Self-Measured Bed-Time, Arising and Day Blood Pressures of Normotensive Young Male and Female Adults

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Abstract: Morning surge in blood pressure is an independent cardiovascular risk factor in the middle-aged and the elderly. Whether such a surge occurs in young subjects is not known. Eighty normotensive subjects (age: 21.8 ± 1.3 yr) measured their own blood pressure (BP) using an automatic device (Omron HEM-7080,) on going to bed and on waking up, for 2 consecutive days. In contrast to large morning BP surges reported for older age groups, there was much smaller but significant (P<0.002) rise only in the DBP (1.9 ± 5 mm Hg) on waking up on day 2 in young subjects. The duration of sleep and the time the subjects slept influence the sleep-wake BP change.

Key words: bed-time vs. arising blood pressure, self-measured, normotensive, young adults

The morning period is recognized as the highest risk period of the day for cardiovascular events, particularly stroke[1]. Previous works using 24 h-ambulatory blood pressure (BP) monitoring demonstrated that independently of the mean level of BP, the variability in BP, or the day-night range, could have prognostic significance. Evidence now exists to show that the morning surge in blood pressure is an independent risk factor in some elderly hypertensive subjects[2]. Sudden activation of the sympathetic nervous system could be the primary mediator of the morning surge in BP. In normal subjects, an alpha receptor-mediated sympathetic vasoconstriction has been found to be higher in the morning than in the afternoon and evening[3]. Another study on 13 healthy men (age, 18 to 35 years) showed that whereas arousal from sleep is associated with a slight rise in plasma epinephrine, arising induces a significant rise both in epinephrine and norepinephrine[4]. The early morning peak in the activity of the hypothalamo-adrenocortical axis is also well established. One study showed lowest plasma ACTH and cortisol levels between 2200 and 0330 h and highest levels between 0400 and 1000 h[5]. In view of the circadian variation of these hormones in normal subjects, morning rises in blood pressure are to be expected in normal subjects regardless of age. However, morning-night variation of BP in young normotensives is less well characterized compared with the hypertensive elderly population. We are more interested in the wakening BP (BP measured first thing on waking up before getting up from bed) rather than the morning BP as the former could reflect age-related biological changes unaffected by morning physical activities or meals. Under standardized conditions, the self-measurement of blood pressure is equally as effective as ambulatory blood pressure monitoring in identifying the white-coat effect, an elevated clinic blood pressure in the presence of a normal daytime ambulatory blood pressure[6]. Hence the objective was to profile the self-measured arterial blood pressure (BP) variation of normotensive young male and female adults during 24 hours at specified time points: on going to bed, on arising and during routine activity in the day. We hypothesize that the arising BP is higher than the bed-time blood pressure in this population.

Healthy normotensive subjects (21.8 ± 1.3 yr; 40 males and 40 females) were recruited from the student population of IMU. The subjects were taught to measure own seated- and supine- blood pressures using the automatic oscillometric digital blood pressure device (Omron HEM-7080, Japan) set to automatically measure the blood pressure thrice on each occasion at one minute intervals and give the mean of the three readings. The subjects then measured and recorded their own blood pressure (i) in the afternoon in the sitting position; (ii) just before going to sleep, in supine position; (iii) first thing in the morning on awakening, in supine position; taking at least 5 min. rest after applying the arm cuff; (iv) anytime during the day in sitting position. The subjects were asked to send the results by phone message to the designated number. The values were checked against the values stored in the memory of the BP device. The procedure was repeated for another day.

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As shown in Table 1, there is not much difference in bedtime and waking BP and heart rate on both days. However, a small rise in DBP (1.9 ± 5 mm Hg) (mean ± SD) on waking up on day 2 was statistically significant (P<0.002, student's paired t test) (Table 2). On further analysis, this rise in DBP was significant for subgroup of subjects (i) who went to sleep after 12 am on day 2 (n=54) (2.1 + 5.5 mm Hg, P=0.006) and not in those (n = 32) who went to bed earlier; and (ii) who slept for less than 7 hr (n = 37) (1.8 ± 5 mm Hg, P=0.029) and not in those (n= 43) who slept longer. An auxiliary preliminary study on five middle-aged men (51-56 yr) following the same protocol and BP device showed that on waking up there were significant rises in SBP by 6.9 ± 6.6 mm Hg and in DBP by 8.4 ± 5.5 mm Hg (vs. 1.9 mm Hg in young subjects). Other workers reported that the early morning BP surge was significantly greater in the elderly subjects (65 ± 4 yr) compared with the younger subjects (44 ± 10 yr) (18 ± 14 vs. 24 ± 14 mmHg, p=0.002)[7] and in hypertensive subjects (53.2 ± 10.1 years) (29 ± 13 / 24 ± 10 mmHg)[8]. It should be noted that ambulatory BP recording used in those studies could only capture the morning BP (average of several measurements in the morning) and not the BP on waking up.

In contrast to older normotensive or hypertensive subjects, there was a much smaller but significant increase only in DBP on waking up in young normotensive young subjects. The results point to an exciting area to explore: at which particular age group do the sleep-wake BP differences begin to increase significantly (statistically and biologically), and do time of retiring at night and duration of sleep influence waking BP, and the implications.

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TABLE 1. Supine BP and HR in Young Healthy Subjects (n= 80) at Bedtime and on Waking up in the Morning

	Day 1 (mean ± SD)	Day 2 (mean ± SD)	Days 1 and 2 (mean ± SD)
Bedtime SBP (mm Hg)	101.5 ± 10.5	101.1 ± 10.4	101.3 ± 10.0
Bedtime DBP (mm Hg)	63.2 ± 6.1	63.1 ± 6.5	63.1 ± 5.9
Bedtime HR (beats per min)	65.4 ± 8.6	65.3 ± 9.9	64.9 ± 8.6
Wake SBP (mm Hg)	101.0 ± 10.0	101.8 ± 9.8	101.4 ± 9.4
Wake DBP (mm Hg)	63.9 ± 6.7	65.0 ± 6.7	64.4 ± 6.3
Wake HR (beats per min)	64.1 ± 9.9	64.9 ± 9.6	64.1 ± 9.8

SBP, DBP: Systolic and Diastolic Blood Pressure; HR: Heart Rate

TABLE 2. Wake-bedtime Differences in SBP, DBP and HR in Young Healthy Subjects (n=80)

Day	Parameter	Wake-Bedtime Difference	p-value
Day 1	SBP (mm Hg)	-0.6 ± 7.1	NS
	DBP (mm Hg)	0.7 ± 5.3	NS
	HR (beats/min)	-1.2 ± 8.5	NS
Day 2	SBP (mm Hg)	0.7 ± 6.4	NS
	DBP (mm Hg)	1.9 ± 5.4	0.002
	HR (beats/min)	-0.4 ± 9.1	NS
Days 1 and 2	SBP (mm Hg)	0.1 ± 5.0	NS
	DBP (mm Hg)	1.3 ± 4.6	0.015
	HR (beats/min)	-0.8 ± 7.7	NS