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Original articles:

Clinical significance of blood pressure ratios in hypertensive crisis in children

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Identifying Hypertension using Centile Charts: Overcoming the Problem of Blood Pressure Variability

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We commend Wu et al for their work on blood-pressure-ratios. Up until now hypertension was defined using statistically derived limits based on gender, age and height specific norms. The formulation of Wu et al permits assessments of adverse effects at different blood-pressure- ratios across age, gender and height percentile groups. (1) However given that multiple readings in an individual fluctuate quite wildly, identification of the 'real BP' for calculation of blood pressure ratio is still a problem. The statistically derived limits of normal BP are relatively tight bands. Conventionally, blood pressure (BP) above the 95th centile is classified as hypertension. That below the 90th centile is considered normal and BP between the 90th and 95th percentile is labeled 'pre-hypertension'. The difference between the 89th percentile (normal BP) and the 95th percentile, (abnormal BP) is only 3 to 4 mm of Hg. (2). It is presumed that the average of 4 readings taken in an individual during at least 2 office visits reflects 'usual blood pressure' accurately. (3) The validity of this assumption is uncertain. A journal club discussion around the work of Wu et al prompted the authors to investigate variability of BP readings in individuals to determine the confidence limits within which the real blood pressure would lie, given that the mean of 4 readings is available for an individual. We also estimate the number of readings of BP that need to be averaged, to be able to predict the real BP of the individual within a 4 mm of Hg range (95% CI +/- 2).

Material and Methods Five researchers comprised the subjects for this study and they had their BP readings recorded 3 times a day for five days. They were neither known to be hypertensive nor on any drug that affects BP. A sixth researcher on anti-hypertensive medication was excluded. The readings were not disclosed to the study subjects till the end of the observation period.

The protocol for validation of instruments requires BP to be noted 9 times sequentially with a 30 second gap between readings. We recorded BP sequentially 5 times on each occasion. (4) The procedure for taking blood pressure prescribed for the National Health and Nutrition Examination Survey (NHANE) was followed. (5) Readings were taken after a waiting period of 5 minutes where the subjects sat with their feet flat on the floor. A 'Planet 50' multi-parameter patient monitoring system, Model 200 (Larsen and Toubro Medical Equipments & Systems, Mysore India) was used for non-invasive oscillatory BP measurement. An appropriate sized adult cuff was used for all the measurements. The same BP measuring device and cuff were used for all the readings. .

For purposes of this study, variability of systolic and diastolic BP is defined as the difference between the highest and lowest readings recorded for the individual.

Results

In the individual with the steadiest BP, there was a difference of 26 mm of Hg between her highest and lowest systolic BP recordings (SD 5.4). We calculated that if the mean of only 4 readings is available, her real BP would be anywhere within an 11 mm range. The mean of 29 observations will be required to achieve CI of 4 (+/- 2) or SE =1.

The table gives the data for systolic BP in the five volunteers. Taking the average from the 5 individuals, if one is to rely on just the mean of 4 readings from an individual, we calculate the real BP would lie anywhere within 13 mm range. To be able to estimate BP accurately to within 4 mm , blood pressure recordings need to be taken 36 times.

Discussion We found the blood pressure varied a lot during the 5-day study period. On account of the fact that our readings were taken over a short duration, the readings are not independent of one another and we anticipate a certain amount of autocorrelation. This will narrow the SD more than if the readings were independent variables and we believe that ours is therefore an underestimation of the real variability. The difference between the 90th and 95th percentile in the Fourth Report on High Blood Pressure in Children and Adolescent is only 4 mm of Hg and that between the 75th percentile and 99th percentile is about 13 mm of Hg for both systolic and diastolic blood pressures. (2) Earlier studies have noted big differences between daytime and night time readings in children. In 5 year old children, the 75th percentile for day time blood pressure is about 17 mm of Hg higher than the 75th percentile at night, both for systolic and diastolic blood pressures. (6)

This pilot study has obvious limitations given the small number of subjects studied. Ambulatory readings taken periodically through out the day and night must be used to study the full extent of the variance in BP. Although ambulatory BP monitoring has been available for many years now, this is arguably the first study to look at the confidence limits within which the 'real blood pressure' will lie when only a limited number of readings are available from a person. Larger studies are needed to arrive at the real average variance in the BP in the population as a whole.

Conclusion Multiple readings are needed to determine the 'real BP' in a person when looking at blood pressure ratios. The practice of diagnosing hypertension based on 4 readings on 2 clinic visits is unreliable. Discussions with patients must include an acknowledgement of these uncertainties

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Table I Variability in Systolic and Diastolic BP in the Subjects Studied (75 observation per subject)

35y(M) 26y(F) 25y(M) 26y(M) 32y(F) Highest SBP 139 117 118 132 108 Lowest SBP 95 87 88 98 82 Mean SBP 112 99 100 108 93 (SD) (7.7) (5.8) (7.6) (6.7) (5.4) 95% CI (4 obs) 15 12 15 13 11 Obs. required (CI4 (+/-2) SE=1 59 34 58 45 29

Mean Width of CI if 4 readings are averaged = 13 mm On an average 45 readings must be obtained to estimate the real BP (Mean of number of observations (obs.) required to reduce the width of 95% CI to 4 mm of Hg = 45)

Conflict of Interest:

None declared

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