

IS NEAR BASAL BLOOD PRESSURE A MORE ACCURATE PREDICTOR OF CARDIORENAL MANIFESTATIONS OF HYPERTENSION THAN CASUAL BLOOD PRESSURE?

JOHN R. CALDWELL,* M. ANTHONY SCHORK† and ROBERT D. AIKEN‡

*Department of Internal Medicine, Henry Ford Hospital, Detroit, MI 48202, U.S.A.

†School of Public Health, The University of Michigan, Ann Arbor, MI, U.S.A.

‡Intern, Baylor College of Medicine, Texas Medical Center, Houston, TX, U.S.A.

(Received in revised form 13 February 1978)

Abstract—Measurement of casual and near basal systolic and diastolic blood pressures were correlated with the severity of cardiorenal manifestations of hypertension in 471 patients. There was a significant association of each of the four blood pressure measurements with each other ($P < 0.001$). Systolic blood pressure and manifestations of hypertension increased with age. Blacks had higher blood pressures and more manifestations than whites.

All four blood pressure measurements were significantly associated ($r \geq 0.78$, $P < 0.0005$) with grade 3 fundi, proteinuria and casts in the urine, electrocardiographic left ventricular hypertrophy, cardiomegaly by chest X-ray and aortic dilatation and/or elongation by chest X-ray.

The level of blood pressure is the important correlate of these manifestations of hypertension. This is equally true whether systolic, diastolic, casual or near basal measurements are used. Near basal blood pressure does not correlate better with the cardiorenal manifestations of hypertension than casual blood pressure, neither does diastolic blood pressure correlate better with these manifestations than systolic blood pressure.

MANY PATIENTS whose blood pressure is raised in the physician's office may have normal blood pressure at other times, an observation which is the basis for the traditional distinction between fixed and labile hypertension [1, 2]. Some who accept this distinction believe that basal blood pressure is more important in prognosis than casual blood pressure [3, 4]. To avoid the inconvenience of hospitalization, near basal readings have been used as an approximation of the basal blood pressure [5]. We compared casual with near basal blood pressure and systolic with diastolic pressure as to indications of the clinical manifestations of hypertension. We found that both casual and systolic blood pressure correlate as well with the manifestations of hypertension as near basal and diastolic blood pressure.

METHODS

Selection of subjects

Four-hundred and seventy-one hypertensive patients were selected for study. They comprised about 80% of new patients registered in the hypertension clinic during the period 1955-1959. All had a casual blood pressure [3] of 150 mmHg systolic and/or of 90 mmHg diastolic or greater without treatment and measurements of near basal blood pressure within 1 month. Secondary causes of hypertension were excluded by physical examination, intravenous pyelography, repeated urinalyses, serum potassium and urinary catecholamine determinations. Seriously ill patients and those requiring

Address requests for reprints to John R. Caldwell, M.D., Department of Internal Medicine, Henry Ford Hospital, Detroit, MI 48202, U.S.A.

*Clinical Associate Professor of Internal Medicine, University of Michigan Medical School.

†Professor of Biostatistics.

immediate treatment were excluded. The patients were aged from 15 to 80 yr with a mean of 43.8. There were 251 males and 220 females, 411 white and 60 black.

The measurements of casual blood pressure were made at the time of a physical examination by many different resident physicians. One blood pressure was taken on the left arm with the patient seated and the arm at heart level using either an aneroid or mercury sphygmomanometer. The highest reading was used. The stage at which Korotkoff sounds disappeared (fifth phase) was taken as the diastolic pressure.

Measurement of near basal blood pressure

This was done by a modification of the method of Alam and Smirk [3, 5] in a special room, which was quiet and dimly lit. Before entering this room, the patient voided if necessary and removed shoes, tight clothes, or wristbands. Blood pressure was measured in recumbency every 5 min for 30 min. All readings were recorded on the same arm at heart level with the same mercury manometer or recently calibrated aneroid sphygmomanometer, using the method of judging systolic and diastolic levels recommended by the American Heart Association [6]. The lowest diastolic reading obtained during the 30 min period was noted and systolic and diastolic readings at that particular 5 min interval were used as the near basal blood pressure. The procedure was carried out entirely by one of three technical assistants whose accuracy at blood pressure recording was checked periodically by the nurses or staff physicians in the clinic. The patient laid down on a comfortable bed and the technicians were trained to assume a friendly, sedate and reassuring manner and to remain in the room throughout the procedure, which was done without interruption.

Cardio-renal manifestations of hypertension

Well established criteria were used for the assessment of retinal abnormalities [7], electrocardiographic evidence of left ventricular hypertrophy (ECG-LVH) [8] and X-ray evidence of cardiac enlargement [9]. Three successive urine specimens were tested for protein and urinary sediment was examined for cells, bacteria and casts. A serum creatinine ≥ 1.3 mg/100 ml was designated as azotemia.

Analysis of data

All data were entered on McBee Keysort punch cards. After preliminary inspection, it was apparent that mean casual blood pressure was significantly higher than near basal blood pressure (Table 1). The prevalence of the various manifestations are listed in Table 2.

TABLE 1. MEAN BLOOD PRESSURE LEVELS (mmHg) (471 PATIENTS)

	Systolic		Diastolic	
	Casual	Near basal	Casual	Near basal
BP	192 \pm 33	146 \pm 29	111 \pm 19	89 \pm 18
Difference		-46		-22
Significance		$P < 0.001$		$P < 0.001$

\pm = S.D.

TABLE 2. CLINICAL MANIFESTATIONS OF HYPERTENSION (471 PATIENTS)

	Percent
ECG-LVH	19
Cardiac enlargement (X-ray)	19
Aortic dilatation and/or elongation (X-ray)	30
Optic fundi	
Grade 1	38
Grade 2	18
Grade 3	5
Grade 4	1
Casts in urine	36
Proteinuria	23
Azotemia	11

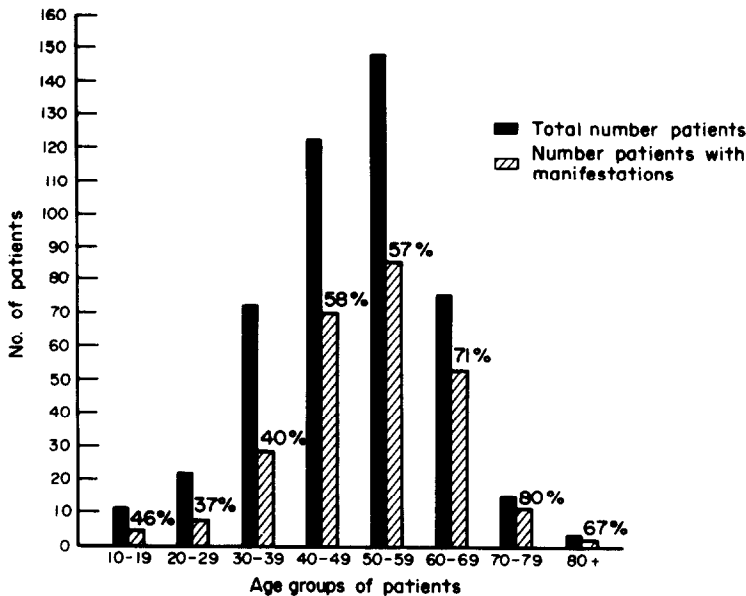


Fig. 1. Total number of patients in each age group is shown and number of patients with at least one of the manifestations of hypertension. There is an increase in the number of patients with at least one of these manifestations associated with increasing age ($\chi^2 = 22.69$, $P < 0.005$).

Subjects were grouped into 10 yr intervals by age. Percentages with and without manifestations were computed. With increasing age, there was an increase in the per cent of patients who had one or more of these manifestations (Fig. 1). Except for near basal diastolic blood pressure there was an increase in blood pressure with age. Males had a higher number with manifestations (59%) than females (52%) but the differences did not reach statistical significance ($\chi^2 = 2.38$ $P < 0.20$). Significantly ($P < 0.05$) more blacks than whites had manifestations (70% vs 54%). However, the mean blood pressure for the blacks was higher than the mean blood pressure for the whites (Table 3.).

Casual and near basal systolic and diastolic blood pressure levels were correlated with grade 3 fundi, ECG-LVH, cardiomegaly by X-ray, aortic dilatation and elongation by chest X-ray, proteinuria and casts in urine. Statistical significance was evaluated by students' *t*-test, correlation coefficient (*r*), Fisher Z transformation and chi-square test. Chi-square tests were completed to investigate the significance of eight different groups according to the levels of blood pressure with the prevalence of the above mentioned manifestations in each group.

Correlation between blood pressure categories and the per cent of each category having clinical manifestations

Relationships between severity of blood pressure and per cent in prevalence of ECG-LVH are shown for each type of measurements in Table 4 and Figs. 2 and 3. Relationships between the severity of blood pressure and percent of each clinical manifestation in each of the blood pressure groups are shown (Table 5).

TABLE 3. BLOOD PRESSURE LEVELS (mmHg) BY RACIAL DIFFERENCE

	Systolic		Diastolic	
	Casual	Near basal	Casual	Near basal
Black's BP (<i>N</i> = 60)	202 ± 36	153 ± 31	120 ± 21	97 ± 19
White's BP (<i>N</i> = 411)	191 ± 33	145 ± 29	110 ± 19	88 ± 18
<i>t</i> -Test	2.405	3.768	2.112	3.777
<i>P</i> Value	0.01 < <i>P</i> < 0.05	<0.0005	0.01 < <i>P</i> < 0.05	<0.0005

± = S.D.

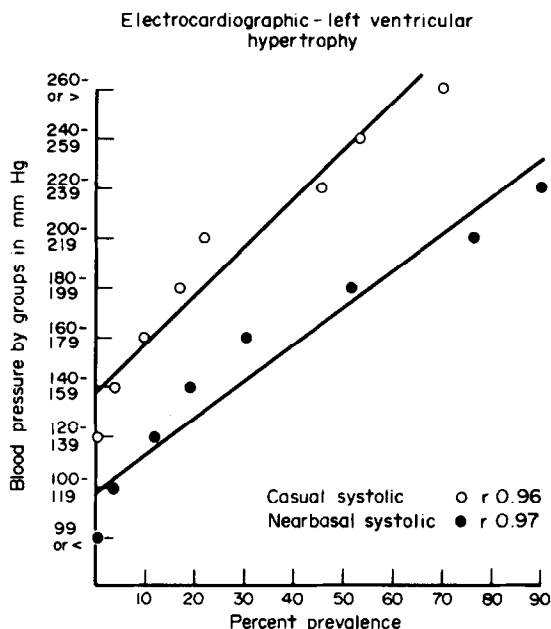


Fig. 2. The per cent prevalence of ECG-LVH in each of eight different groups of patients according to the level of systolic blood pressure measurements. Casual systolic \circ open circles, near basal systolic \bullet closed circles.

DISCUSSION

Near basal blood pressure demonstrates the degree of reduction of blood pressure which may be accomplished by the recumbent posture and minimizing of the effect of environmental stimuli. Furthermore, it is lower than the mean blood pressure recorded in hospitals and the same as the mean blood pressure recorded at home [10].

However, our answer to the question posed in the title is no. Near basal blood pressure is not a more accurate indicator of cardiorenal manifestations of hypertension than casual blood pressure. There is no longer any reason for determining basal or

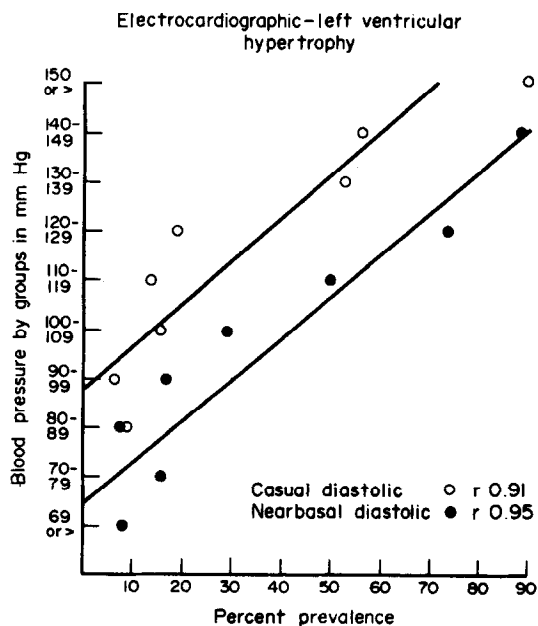


Fig. 3. The per cent prevalence of ECG-LVH in each of eight different groups of patients according to the level of diastolic blood pressure measurements. Casual diastolic \circ open circles, near basal diastolic \bullet closed circles.

TABLE 4. BLOOD PRESSURE GROUPS, NUMBER IN EACH GROUP AND PER CENT WITH ECG-LVH

Casual systolic BP groups mmHg					Near basal systolic BP groups mmHg				
*	No. of patients	No. with ECG LVH	% With ECG LVH		*	No. of patients	No. with ECG LVH	% With ECG LVH	
139 or less	130	6	0	0.0	99 or less	90	9	0	0.0
140-159	150	51	2	6.5	100-119	110	39	1	3.8
160-179	170	117	9	9.9	120-139	130	183	14	10.4
180-199	190	105	12	15.4	140-159	150	112	17	19.1
200-219	210	88	17	22.1	160-179	170	61	17	31.5
220-239	230	53	21	45.5	180-199	190	36	18	51.3
240-259	250	31	15	53.8	200-219	210	20	13	76.5
260 or above	270	20	14	70.0	220 or above	230	11	10	91.0

Casual diastolic BP groups mmHg					Near basal diastolic BP groups mmHg				
*	No. of patients	No. with ECG-LVH	% With ECG-LVH		*	No. of patients	No. with ECG-LVH	% With ECG-LVH	
89 or less	85	37	2	8.3	69 or less	65	40	2	8.3
90-99	95	60	3	6.5	70-79	75	98	12	15.8
100-109	105	98	11	15.5	80-89	85	123	7	7.9
110-119	115	119	13	13.8	90-99	95	79	11	16.7
120-129	125	72	12	19.1	100-109	105	68	18	29.0
130-139	135	28	12	52.3	110-119	115	26	11	50.0
140-149	145	35	18	56.1	120-129	125	19	14	73.9
150 or above	155	22	19	90.5	130 or above	135	18	15	88.5

* = Median BP in group.

near basal blood pressures, unless there is value to the patient in learning that his blood pressure may drop as much as 40/20 mmHg or more during a 30 min recumbency in a quiet room. The desirable levels of casual blood pressure and home blood pressure in therapeutic management are those at which no clinical manifestations of hypertension appear. These levels of near basal blood pressure are lower (80/50 to 110/70) than for casual blood pressure (100/60 to 130/80). These are the respective levels and corre-

TABLE 5. CORRELATIONS OF MEDIAN OF BLOOD PRESSURE IN GROUPS WITH PER CENT OF GROUP HAVING THESE CLINICAL MANIFESTATIONS

Manifestations*	Statistical test	Systolic		Diastolic	
		Casual†	Near basal‡	Casual§	Near basal
Grade 3 fundi	r	0.86	0.89	0.89	0.78
	χ²	66.48	69.94	66.71	90.39
	P	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Proteinuria	r	0.98	0.83	0.94	0.92
	χ²	44.70	68.83	72.98	86.34
	P	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Cardiac enlargement by X-ray	r	0.96	0.91	0.91	0.95
	χ²	76.09	114.89	102.58	91.30
	P	< 0.0005	< 0.0005	< 0.0005	< 0.0005
ECG-LVH	r	0.96	0.97	0.91	0.95
	χ²	67.77	90.46	98.88	93.42
	P	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Aortic dilatation and or elongation by chest X-ray	r	0.94	0.88	0.86	0.90
	χ²	47.53	47.10	34.62	29.43
	P	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Casts in urine	r	0.93	0.90	0.96	0.94
	χ²	31.22	49.34	53.17	62.48
	P	< 0.0005	< 0.0005	< 0.0005	< 0.0005

r = Correlation coefficient.

χ² = Chi-square.

P = Significance level.

* The number and per cent of each clinical manifestation in each of the 32 blood pressure groups is available from the author on request.

† Casual systolic BP groups were 139 or less, 140-159, 160-179, 180-199, 200-219, 220-239, 240-259, 260 or above.

‡ Near basal systolic BP groups were 99 or less, 100-119, 120-139, 140-159, 160-179, 180-199, 200-219, 220 or above.

§ Casual diastolic BP groups were 89 or less, 90-99, 100-109, 110-119, 120-129, 130-139, 140-149, 150 or above.

|| Near basal diastolic BP groups were 69 or less, 70-79, 80-89, 90-99, 100-109, 110-119, 120-129, 130 or above.

spond to our value of near basal and casual blood pressure levels in normotensive controls (unpublished data). In elderly patients with occlusive arterial disease higher levels of both casual and near basal blood pressure may be necessary to maintain adequate perfusion of vital organs.

This data suggests that physicians should stop the practice of having the patient lie down in a quiet room to recheck the resting, recumbent blood pressure unless this reading is reported as such. Physicians have made decisions on a great many people for many years based on this maneuver. This applies particularly to pre-employment, life insurance, military induction and preschool physical examinations. For example, if the blood pressure is 160/95 at the office visit and a resting, recumbent reading is 130/80, the physician may report the 130/80 if the patient wants to get insurance or employment or to enter military service. On the other hand, the physician may report the 160/95 if the patient wants to avoid military service or has some reason for citing the existence of hypertension to his employer. The leeway physicians have had in making such decisions about patients with borderline hypertension is narrowing. For life insurance examination, the physician is obligated to present the highest casual readings since these are believed to have the greatest diagnostic significance. For men aged 35 with a casual blood pressure reading of 142/90 mmHg without complications, the mortality rate over the next 20 years was 19.4%, compared to 11.0% for normotensive persons. This modest elevation of blood pressure, all too frequently ignored by clinicians, was then associated with a 76.4% higher death rate in middle age [11].

It should be reassuring to the physician to know that his casual blood pressure readings are as meaningful as the near basal readings. As Pickering states "millions of such measurements (casual) have been made and they constitute nearly all of the large scale data." [12].

Acknowledgements—The authors thank Michael Parfitt, M.D., F. Wayne Hollinger, M.D., Leonora Nigra, R.N., Gloria Stewart, R.N., Esther Livingston, R.N., Marjorie Rouleaux and Edith Ross for their help. The work was supported by a grant from the Harold Suter Hypertension Research Fund and a gift from Mrs. Elsa Oppenheim.

REFERENCES

1. Freis ED: The treatment of hypertension. *Am J Med* 52: 664-671, 1972
2. Perloff D: Diagnostic assessment of the patient with hypertension. *Geriatrics* 31: 77-83, 1976.
3. Alam GM, Smirk FH: Casual and basal blood pressure in British and Egyptian Men. *Brit Heart J* 5: 152-155, 1943
4. Harlan WR, Osborne RK, Graybiel A: Prognostic value of the cold pressor test and the basal blood pressure. *Am J Cardiol* 13: 683-687, 1964
5. Smirk FH: *High Arterial Pressure*. Oxford: Blackwell, 1957
6. Bordley J, Connor CAR, Hamilton WF *et al.*: Recommendations for human blood pressure determinations by sphygmomanometers. *Circulation* 4: 503-509, 1951
7. Keith NM, Wagener JP, Barker NW: Some different types of essential hypertension: their course and prognosis. *Am J Med Sci* 197: 332-343, 1939
8. Sokolow M, Lyon TP: The ventricular complex in left ventricular hypertrophy as obtained by unipolar precordial and limb leads. *Am Heart J* 37: 161-186, 1949
9. Ungerleider HE, Gubner R: Evaluation of heart size measurements. *Am Heart J* 24: 494-510, 1942
10. Caldwell JR: Near basal blood pressure: a method applicable to clinical practice. *Henry Ford Hosp Med J* 21: 191-198, 1973
11. Stamler J, Schoenberger JA, Shekelle RB *et al.*: Hypertension, the problem and the challenge. In *The Hypertension Handbook*. Rahway N. J. (Ed.) Merck & Co., 1974
12. Pickering G: Hypertension: definitions, natural histories and consequences. *Am J Med* 52: 570-583, 1972