendency and dispersion for quantitative variables. Qualitative variables were summarized as absolute frequencies and were analyzed using the chi square test of independence. Quantitative variables were compared using the nonparametric Wilcoxon test for paired samples. This test was used due to non-normal data distribution according to the analysis performed with the modified Shapiro-Wilk test. All the statistical calculations were performed using Infostat software package. (16) A p value <0.05 was considered statistically significant.

Ethical considerations

The study protocol and the model of the informed consent form were approved by the Provincial Committee on Health Sciences Research of the Ministry of Health of the Province of Salta. All information was protected according to the Argentine personal data protection law 25,326.

RESULTS

A total of 311 subjects were evaluated, among which 189 (60.77%) were women and 122 (39.23%) were men. Mean age was 56.15 ± 13.8 years (range: 18 to 91). A total of 622 BP measurements were recorded.

The frequency of BP recordings ending in zero was as follows: systolic BP measured in NS, 36%; diastolic BP measured in NS, 40.51%; systolic BP measured in PO, 11.58% and diastolic BP measured in PO, 7.72% (p < 0.0001). Both systolic and diastolic BP recordings ended in zero in 97 (30.87%) persons in NS and in 2 (0.64%) in PO (p < 0.0001) (Figure 1). Figures 2 and 3 show the percentage of BP recordings ending in zero, i.e., systolic BP of 120, 130, 140 and 150 mmHg and diastolic BP of 60, 70, 80 and 90 mmHg, measured in NS and PO. The frequency of systolic BP recorded as 120 and 130 mmHg and diastolic BP recorded as 60, 70, and 80 mmHg was significantly different between PO and NS.

Mean systolic BP recordings in NS and PO were 134.4 ± 21.8 mmHg (95% CI, 131.96-136.84) and 142.96 ± 22.7 mmHg (95% CI, 140.43-145.5), respectively (p < 0.0001). Mean diastolic BP recordings in NS and PO were 80.75 ± 13.8 mmHg (95% CI, 79.21-82.3) and 87.96 ± 13.14 mmHg (95% CI, 86.49-89.43),

respectively (p < 0.0001).

Previous HTN was reported by 209 (67.2%) subjects; 110 of them (52.63%) had uncontrolled BP measured in NS, while BP measured in PO was uncontrolled in 151 (72.24%) (p = 0.00003).

Among the 102 subjects who did not report previous HTN, 40 presented de novo HTN measured in NS (39.21%) and 49 presented de novo HTN measured in PO (48%) (p = 0.21).

Of the 209 subjects who reported previous HTN, 37 (17.7%) were taking enalapril once a day and 34 (16.26%) had not taken the medication on the day BP was recorded.

DISCUSSION

The percentage of BP recordings ending in zero in NS was 36% for systolic BP and 41% for diastolic BP, and 12% and 8%, respectively, for BP measured in PO. Thus, systolic and diastolic BP measured in NS end-

ing in zero were three and five times more frequent than those measured in PO, respectively. Moreover, both systolic and diastolic BP recordings measured in NS ended simultaneously in zero in 31% of the cases in NS and in 0.6% in PO. Therefore, the frequency of both systolic and diastolic BP recordings ending simultaneously in zero was 48 times higher in NS than in PO. The percentage expected of BP recordings ending in zero with automated BP monitors is 10%. (14) For example, in a study conducted in primary care practice in Canada and the United Kingdom with automated BP devices in NS and PO, BP recordings ending in zero were 11.1% for systolic BP and 11.3% for diastolic BP. (13)

In a study using automated BP monitors with BP measured by physicians, systolic and diastolic blood pressure recordings ended in zero in 61% and 58% of cases, respectively. After the intervention, with the patient resting alone in the examination room and

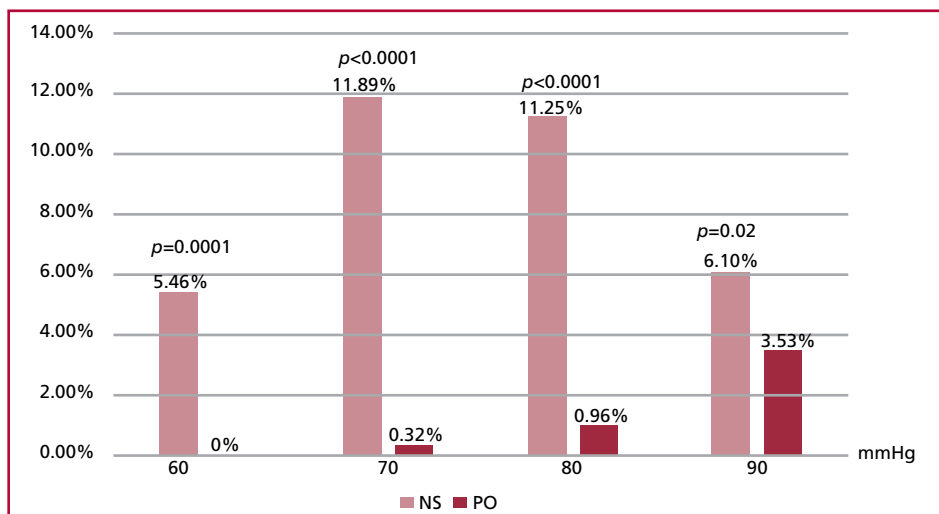**Fig. 1.** Percentage of blood pressure recordings ending in zero (n = 311).
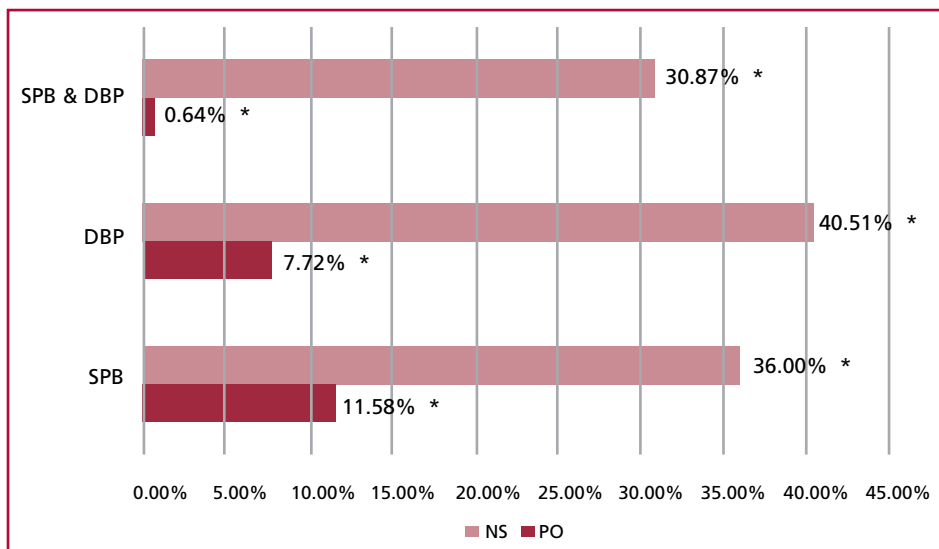
SBP; systolic blood pressure; DBP: diastolic blood pressure; NS: nurse station; PO: physician's office.
* p < 0.0001

Fig. 2. Percentage of systolic blood pressure recordings ending in zero, discriminated by value (n = 311)
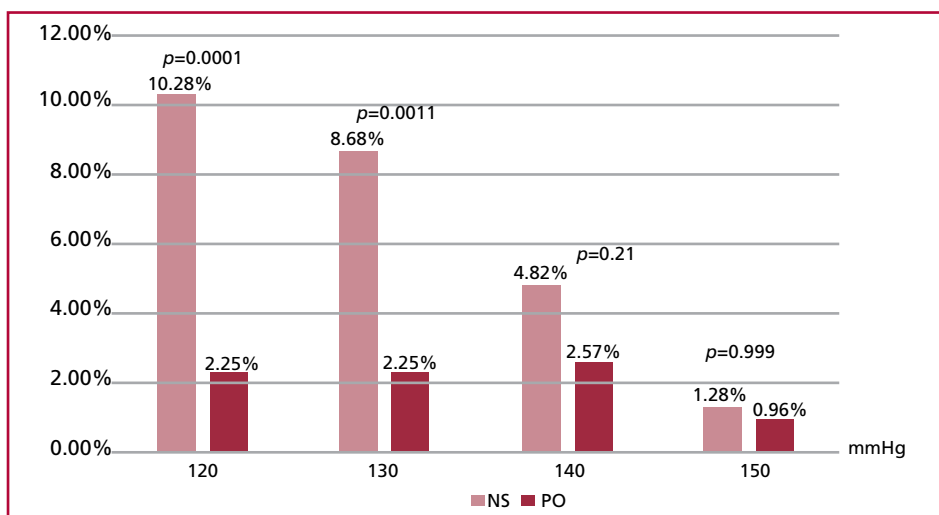
NS: nurse station; PO: physician's office

Fig. 3. Percentage of diastolic blood pressure recordings ending in zero, discriminated by value (n = 311)

NS: nurse station; PO: physician's office

following the guidelines for proper BP measurement, this percentage decreased to 14% for both systolic and diastolic BP, with similar percentages to those obtained in our study in the PO. (17) Mengden et al. reported similar figures to those found in BP measurements in PO in our study. (18) In that study, BP was measured with an automated BP monitor by trained nurses or physicians, and both systolic and diastolic BP recordings ended in zero in 10% of the cases.

In our study, the trend to zero end-digit preference in BP measured in NS was observed when systolic BP readings of 120, 130, 140 and 150 mmHg and diastolic BP readings of 60, 70, 80 and 90 mmHg were compared in both NS and PO, with significant differences in the readings of 120 and 130 mmHg for systolic BP and 60, 70 and 80 mmHg for diastolic BP.

A higher rate of cardiovascular events (stroke, acute myocardial infarction, and angina) has been demonstrated in those patients in whom BP was recorded with zero end-digit preference. (13)

Mean systolic and diastolic BP measured in NS were significantly lower compared with those measured in PO. This finding has been verified in another study and attributed to an alerting reaction in the presence of the physician. (19) This may be the reason why we detected more patients with uncontrolled BP in hypertensive patients in PO than in NS. In any case, the percentage of detection of this situation in the PO (72%) is close to the percentage of detection of uncontrolled HTN (76%) in the last population-based study carried out in Argentina. (20) As we did not perform ambulatory or home BP monitoring in our study, we cannot rule out the possibility of a "white coat" effect in hypertensive patients with uncontrolled BP and in those with de novo hypertension.

Although we did not verify if clinical practice guidelines for proper BP measurement had been followed in the NS, and the participating nurses did not receive special training before the study, we believe

that this situation does not detract from the value of our findings, as they perhaps better reflect the "real world" of this diagnostic practice in our study site. The heavy workload of the nurses in the health care centers where the study was carried out should be taken into account, as it results in little time for proper BP measurement and recording. This may affect the tendency to record BP measurements with zero end-digit preference. (21) Anyway, in our study it would have been better if the nurses had been previously trained in proper BP measurement according to clinical practice guidelines to reduce the influence of other confounders on the results.

One limitation of our study could be that the participating physicians were aware of the objectives of the investigation, so there could be an observation bias, although, ultimately, the exact BP figures obtained with automated BP devices in the PO were compared with the measurements recorded in the NS.

In our study, 18% of the patients were taking enalapril once a day when clinical practice guidelines recommend one pill twice a day. (22) In addition, 16% of hypertensive patients had not taken the medication when BP was measured.

Hypertension is a highly prevalent disease. The Fourth National Risk Factor Survey performed in Argentina in 2018 among people ≥18 years showed an increase in its prevalence, from 34.1% to 34.6%, compared with the previous 2013 survey. (23) Proper BP measurement improves BP control in hypertensive patients, as shown by the Kaiser Permanente Northern California, a health care institution in the United States, that reported an improvement in BP control from 44% to 90%. (24) A 5-mmHg measurement error may lead to incorrect hypertensive status classification in 84 million individuals worldwide. (21)

The Lancet Commission on HTN group position statement identified that a key action to address the worldwide burden of HTN was to improve the quality

of BP measurements. (4)

It would be convenient to carry out a study in which the health care workers involved in BP measurement should be blinded to the objectives of the study to assess the true magnitude of the tendency to rounding BP readings to the nearest 10 mm Hg in physicians and nurses.

CONCLUSIONS

The results of this study highlight the need for ongoing training of nurses and physicians, both at undergraduate and postgraduate levels, for correct BP measurement, considering that accurate BP measurement is considered one of the most important examinations in health care practice. (5) Special emphasis should be made on recording the exact BP figure obtained with the sphygmomanometer. Training has demonstrated effectiveness in reducing BP recordings with zero end digit preference. (25)

Conflicts of interest
None declared.

(See authors' conflicts of interest forms on the website/ Supplementary material)

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