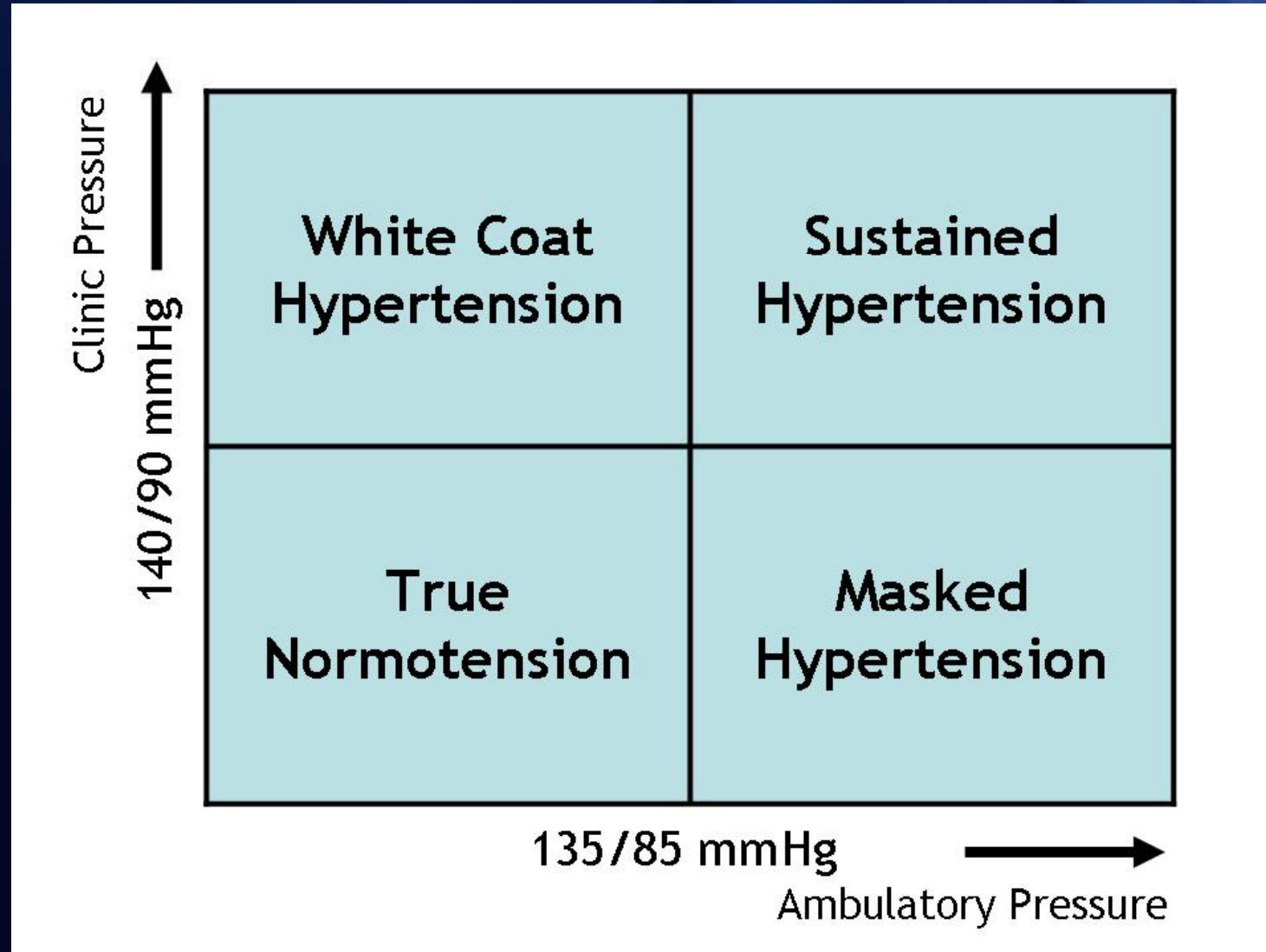


Critical Review for Masked Hypertension

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Classification of Hypertension



Terms

- Masked hypertension
- White-coat normotension
- Isolated ambulatory hypertension
- Reverse white-coat hypertension

Prevalence of Masked Hypertension

	population	n	treated	MH (%)	
Sega et al.					ABPM
Stergiou et al.					ABPM
Ohkubo et al.					ABPM
Bobrie et al.					SBPM
Clement et al.	HT	1963	100	143 (7.3)	ABPM
Obara.	HT	3400	100	782 (23)	SBPM
Hansen.	GP	1700	14	159 (9)	ABPM

≈ 10 %

Prevalence in Korea

Table 1. Baseline characteristics of the study subjects

Variables	All subjects	Clinic BP<140/90 mmHg		<i>p</i> *	Clinic BP≥140/90 mmHg		<i>p</i> †
		NT	MHT		WCHT	SHT	
n (%)	967 (100)	51 (5.3)	55 (5.7)		273 (28.2)	588 (60.8)	
Age (year)	51.9±11.9	56.2±10.0	51.2±10.1	0.013	52.3±12.9	51.4±11.7	0.318
Sex (% woman)	48.2	60.8	93.2	0.007	62.3	41.8	<0.0001
BMI (kg/m ²)	25.2±3.1	24.3±3.0	25.8±3.3	0.021	24.8±3.3	25.4±2.9	0.005
Current smoker (%)	32.7	25.5	36.4	0.227	21.2	38.3	<0.0001
Habitual drinker (%)	41.9	23.5	47.3	0.011	32.6	47.3	<0.0001
FHx of HT (%)	13.7	7.8	5.5	0.709	13.6	15.0	0.584
Clinic BP							
Systolic	157.7±22.0	124.7±10.1	128.5±8.2	0.038	158.3±18.7	163.1±20.1	0.001
Diastolic	95.3±13.1	77.7±8.2	82.0±5.5	0.002	93.1±11.8	99.1±12.1	<0.001
Daytime BP							
Systolic	136.4±15.0	119.0±8.2	138.9±9.0	<0.0001	122.1±7.3	144.4±12.0	<0.0001
Diastolic	86.2±10.7	74.8±6.2	90.4±5.3	<0.0001	76.±5.7	91.3±9.1	<0.0001

* difference between NT and MHT

† difference between WCHT and SHT

Retrospective
Selection bias

Prevalence in Korea

Table 3. Comparisons of blood pressure related variables between two groups (BP unit: mmHg). N (%) or Mean±SD*.

Variables	Masked (n=15)	Normotensive (n=38)
Prehypertension [‡]	14 (93.3)	25 (65.8)
Mean Office SBP [§]	133.33±6.44	126.29±12.82
Mean Office DBP	86.20±6.21	80.63±8.62
Mean Office PP [¶]	47.53±4.32	45.39±6.47
Office Pulse Rate	71.13±9.80	68.58±9.29
Daytime** SBP	145.07±7.51	125.16±9.02
Daytime DBP	95.00±7.12	81.29±8.39
Daytime PP	50.00±5.83	43.87±5.92
V-SBP ^{††}	12.50±3.55	10.13±2.75
V-DBP	8.31±2.55	8.18±1.98

*standard deviation, [†] analyzed by χ^2 test & student t-test (P < 0.05: significant), [‡] 120/80 ≤ BP < 140/90 (mmHg), [§] systolic blood pressure, ^{||} diastolic blood pressure, [¶] pulse pressure, **A.M. 6:00 ~ P.M.10:00, ^{††} V:variability (standard deviation).

Small number
volunteers

Clinical impact of masked hypertension

- High association with target organ damage
- Increased risk of cardiovascular morbidity and mortality
- Increased risk of development of sustained hypertension, and of needing antihypertensive medication

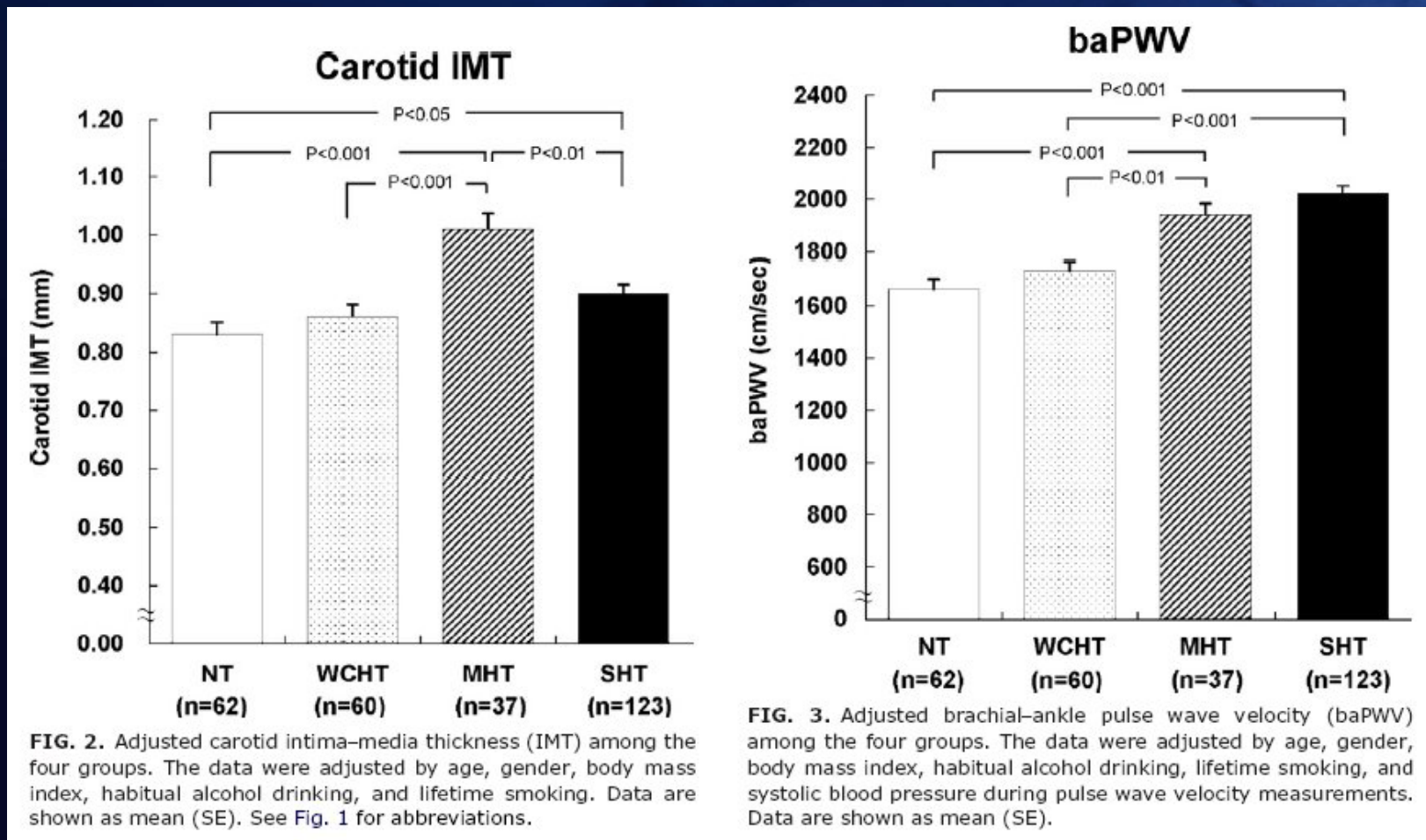
LV Mass in Patients With Persistent MH or SH vs Matched Normotensives

Characteristics	Controls (n=20)	Cases (n=20)	<i>P</i>
Anthropometry			
Girls, no.	12	10	0.53
Age, y	11.5 (3.5)	11.2 (3.2)	0.81
Weight, kg	47.9 (12.9)	52.7 (15.6)	0.30
Height, cm	1.50 (0.16)	1.49 (0.15)	0.94
Body mass index, kg/m ²	21.2 (3.6)	23.2 (4.0)	0.09
Left ventricular mass			
Not indexed, g	90.1 (28.2)	107.7 (45.1)	0.15
Indexed to body surface area, g/m ²	63.1 (12.5)	71.9 (20.6)	0.11
Indexed to height, g/m ^{2.7}	29.6 (4.8)	34.9 (8.8)	0.023

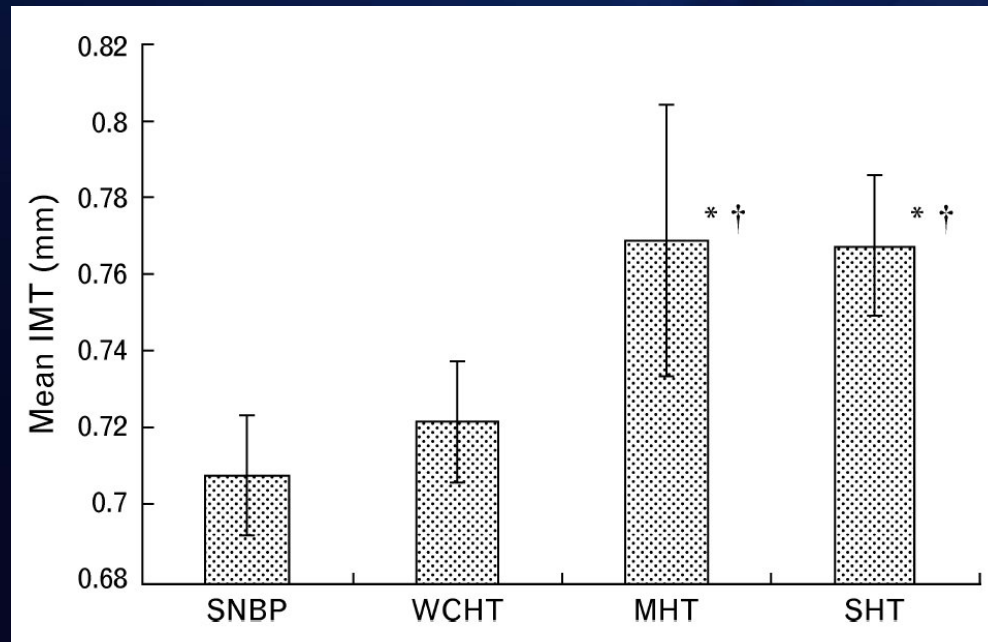
Cases and controls were matched for sex, age, and body height.

Prevalence, Persistence, and Clinical Significance of Masked Hypertension in Youth

Subclinical arterial damage in untreated MH - SBPM

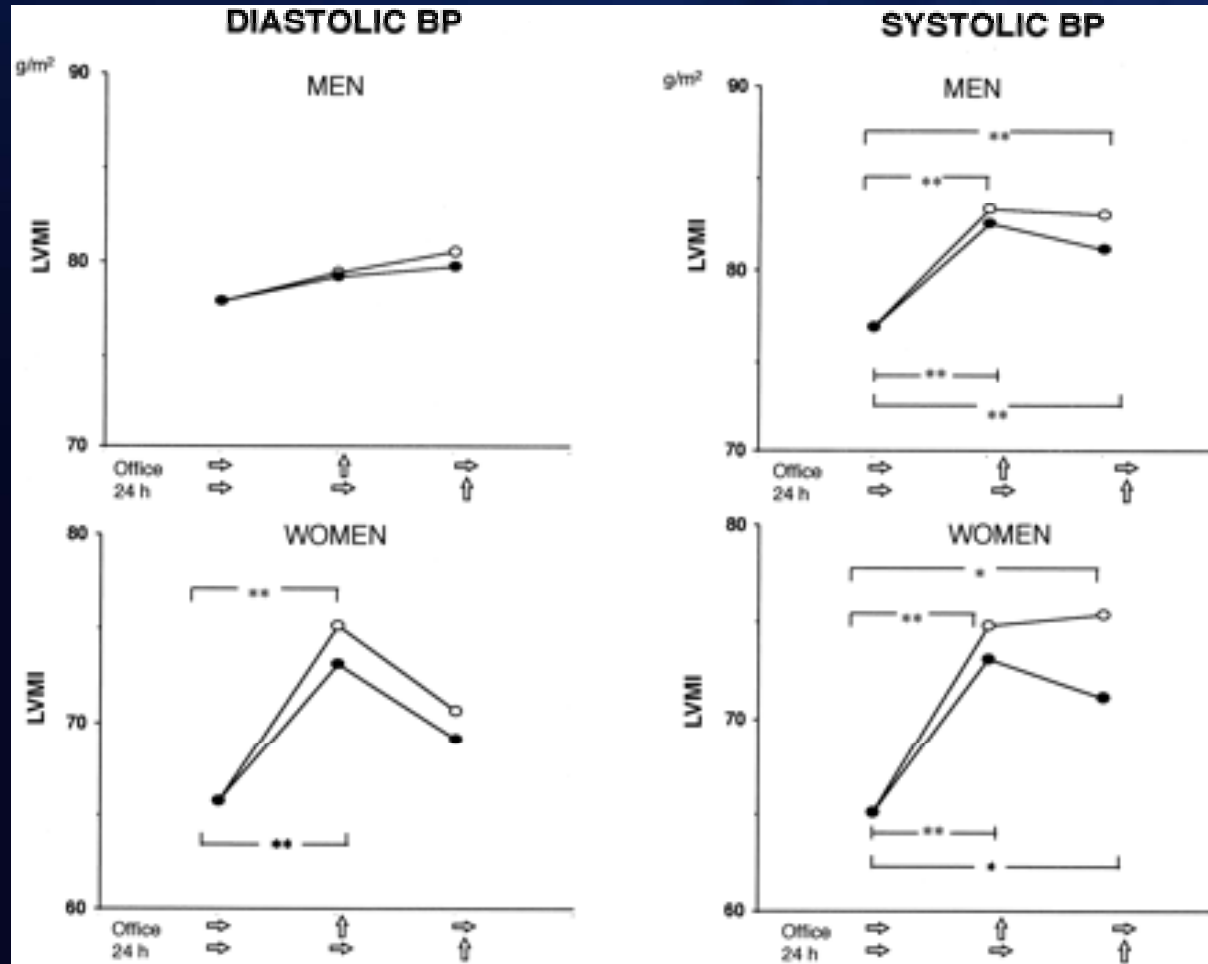


Carotid atherosclerosis in MH – Ohasama Study



Adjusted mean intima–media thickness (IMT) and 95% confidence intervals of the four groups classified by blood pressure threshold. Mean IMT was adjusted for age, sex, body mass index, smoking status, drinking status, antihypertensive medication and history of cardiovascular disease, hypercholesterolaemia, or diabetes. SNBP, sustained normal blood pressure; WCHT, white-coat hypertension; MHT, masked hypertension; SHT, sustained hypertension. Significant differences: $P < 0.05$ compared with *SNBP, †WCHT.

Alterations of Cardiac Structure in Patients With Isolated Office, Ambulatory, or Home Hypertension – PAMELA study

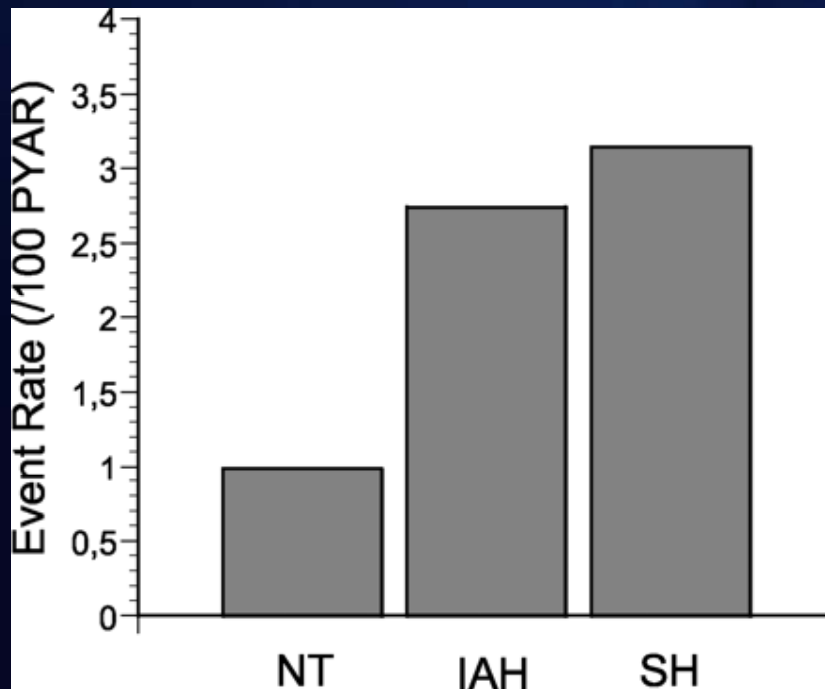


Mean age adjusted left ventricular mass index (LVMI) values in men and women in whom office BP was elevated, 24-hour average BP was elevated, or both BPs were normal

Clinical impact of masked hypertension

- High association with target organ damage
- Increased risk of cardiovascular morbidity and mortality
- Increased risk of development of sustained hypertension, and of needing antihypertensive medication

Isolated Ambulatory Hypertension Predicts Cardiovascular Morbidity in Elderly Men



Cardiovascular morbidity rates in subjects with normotension, isolated ambulatory hypertension, and sustained hypertension. NT indicates normotension; IAH, isolated ambulatory hypertension; and SH, sustained hypertension.

Isolated Ambulatory Hypertension Predicts Cardiovascular Morbidity in Elderly Men

TABLE 4. Multivariate Cox Proportional Hazard Models of Risk Factors for Cardiovascular Morbidity

	HR (95% CI)	<i>P</i>
Subjects, n/N	72/513	
Model with categorical BP variables		
Isolated ambulatory hypertension	2.77 (1.15 to 6.68)	0.023
Sustained hypertension	2.94 (1.49 to 5.82)	0.002
Serum cholesterol, 1 SD	1.13 (0.90 to 1.43)	0.282
Smoking, yes/no	1.92 (1.17 to 3.14)	0.009
Diabetes, yes/no	2.11 (1.17 to 3.83)	0.002
Model with continuous BP variables		
Office systolic BP, 1 SD	1.08 (0.79 to 1.47)	0.632
Daytime ambulatory systolic BP, 1 SD	1.47 (1.09 to 1.97)	0.011
Serum cholesterol, 1 SD	1.16 (0.92 to 1.47)	0.203
Smoking, yes/no	1.90 (1.16 to 3.11)	0.011
Diabetes, yes/no	1.92 (1.05 to 3.52)	0.035

Values are HRs and 95% CIs or as indicated.

Cardiovascular prognosis of MH detected by SBPM in elderly treated HT

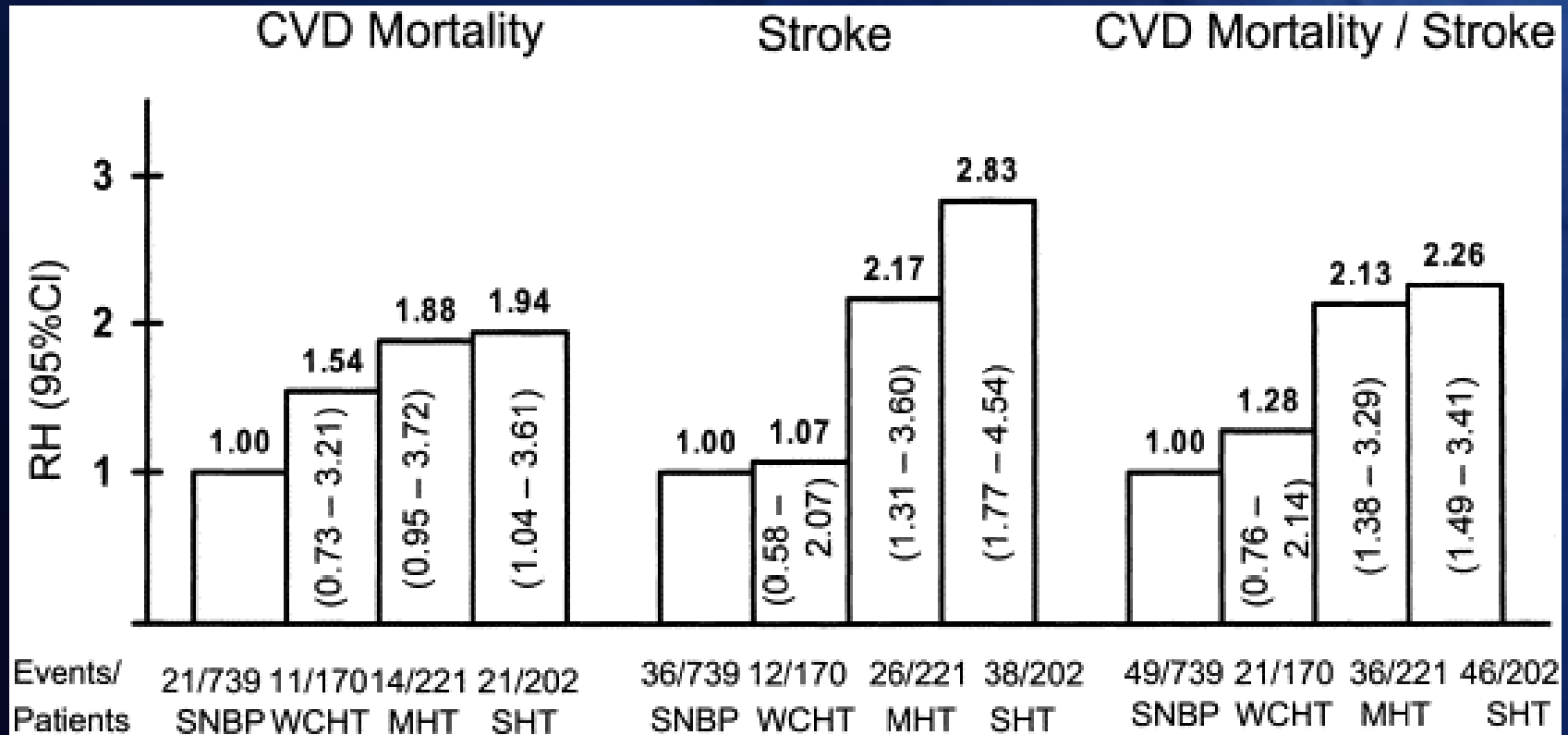
Table 6. Population Baseline Characteristics and Follow-up Events Classified by Threshold of BP Normality by Measurement Method*

	Controlled Hypertension (n = 685)	Elevated BP in the Office but Not at Home (n = 656)	Elevated BP at Home but Not in the Office (n = 462)	Uncontrolled Hypertension (n = 3125)	P Value
Age, mean (SD), y	68.7 (6.3)	69.5 (6.2)	70.0 (6.5)	70.4 (6.6)	<.001
Duration of hypertension, y					
Mean (SD)	10.8 (7.4)	10.8 (7.7)	11.7 (7.3)	11.5 (8.6)	
Median (IQR)	9.4 (4.9-16.1)	9.5 (4.5-15.3)	10.4 (6.1-16.7)	10.2 (4.3-17.2)	.54
Men	264 (38.5)	242 (36.9)	269 (58.2)	1630 (52.1)	<.001
Obesity	112 (16.4)	102 (15.6)	92 (20.1)	629 (20.3)	.01
Diabetes	74 (10.8)	89 (13.6)	65 (14.1)	497 (15.9)	.005
Treated dyslipidemia	305 (44.5)	292 (44.5)	202 (43.7)	1349 (43.2)	.88
Ex-smoker	139 (20.3)	117 (17.8)	124 (26.8)	822 (26.3)	<.001
Current smoker	52 (7.6)	40 (6.1)	39 (8.4)	248 (7.9)	.39
≥1 Previous coronary event	89 (13.0)	56 (8.5)	61 (13.2)	407 (13.0)	.01
Heart failure	40 (5.8)	24 (3.7)	25 (5.4)	165 (5.3)	.28
Peripheral vascular disease	25 (3.7)	28 (4.3)	27 (5.8)	217 (6.9)	.001
Previous stroke syndrome	24 (3.5)	21 (3.2)	30 (6.5)	157 (5.0)	.02
BP, mean (SD), mm Hg					
Office					
Systolic	130.2 (6.8)	150.5 (10.3)	133.7 (5.0)	159.5 (14.1)	NA
Diastolic	77.0 (5.9)	84.8 (7.3)	78.3 (6.2)	87.3 (8.5)	NA
Home					
Systolic	123.0 (7.9)	126.6 (6.7)	143.8 (9.8)	155.4 (15.3)	NA
Diastolic	73.6 (6.3)	74.3 (6.1)	82.5 (7.3)	85.6 (9.4)	NA
Home heart rate, mean (SD), beats/min	69.4 (9.0)	68.3 (9.1)	68.0 (9.5)	68.8 (9.9)	.07
Cardiovascular events					
Incidence	23 (3.4)	24 (3.7)	41 (8.9)	236 (7.6)	NA
Incidence rate per 1000 patient-years (95% CI)	11.1 (6.5-15.6)	12.1 (7.3-16.9)	30.6 (21.2-39.9)	25.6 (22.4-28.9)	NA

Abbreviations: BP, blood pressure; CI, confidence interval; IQR, interquartile range; NA, not applicable.

*Data are expressed as No. (%) unless otherwise noted.

Prognosis of MH and WH : 10-year follow-up from the Ohasama study



Relative hazards (RH) and 95% confidence intervals (CI) of sustained normal blood pressure (SNBP), white-coat hypertension (WCHT), masked hypertension (MHT), and sustained hypertension (SHT) for cardiovascular disease (CVD) mortality, stroke morbidity, and the composite of CVD mortality/stroke morbidity

Clinical impact of masked hypertension

- High association with target organ damage
- Increased risk of cardiovascular morbidity and mortality
- Increased risk of development of sustained hypertension, and of needing antihypertensive medication

Clinical significance of isolated ambulatory hypertension in young subjects screened for stage 1 hypertension

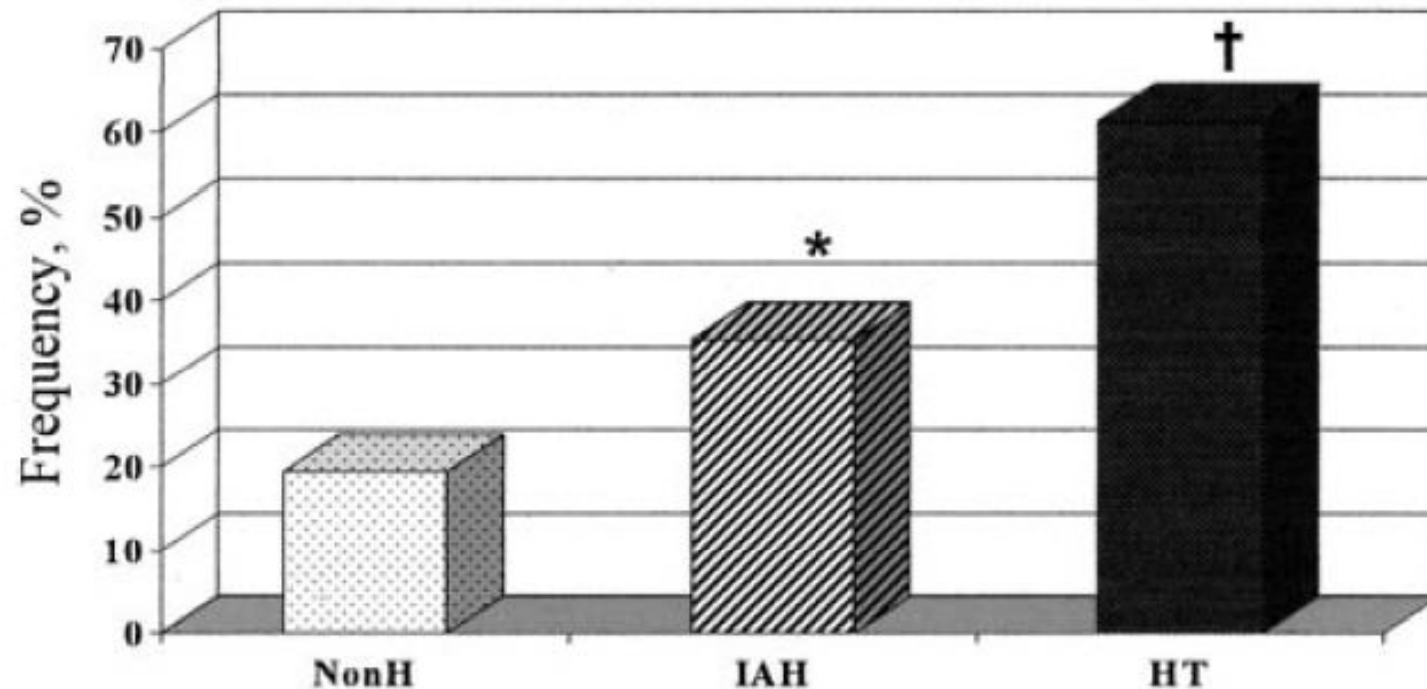


Figure 2. Frequency of subjects reaching the end point during the follow-up. * $P=0.019$ vs NonH; † $P<0.001$ vs others.

The end point was the development of sustained hypertension and the need for antihypertensive medication

Factors affecting ambulatory blood pressure

Demographic and lifestyle factors	Physiological and behavioral factors
• Age (young)	• Activities during recording
• Sex (male)	• Reactivity to some stressors
• Family history of hypertension	• BP response to standing
• Smoking	
• Alcohol use	
• Contraceptive use	
• Sedentary habits	

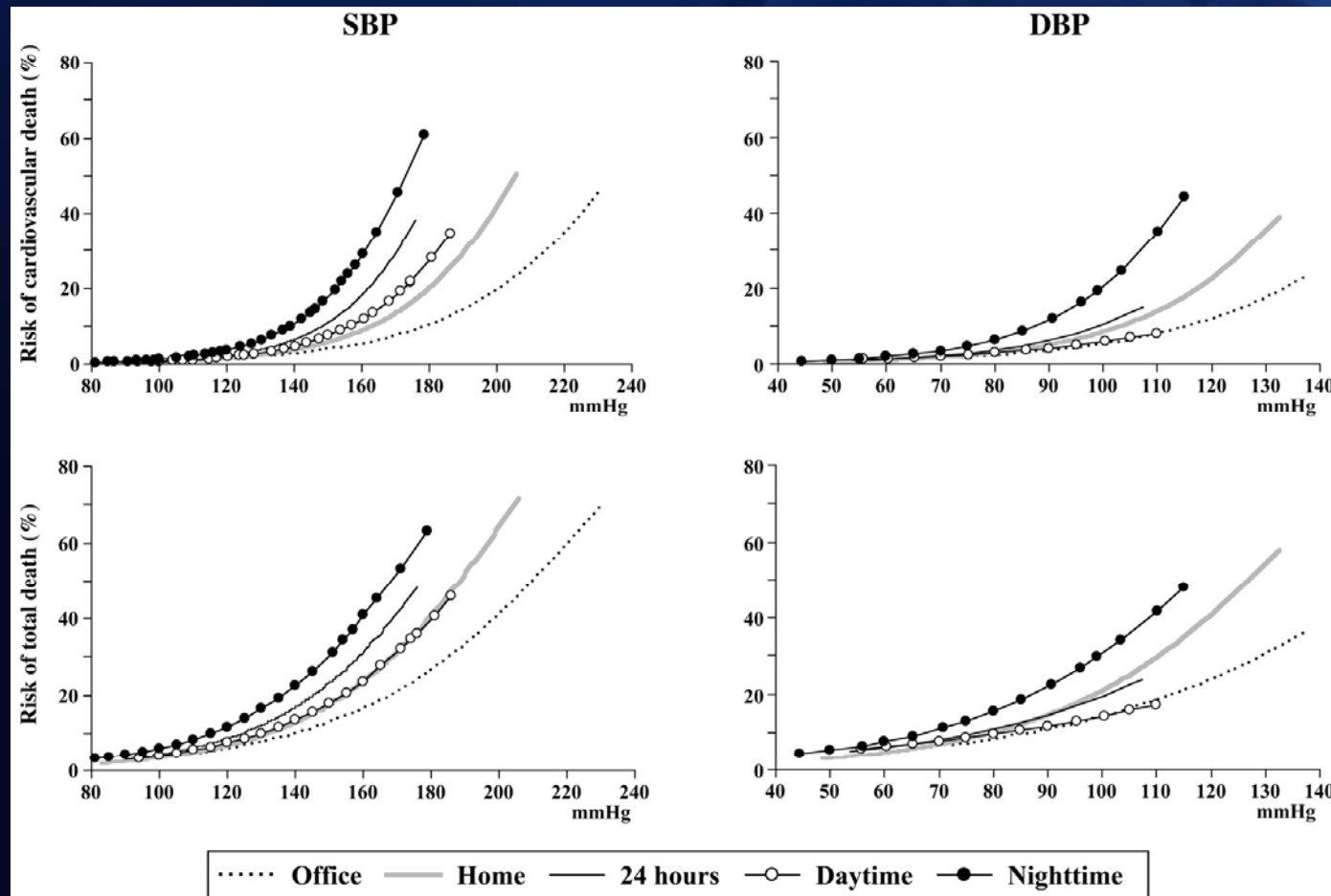
Subjects with normal clinic BP in whom MH should be searched for

- Young men
- Subjects with unfavorable lifestyle (smoking, drinking)
- Subjects hyper-reactive to standing
- Subjects with high-normal clinic BP
- Subjects at high CV risk
- Subjects with DM
- Subjects with kidney disease (proteinuria)
- Subjects with transiently elevated BP

Unmasking of MH

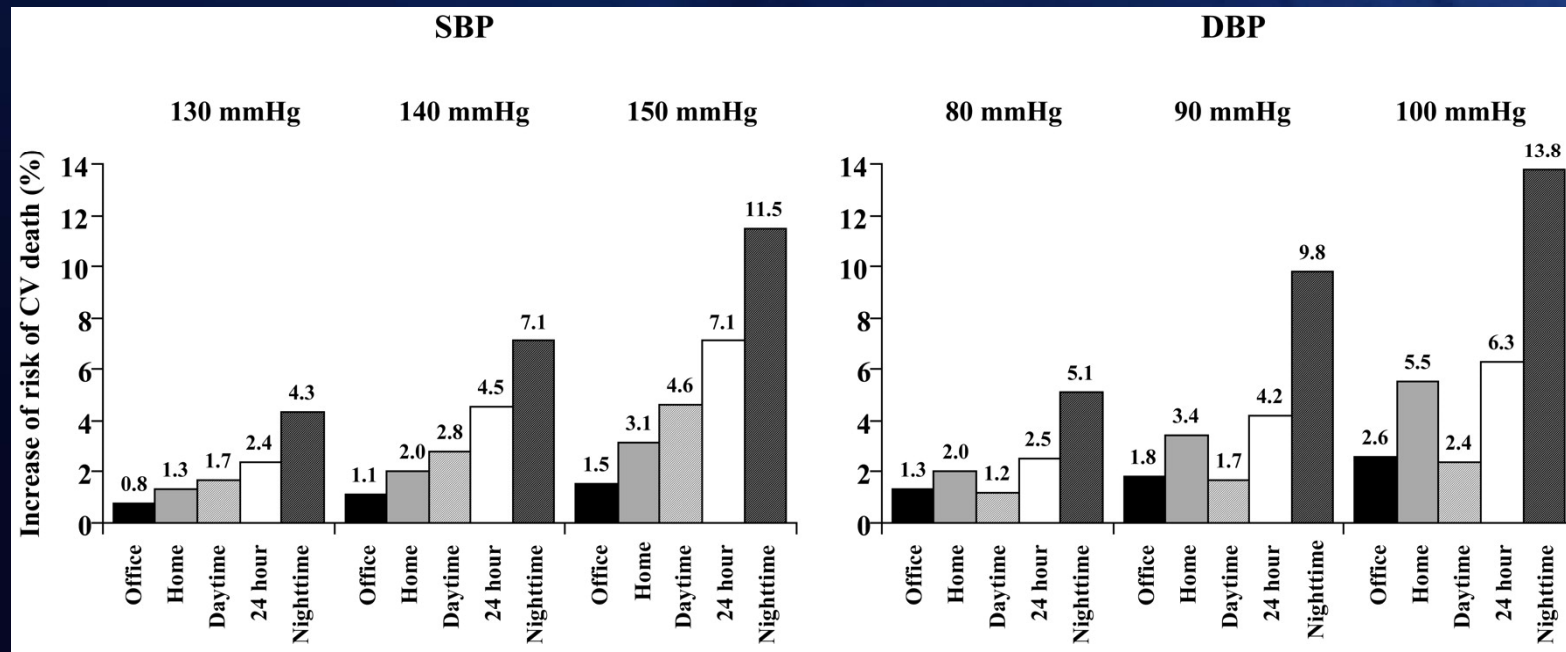
- ABPM
- SBPM

Prognostic Value of Ambulatory and Home Blood Pressures Compared With Office Blood Pressure in the General Population – PAMELA study



Office, home, 24-hour, daytime, and nighttime systolic (S) and diastolic (D) BP as predictors of 11-year risk of cardiovascular or all-cause deaths

Prognostic Value of Ambulatory and Home Blood Pressures Compared With Office Blood Pressure in the General Population – PAMELA study



Increase in 11-year risk of cardiovascular (CV) mortality for 10-mm Hg increase in office, home, and ambulatory BP at various initial BP values

Clinical indication for ABPM

Accepted	Suspected WH
	Suspected nocturnal HT
	Suspected MH
	To establish dipper
	Resistant HT
	HT of pregnancy
Potential	Elderly
	As a guide to antihypertensive drug
	Type 1 diabetes
	Suggesting orthostatic hypotension
	Autonomic failure

Suggested protocol for SBPM (1)

- Commencement phase:
 - For an initial 7-day measurement period
 - 5-min period of rest before measurement
 - two SBPMs in the morning and in the evening at predefined times (0600–0900 h and 0600–2100 h)
 - exclude the first day BP
- Treatment phase:
 - exactly same as in the commencement phase
 - If treatment is changed, the averages of the SBPM values measured over 2 weeks
- Follow-up phase:
 - one day per week if hypertension is controlled
 - for 1 week every 3 months

Suggested protocol for SBPM (2)

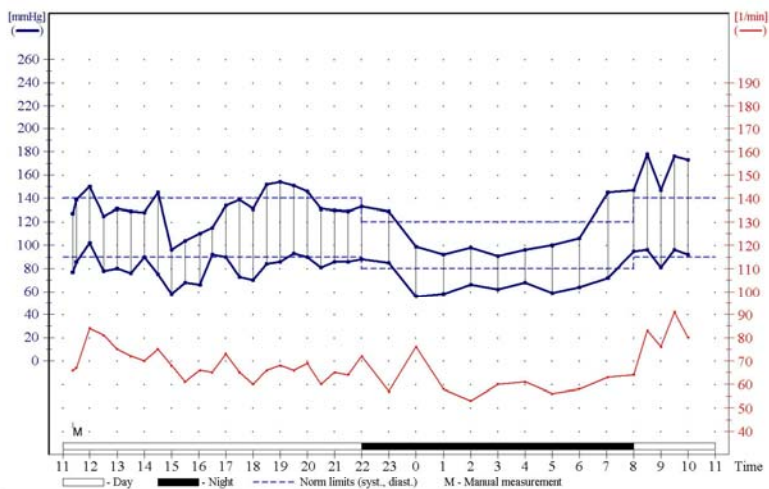
- In the morning
 - within 1 h after getting up
 - after urination
 - after rest in the seated position for 1–2 min
 - before taking antihypertensive drugs
 - before breakfast in the morning
- In the evening
 - before going to bed
 - after rest in the seated position for 1–2 min

Pressurometer® Report
- Pressurometer -

Patient ID: 10022243 Date of birth: 12/10/1946
 Surname: **PARK SUN AE** Weight: 58 kg
 First name: Height: 154 cm
 Address: Sex: Female
 Town/City: Medication: -

Profile

Measurement row 3 Begin: 02/26/2008, 11:22
 (PM) End : 02/27/2008, 10:00



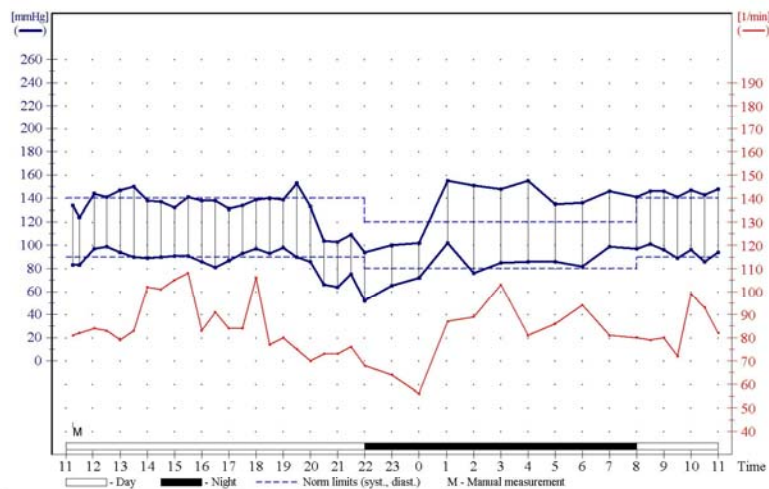
Remarks:

Pressurometer® Report
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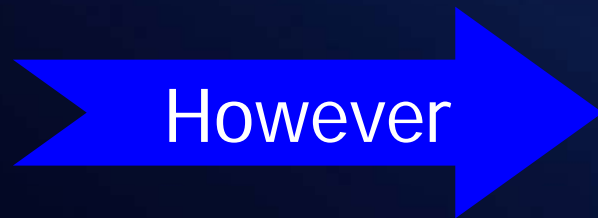
Measurement row 1 Begin: 11/23/2007, 11:16
 (PM) End : 11/24/2007, 11:30



Remarks:

Management

- No consensus



- Life style modification
- Antihypertensive medications in case of target organ damage

Conclusion

- **Masked Hypertension**
 - Not uncommon
 - Strong predictor of cardiovascular morbidity and mortality
 - Strong association with target organ damage
 - Should be unmasked and treated

- **SBPM and ABPM**