

## Brief Communication

# Time Interval Between Pairs of Arterial Blood Pressure Measurements—Does It Matter?

Nelson Rudi Koehler, Carlos Eduardo Poli de Figueiredo, and Antônio Cláudio Mendes-Ribeiro

Guidelines on arterial blood pressure (BP) measurements recommend a time interval between readings. There has been little evidence supporting this recommendation. Therefore, we measured the variation in arterial pressure between the pairs of measurements without an interval ( $n = 269$ ) or with venous congestion interposed ( $n = 79$ ). The variation in BP readings was not significantly greater whether a 60-sec interval or venous congestion were present. These overall results do not support the hypoth-

esis that the absence of the time interval or of presence of venous congestion, as may occur in clinical practice, significantly affects BP measurements. *Am J Hypertens* 2004;17:194–196 © 2004 American Journal of Hypertension, Ltd.

**Key Words:** Blood pressure, blood pressure determinations, short term course, venous cutdown, venous pressure.

**H**ypertension is one of the leading risk factors for coronary artery disease, congestive heart failure, renal disease, and stroke. Cuff measurements of arterial blood pressure (BP) remains the most appropriate screening test for hypertension. This method of BP measurement is prone to errors resulting from instrument-, observer-, and patient-related factors. Among other standards, guidelines on arterial BP measurements recommend that two or more readings separated by at least 30 to 60 sec be averaged. The recommendation of having an interval between two consecutive measurements is present in textbooks and even in guidelines prepared by societies and committees involved in BP and high BP investigation.<sup>1–8</sup> However, we are not aware of documentation in the literature that describe experimental studies supporting this recommendation, except our previous report.<sup>9</sup>

There are reports that venous congestion after the first arterial BP measurement could be responsible for a possible alteration in the next reading.<sup>10</sup> Although the existence of a peripheral circulation regulatory reflex in humans (namely, the venous cutaneous vasoconstrictor reflex) is known,<sup>11,12</sup> an effect of venous congestion on arterial BP measurement is speculative.

The present work compares the oscillation of arterial BP assessed in pairs of measurement separated by the conventional interval with the variation observed without

this delay between records. We also investigated the effect of venous congestion upon the second reading by comparing two measurements after the recommended time interval with pairs of readings, with venous congestion interposed without an additional interval.

## Methods

Arterial BP was measured four times at rest, in the right arm, by a conventional noninvasive method and same examiner (NK), in 345 consecutive patients. Patients in group A ( $n = 92$ ; age range 21 to 86 years) had their BP measured in the sitting position using a mercury sphygmomanometer. Patients in group B ( $n = 158$ ; age range 17 to 80 years) had BP measured in the supine position with a mercury sphygmomanometer. In group C ( $n = 19$ ; age range 27 to 82 years), BP was measured with the patient in the sitting position using an automatic Datascope device, model 2NEL (Datascope Corp., Paramus, NJ). In group D ( $n = 44$ ; age range 17 to 82 years), BP was measured with the patient in the supine position using a mercury sphygmomanometer. In group E ( $n = 32$ ; age range 18 to 75 years), BP was measured using a Nihon Seimitsu Sokk digital electronic device (model DS-91; Nissei, Japan) with the subjects in the supine position.

The first pair of readings was obtained at the beginning

Received July 2, 2003. Accepted August 27, 2003.

From the Faculdade de Medicina/Instituto de Pesquisas Biológicas/Hospital São Lucas da Pontifícia Universidade Católica do Rio Grande do Sul (NRK, CEPDF), Porto Alegre, Rio Grande do Sul, Brazil; and Farmacologia/Universidade Estadual do Rio de Janeiro (ACMR), Rio de Janeiro, Brazil.

Carlos Eduardo Poli de Figueiredo is a Conselho Nacional de Pes-

quisa (Brazil) investigator.

A previous version of this work was published in the *Brazilian Journal of Medical and Biological Research* (Braz J Med Biol Res 2002;35:555–559).

Address correspondence and reprint requests to Dr. Nelson Rudi Koehler, Centro Clínico PUCRS, Av Ipiranga 6690 Conj 207, Porto Alegre, RS, Brazil, CEP 90610.000; e-mail: nelsonrk@terra.com.br

**Table 1.** Analysis of the difference in mean fluctuation between two pairs of BP measurements (systolic and diastolic) with and without a 60-sec interval between them

Group	n	Interval (sec)	Systolic Variation*	P†	Diastolic Variation*	P†
A	92	60	5.47 ± 0.53	.019	3.41 ± 0.29	.249
		0	4.14 ± 0.41		2.94 ± 0.29	
B	158	60	3.60 ± 0.27	.141	2.91 ± 0.23	.054
		0	3.11 ± 0.24		2.26 ± 0.17	
C	19	60	3.46 ± 0.69	.080	2.20 ± 0.46	.304
		0	5.32 ± 0.73		3.24 ± 0.66	
D	44	60	3.25 ± 0.41	.462	2.69 ± 0.33	.687
		0 + VC	2.80 ± 0.41		2.96 ± 0.32	
E	32	60	5.70 ± 1.11	.090	5.75 ± 1.14	.611
		0 + VC	8.29 ± 1.22		6.45 ± 0.97	

VC = venous congestion interposed.

\* Variation is reported as mean of SD (mm Hg) ± mean error.

† Bilateral *t* test for paired samples.

of the consultation, and the second pair at the end. An interval of 60 sec was observed between BP measurements in one pair of readings, and no interval in the other pair was allowed. The arm examined was at heart level. Patients were relaxed, did not talk, did not cross their legs, and did not smoke or drink coffee during the last 15 min.

In group D and E, the first pair of readings was obtained with an interval of 60 sec; in the second pair of readings venous congestion of the right arm was caused immediately after the first reading, with no delay before the second reading. Venous congestion was obtained by using the same cuff as used for BP measurements. The pressure exerted was the mean of the systolic and diastolic pressures over a period of 10 to 15 sec, causing venous dilation.

Systolic BP was measured at Korotkoff phase I and diastolic BP at phase V. The BP devices used were not checked for previous validation because the variable under study was BP fluctuation or oscillation and not the accuracy of measurements. Patients with hemodynamic instability, cardiac arrhythmias, pregnancy, weak Korotkoff sound, or aged <15 years were not included in the study.

Short-term variation in arterial BP at rest was reported as the mean of the standard deviations of the differences in arterial pressure between the pairs of measurements separated by a 60-sec interval, or by no interval or with venous congestion interposed. The paired *t* test was used to compare the fluctuation between paired samples, with the level of significance set at  $P < .05$ . The present study was approved by the University Scientific and Ethics Committee.

## Results

Table 1 lists the study results. In groups B, C, D, and E the fluctuation of arterial BP in the pairs of measurement without an interval or with venous congestion interposed was not significantly greater than that observed in the arterial BP measurement pairs with a 60-sec interval and

no venous congestion between assessments. For group A, the fluctuation in systolic arterial BP was significant and was greater for pairs of measurement obtained with a 60-sec interval. Analysis of smaller strata in groups A and B (women versus men, younger versus older adults, individuals of white versus nonwhite ethnicity) did not show significant differences in the oscillation of arterial BP measurements pairs with a 60-sec interval versus no interval, with the variation being greater in arterial BP measurement pairs with a 60-sec interval than in pairs without such an interval (data not shown).

## Discussion

The present work does not demonstrate a significantly greater variation in arterial BP between pairs of measurements without an interval and with interposed venous congestion when compared with the oscillation in pairs of measurements with a 60-sec interval. In only one group of patients (group A) there was significantly greater oscillation in systolic arterial pressure in the pairs of measurements with an interval.

Therefore, the present study does not support the established guidelines for BP measurement techniques. Neither elimination of a time interval nor the occurrence of venous congestion between measurements increased arterial BP variation in the sample studied. Our main conclusion is that the overall results do not support the hypothesis that absence of the interval or venous congestion that may occur in clinical practice significantly affects the arterial BP oscillation that occurs naturally.

## Acknowledgments

The authors are indebted to Dr. Mário Rigatto (in memoriam) and to Drs. Robert Clarke, Jandira Fachel, and Norman Kaplan.

## References

1. Kaplan NM: Hypertension: mechanisms and diagnosis, in Braunwald E (ed): *Heart Disease: A Textbook of Cardiovascular Medicine*. 5th ed. WB Saunders, Philadelphia, 1997, p 819.
2. Oparil S: Arterial hypertension, in Goldman L, Bennett JC (eds): *Cecil Textbook of Medicine*. 21st ed. WB Saunders, Philadelphia, 2000, pp 258–273.
3. Rourke RA, Shaver JÁ, Salerni R, Silverman ME, Schallant RC: The history, physical examination and cardiac auscultation: methods for measuring the arterial pressure, in Alexander RW, Schlant RC, Fuster V, Rourke RA, Roberts R, Sonnenblick EH (eds): *Hurst's: The Heart, Arteries and Veins*. 9th ed. McGraw-Hill, New York, 1998, pp 254–258.
4. Feldman RD, Campbell NR, Larochelle P: Clinical problem solving based on the 1999 Canadian recommendations of the management of hypertension. *Can Med Assoc J* 1999;161(Suppl 12):S18–S22.
5. Feldman RD, Campbell NR, Larochelle P, Bolli P, Burgess ED, Carruthers SG: 1999 Canadian recommendations for the management of hypertension: Task Force for the Management of Hypertension. *Can Med Assoc J* 1999;161(Suppl 12):1–17.
6. American Society of Hypertension: Recommendations for routine blood pressure measurement by indirect cuff sphygmomanometry. *Am J Hypertens* 1992;5:207–209.
7. Consenso Brasileiro para o Tratamento da Hipertensão Arterial (3: 1998: Campos do Jordão, São Paulo). III Congresso Brasileiro para o Tratamento da Hipertensão Arterial. Campos do Jordão, Sociedade Brasileira de Hipertensão, 1998.
8. The Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure: Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure: the sixth report. *Arch Intern Med* 1998;157:2413–2446.
9. Koehler NR, Poli de Figueiredo CE, Ribeiro ACM: Serial blood pressure measurements. *Br J Med Biol Res* 2002;35:555–559.
10. Hassan AA, Rayman G, Tooke JE: Effect of indirect heating on the postural control of skin blood flow in the human foot. *Clin Sci* 1986;70:577–582.
11. Henriksen O: Effect of chronic sympathetic denervation upon local regulation of blood flow in human subcutaneous tissue. *Acta Physiol Scand* 1976;97:377–384.
12. Leonardo G, Arpaia MR, Del Guercio R, Coltorti M: Local deterioration of the cutaneous venoarterial reflex of the hand in cirrhosis. *Scand J Gastroenterol* 1992;27:326–332.