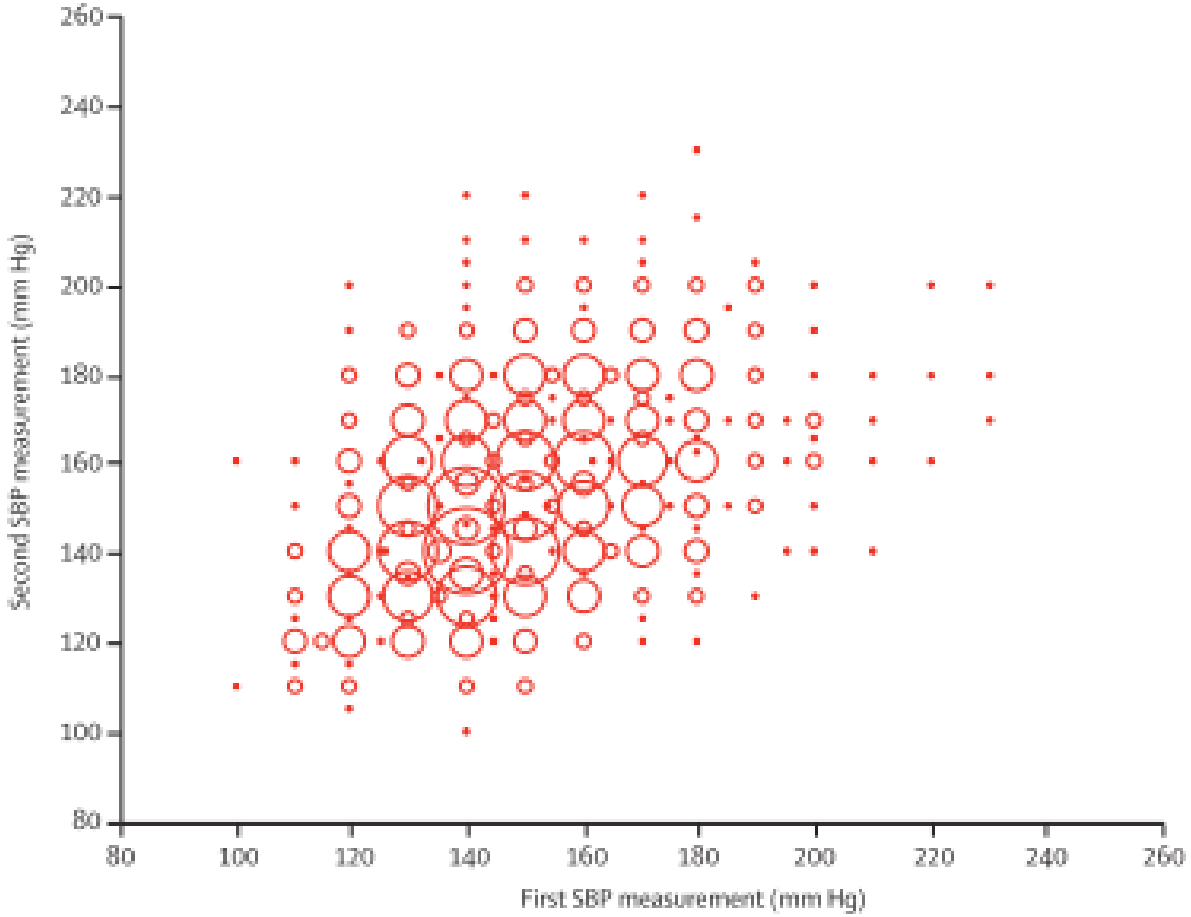
Hot Issues in Hypertension

- Importance of Blood Pressure Variability -

조선의대
정중화

SBP at one clinic visit versus the next visit



Stroke 2006;37:2776-83.

Mean BP and usual BP

Modeling studies show that at least seven to ten measurements of blood pressure on different clinic visits(and ideally many more) are needed for mean blood pressure to be an accurate estimate of usual blood pressure.

	HR for mean SBP		HR for variability in SBP	
	HR (95% CI)	p value	HR (95% CI)	p value
SD SBP				
Two readings	2·44 (1·53–3·89)	<0·0001	1·15 (0·73–1·81)	0·55
Four readings	2·44 (1·39–4·29)	0·002	1·51 (0·86–2·66)	0·16
Six readings	2·49 (1·24–4·97)	0·01	2·02 (0·97–4·22)	0·061
Eight readings	1·85 (0·84–4·10)	0·13	6·01 (1·72–20·96)	0·005
Ten readings	1·44 (0·58–3·57)	0·43	13·04 (1·66–102·6)	0·015
CV SBP				
Two readings	2·67 (1·74–4·11)	<0·0001	1·09 (0·73–1·62)	0·67
Four readings	2·82 (1·67–4·76)	<0·0001	1·50 (0·90–2·48)	0·12
Six readings	3·07 (1·62–5·83)	0·001	1·98 (1·05–3·77)	0·036
Eight readings	2·68 (1·29–5·56)	0·008	5·00 (1·75–14·30)	0·003
Ten readings	2·26 (0·98–5·17)	0·055	13·05 (1·74–97·66)	0·012
VIM SBP				
Two readings	2·86 (1·88–4·36)	<0·0001	1·25 (0·86–1·82)	0·25
Four readings	3·18 (1·90–5·33)	<0·0001	1·59 (1·00–2·54)	0·053
Six readings	3·70 (1·97–6·94)	<0·0001	2·31 (1·26–4·23)	0·007
Eight readings	3·70 (1·81–7·56)	<0·0001	6·04 (2·14–17·03)	0·001
Ten readings	3·31 (1·46–7·47)	0·004	15·35 (2·08–113·1)	0·007

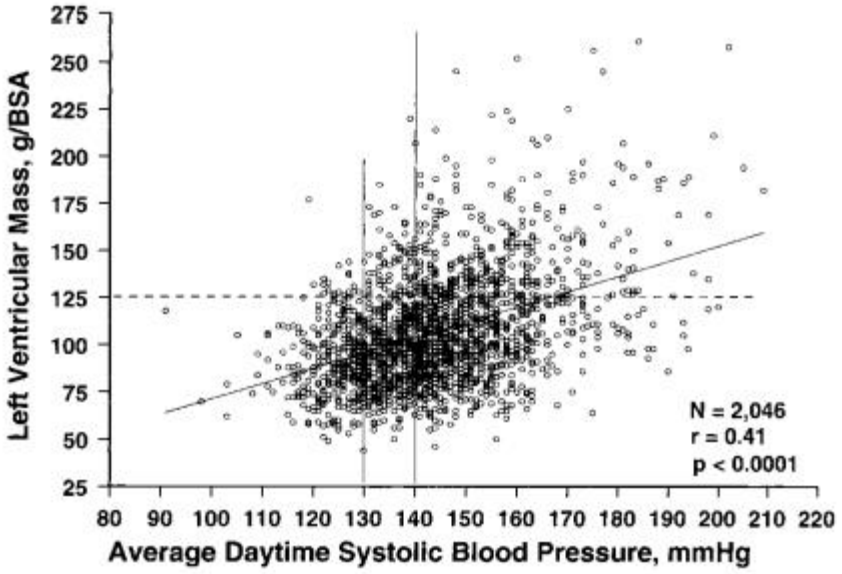
Every row shows the estimates from a Cox model applied to data from patients who survived for at least n follow-up visits, where n ranges from 2 (3 months) to 10 (3 years). Quintiles were used rather than deciles to provide sufficient group sizes to extend the analysis to ten blood-pressure readings. SBP=systolic blood pressure. HR=hazard ratio. CV=coefficient of variation. VIM=variation independent of mean.

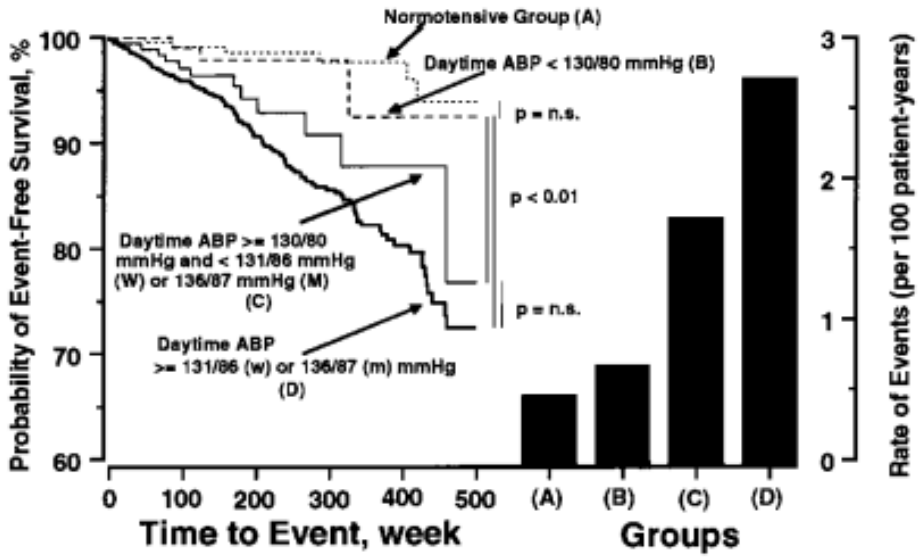
Table 1: **Hazard ratios (top *vs* bottom quintile) for risk of subsequent stroke (ie, after the measurement period) in the UK-TIA trial from a model combining mean SBP and visit-to-visit variability in SBP (SD or CV or VIM), repeated with increasingly precise estimates of both variables**

Lancet 2010;375:895-905.

Prognostic value of ABP

; 9 event-based cohort studies

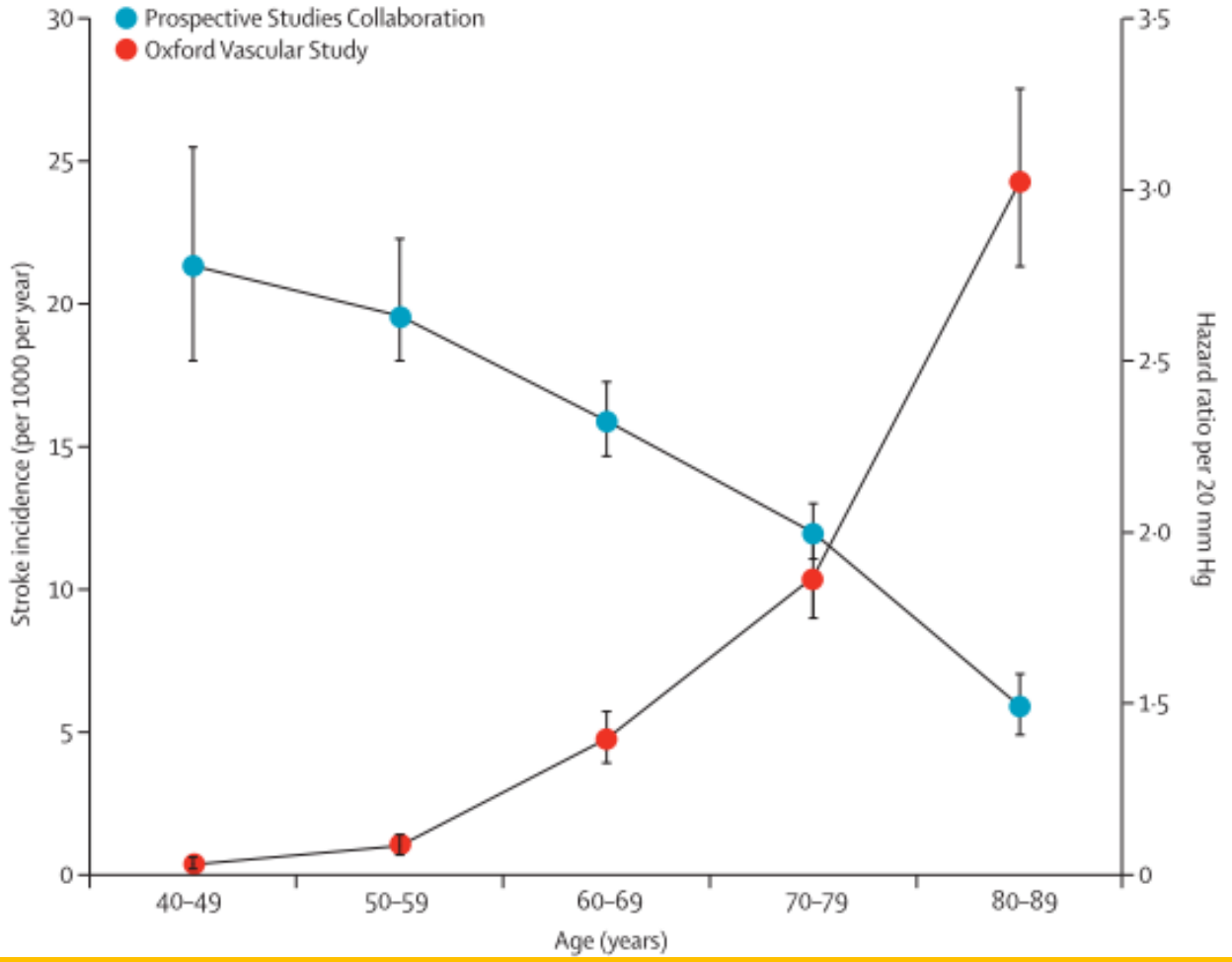




Hazard ratio per 10 mmHg increase of 24-h SBP was 1.27.
Hazard ratio per 10 mmHg increase of daytime SBP was 1.17.
Several studies did not provide effect estimates for DBP.

Hypertension 2000;35:844-51.
J Hypertens 2008;26:1290-9.

Predictive value of estimated mean BP falls with age ; Prospective Studies Collaboration



Mean BP is a very powerful risk factor for vascular events, but…

Hypertension 2006;47:846-53.

High BPV and mean BP

	UK trial	Dutch trial	Pooled*
Patients with low visit-to-visit variability†			
Unadjusted baseline SBP	1·58 (1·25–2·00)	1·35 (0·99–1·85)	1·50 (1·24–1·80)
Estimated usual SBP‡	1·93 (1·38–2·70)	1·60 (0·98–2·61)	1·82 (1·38–2·40)
Actual mean SBP§	1·72 (1·25–2·35)	1·68 (1·18–2·39)	1·70 (1·35–2·15)
Patients with high visit-to-visit variability‡			
Unadjusted baseline SBP	1·30 (1·11–1·52)	1·15 (0·95–1·40)	1·24 (1·09–1·40)
Estimated usual SBP‡	2·83 (1·51–5·30)	4·06 (0·57–28·8)	2·93 (1·61–5·32)¶
Actual mean SBP§	1·27 (1·00–1·61)	1·08 (0·76–1·54)	1·21 (1·00–1·47)¶

Data are hazard ratio (95% CI). Stroke risk calculation included all strokes after the measurement period (ie, after seventh follow-up visit); however, results were very similar when analysis also included events during and after the measurement period. SBP=systolic blood pressure. TIA=transient ischaemic attack. *Based on fixed-effect meta-analysis of the two trials. †Low variability includes patients with median variability or lower, and high those greater than the median; within-individual visit-to-visit variability is expressed as a transformation of the SD of measurements made at seven consecutive visits, which is uncorrelated with mean SBP.[7] ‡Calculated by adjustment of baseline SBP for regression-dilution bias, with regression-dilution ratios of 0·42 (all patients), 0·70 (low variability), and 0·25 (high variability) in the UK trial and 0·38, 0·64, and 0·10, respectively, in the Dutch trial; ratios were calculated from the baseline measurement and the visit 7 (2-year) measurement. §Based on measurements of SBP made at the first seven consecutive follow-up visits. ¶ p value for comparison of difference between hazard ratios was 0·006.

Lancet 2010;375:895-905.

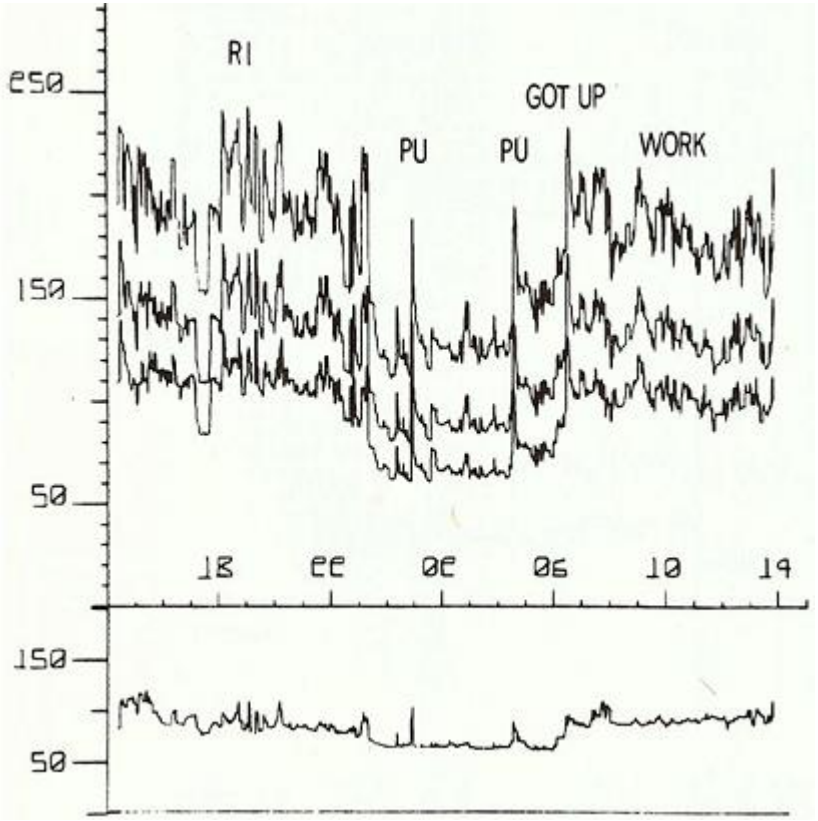
Measures of BP Variability, Instability, and Reativity

Variability	Short term: reading-to-reading (ambulatory monitoring)* Medium term: day-to-day (home monitoring)* Long term: visit-to-visit (office measurements)*
Instability	Maximum BP: office, home, ambulatory monitoring* Morning BP surge: ambulatory monitoring*
Reactivity	Physical tests: isometric or isotonic exercise testing,* cold pressor test, tec Mental tests: arithmetic task, reaction time task, psychologic and emotional challenges, mental stressor test, etc

may carry different clinical implications still poorly understood…

Hypertension 2011;57:1041-2.

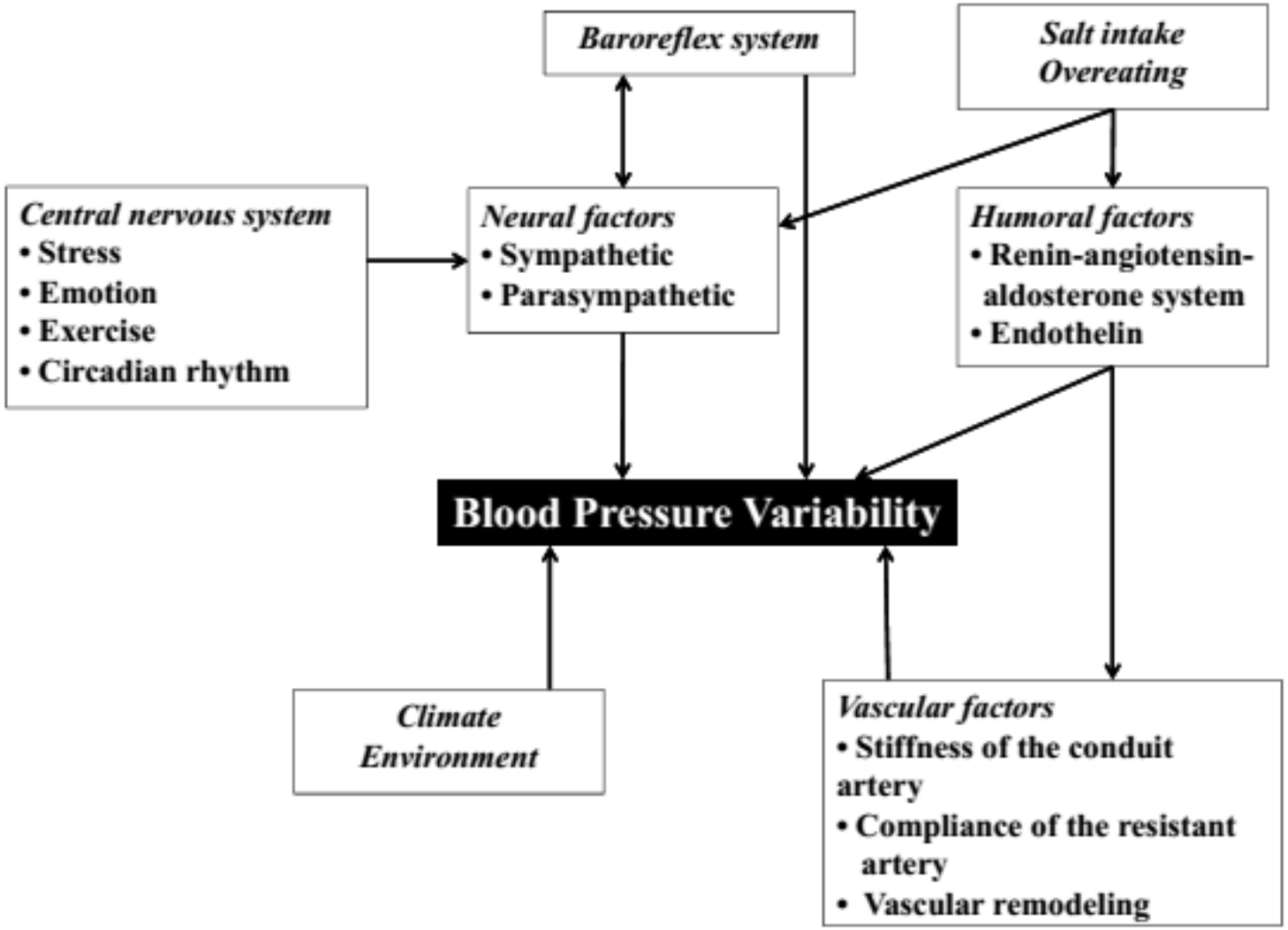
BP changes during daytime



Untreated 43-year-old male; intra-arterial ambulatory BP
(the 120 mmHg range for SBP over the daytime)

Can J Cardiol 2013;29:557-63.

Regulating factors of BPV



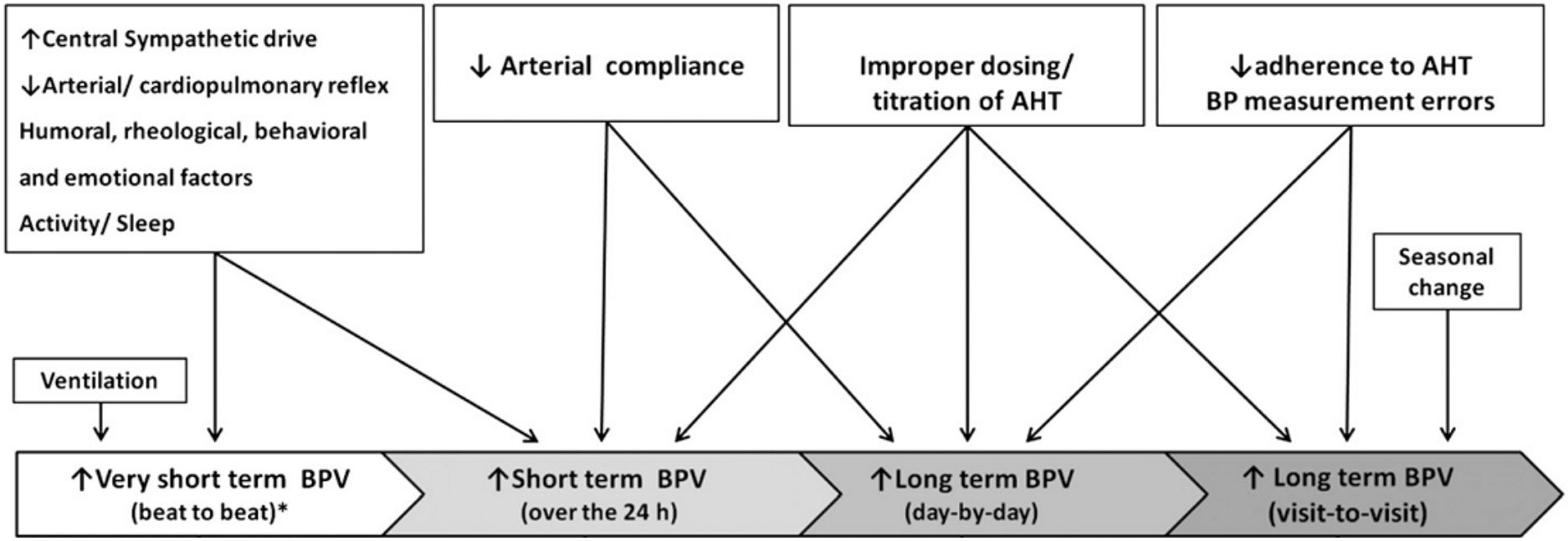
Curr Hypertens Res 2014;10:125-33.

Factors associated with BPV

- Genetic variants
- Average BP levels
- Heart rate
- Temperature
- Diabetes
- Smoking
- Increasing age
- Presence of vascular diseases (stiffness)
- Poor compliance with antihypertensives
  - Subclinical cerebral ischemia
  - Increased arterial stiffness
  - Impaired baroreceptor

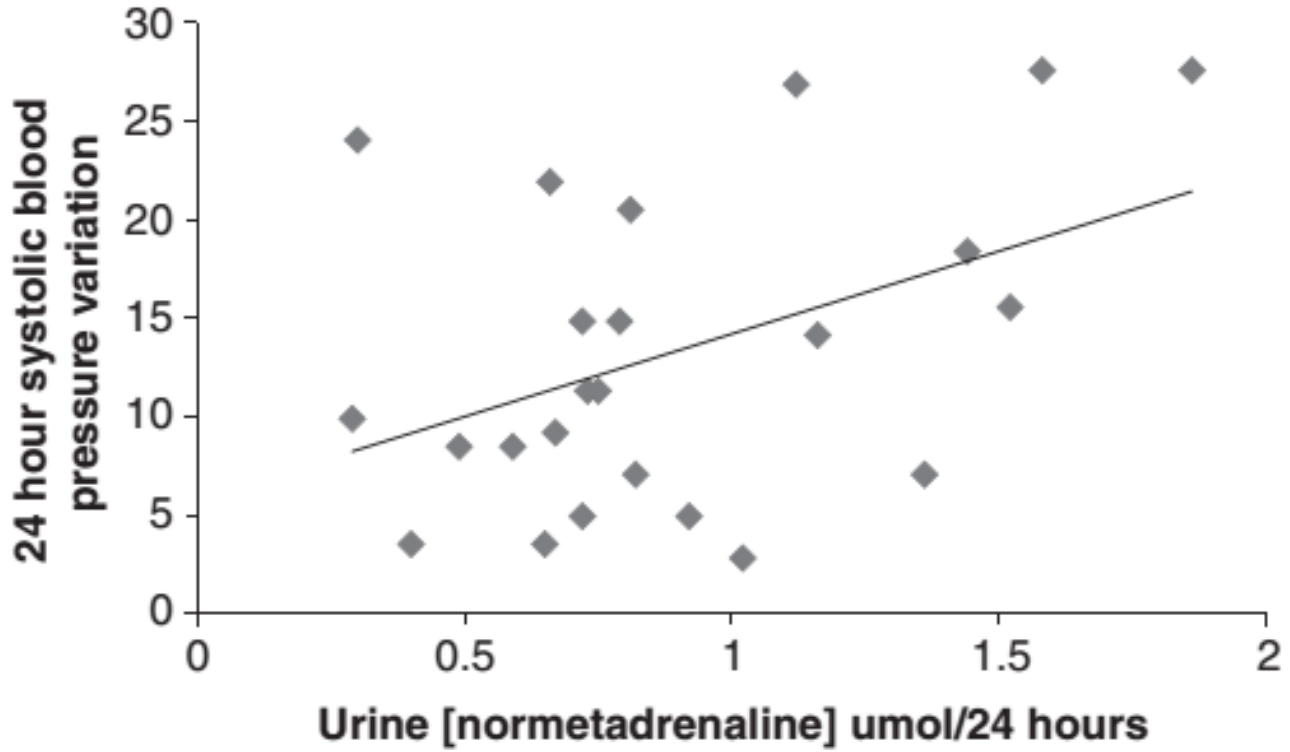
Circ Res 1971;29:424.
Cerebrovasc Dis 1997;7:214-19.
Lancet 2010;375:906-15.

Mechanisms of BPV



Diabetes care 2013;36:S312-24.

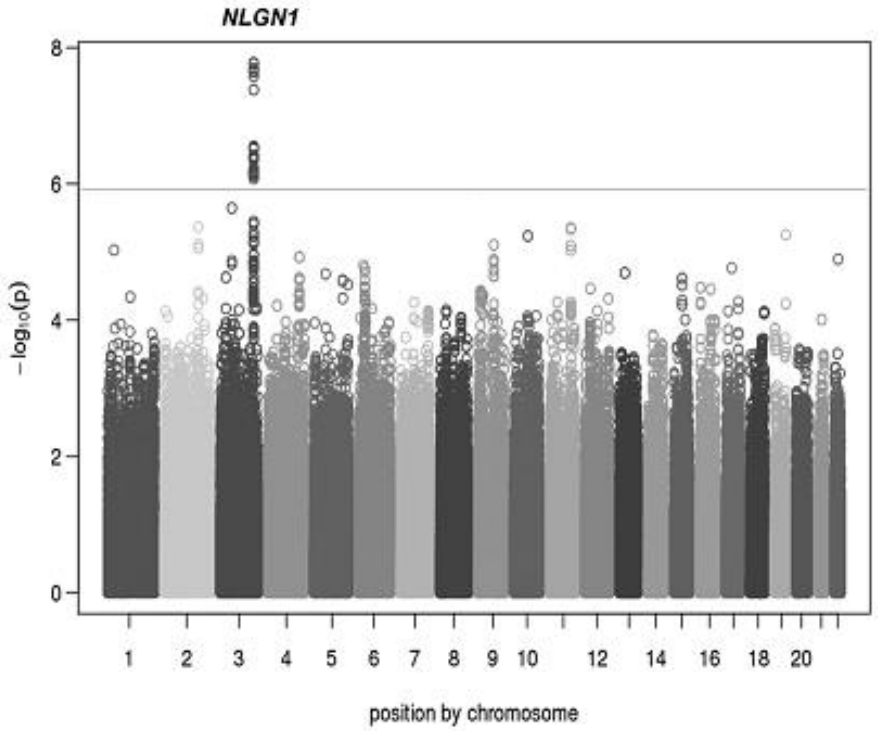
Short-term BPV and sympathetic activity



J Hum Hypertens 2015;29:50-2.

NLGN1(Neuroligin-1) locus and BPV

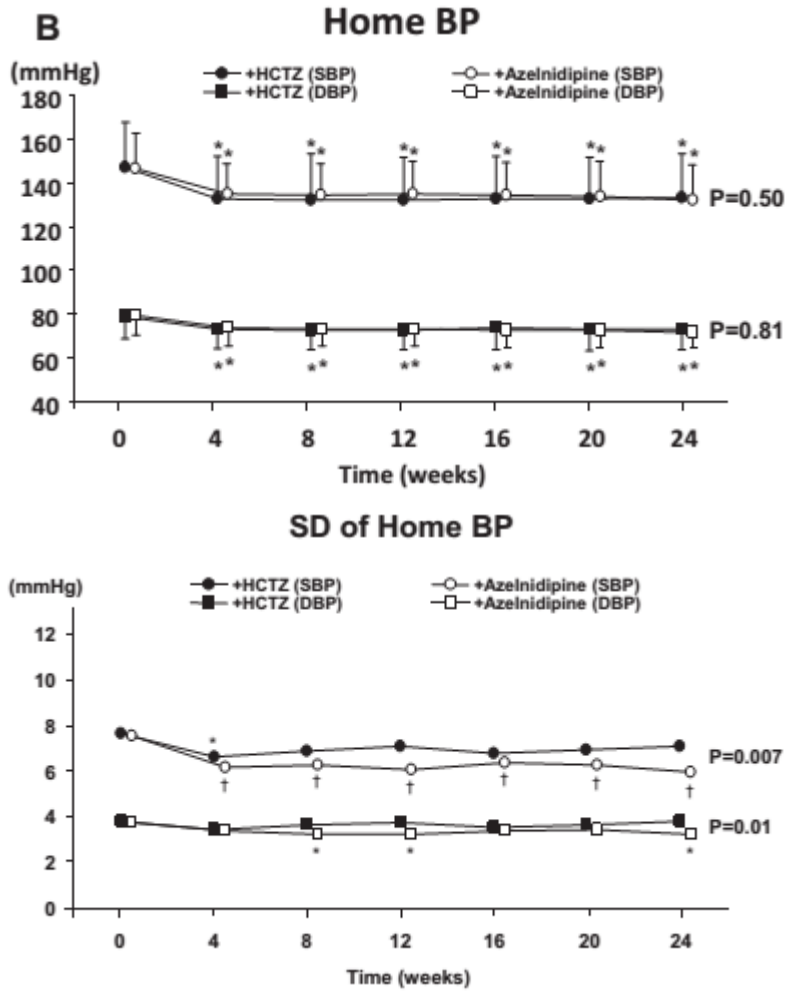
- ASCOT trial -



Unable to demonstrate association btw this locus and ischemic stroke

Stroke. 2013;44:2703-9.

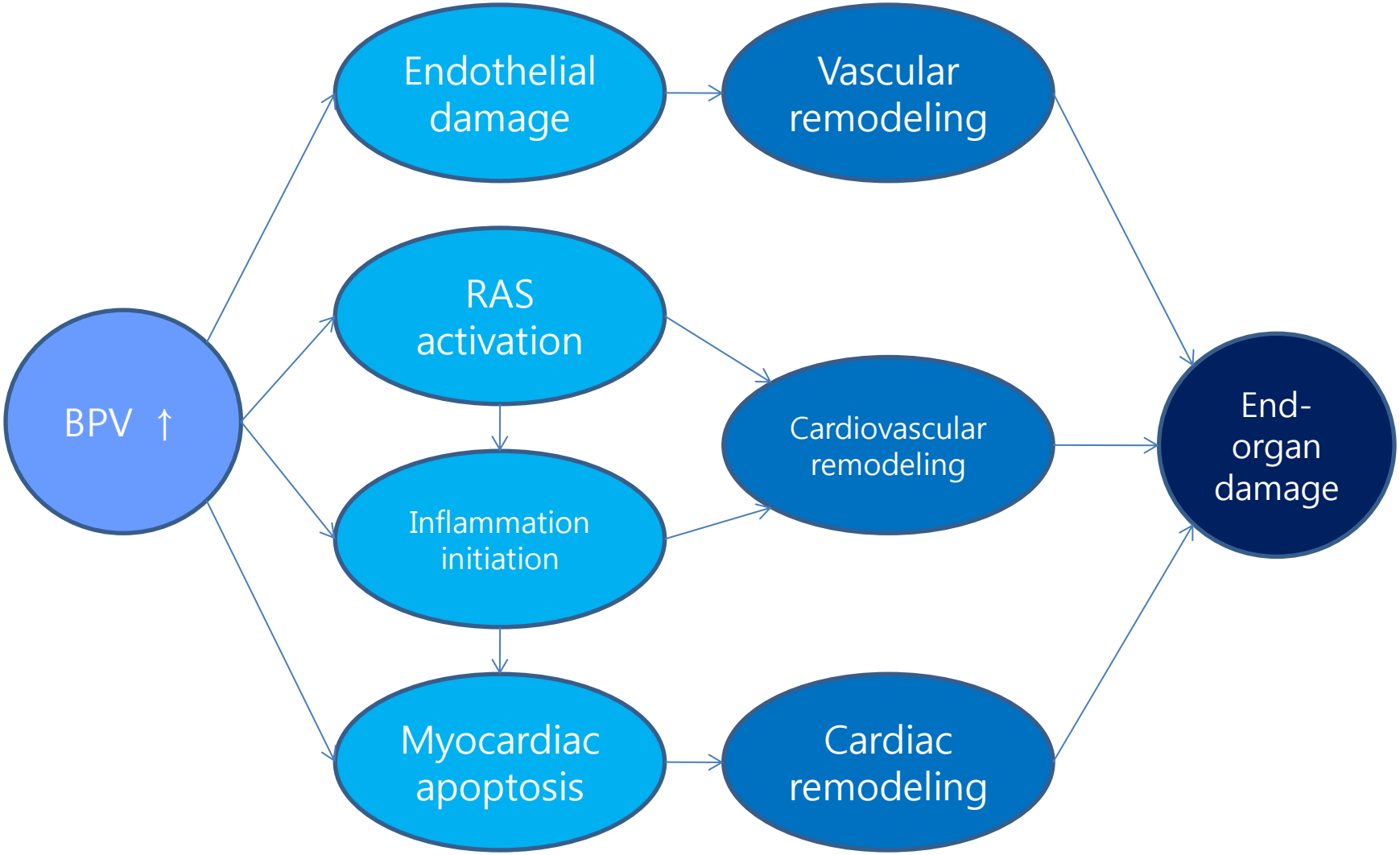
DDV and aortic PWV



	Change in SD of Home SBP			
	Univariate Analysis		Multivariate Analysis*	
Variable	r	*P*	β (SE)	*P*
HCTZ group (n=104)				
Change in home SBP, mm Hg	0.04	0.71	0.02 (0.03)	0.50
Change in home HR, bpm	−0.01	0.94	−0.14 (0.11)	0.21
Change in SD of home HR, bpm	0.24	0.013	0.67 (0.20)	0.001
Change in aortic PWV, m/s	0.03	0.78	0.27 (0.39)	0.50
			Model R^2=0.12	
Azelnidipine group (n=103)				
Change in home SBP, mm Hg	0.11	0.25	0.02 (0.03)	0.38
Change in home HR, bpm	0.03	0.79	0.03 (0.06)	0.68
Change in SD of home HR, bpm	0.16	0.12	0.26 (0.18)	0.16
Change in aortic PWV, m/s	0.23	0.021	0.79 (0.37)	0.036
			Model R^2=0.10	

Hypertension 2012;59:1132-8.

Possible mechanisms involved in high BPV-induced organ damage

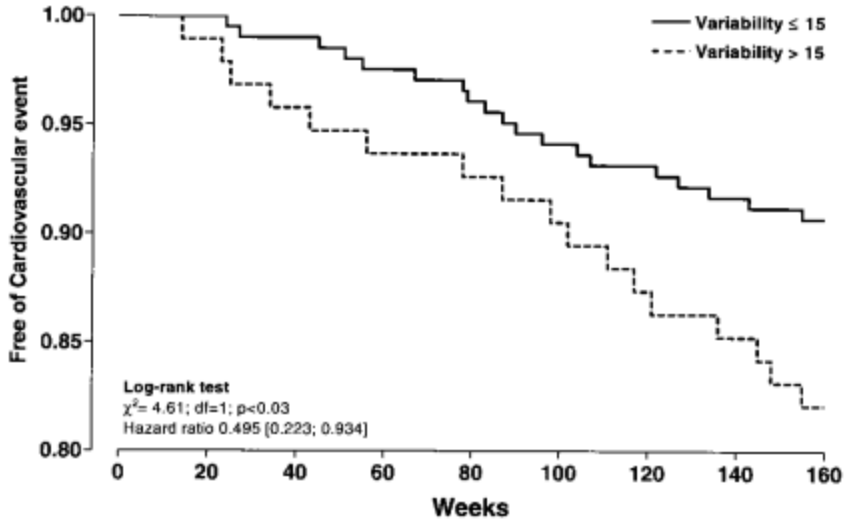


Curr Opin Cardiol 2006;21:486-91.

SHORT TERM(AMBULATORY)

BPV(SBP;ABP) and carotid atherosclerosis
; independent of average BP

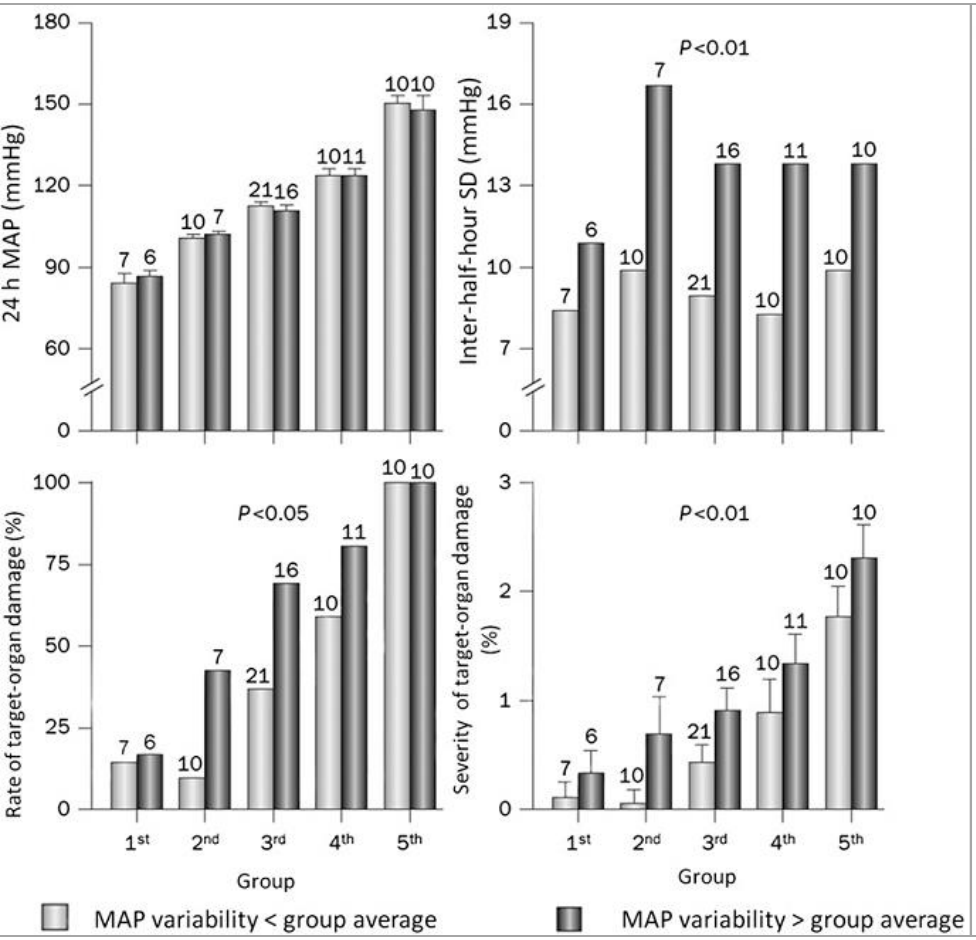
	Odds Ratio (95% CI)	*P*
Variability (>15 vs ≤15 mm Hg)	3.9 (1.4–11.1)	<0.01
Variation (nighttime blood pressure increase vs decrease)	1.27 (0.38–4.3)	NS
Blood pressure (hypertensive vs normotensive)	1.17 (0.55–2.07)	NS

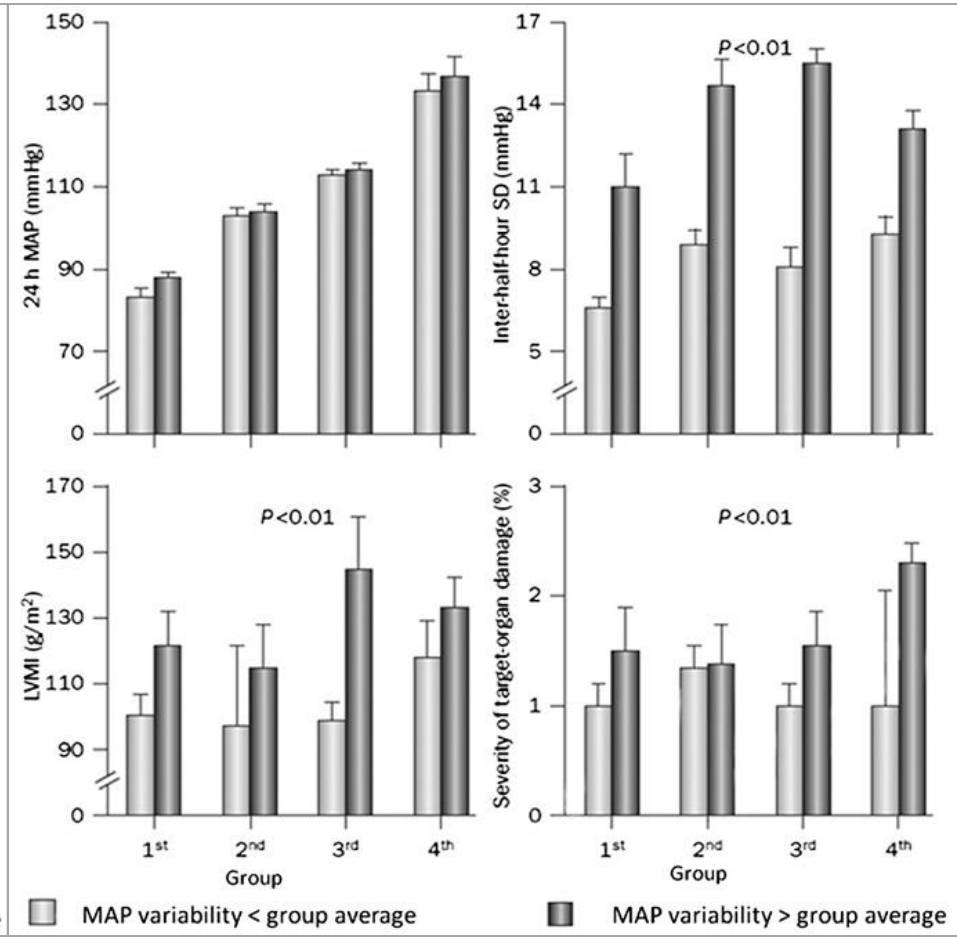


Short-term BPV predict organ damage and CV events.
- A 3 year follow-up study

Circulation 2000;102:1536-41.

Short-term BPV and TOD





J Hypertens 1987;5:93-8.
J Hypertens 1993;11:1133-7.

CV mortality and short-term diastolic BPV

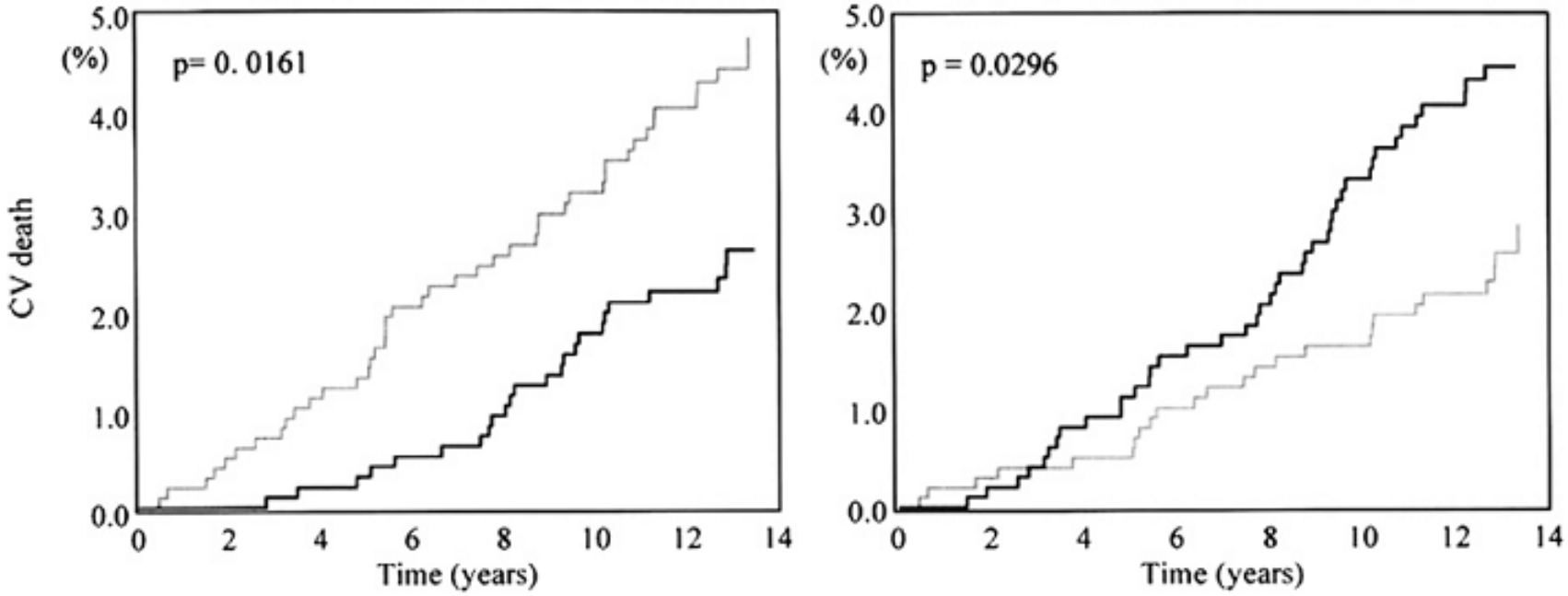
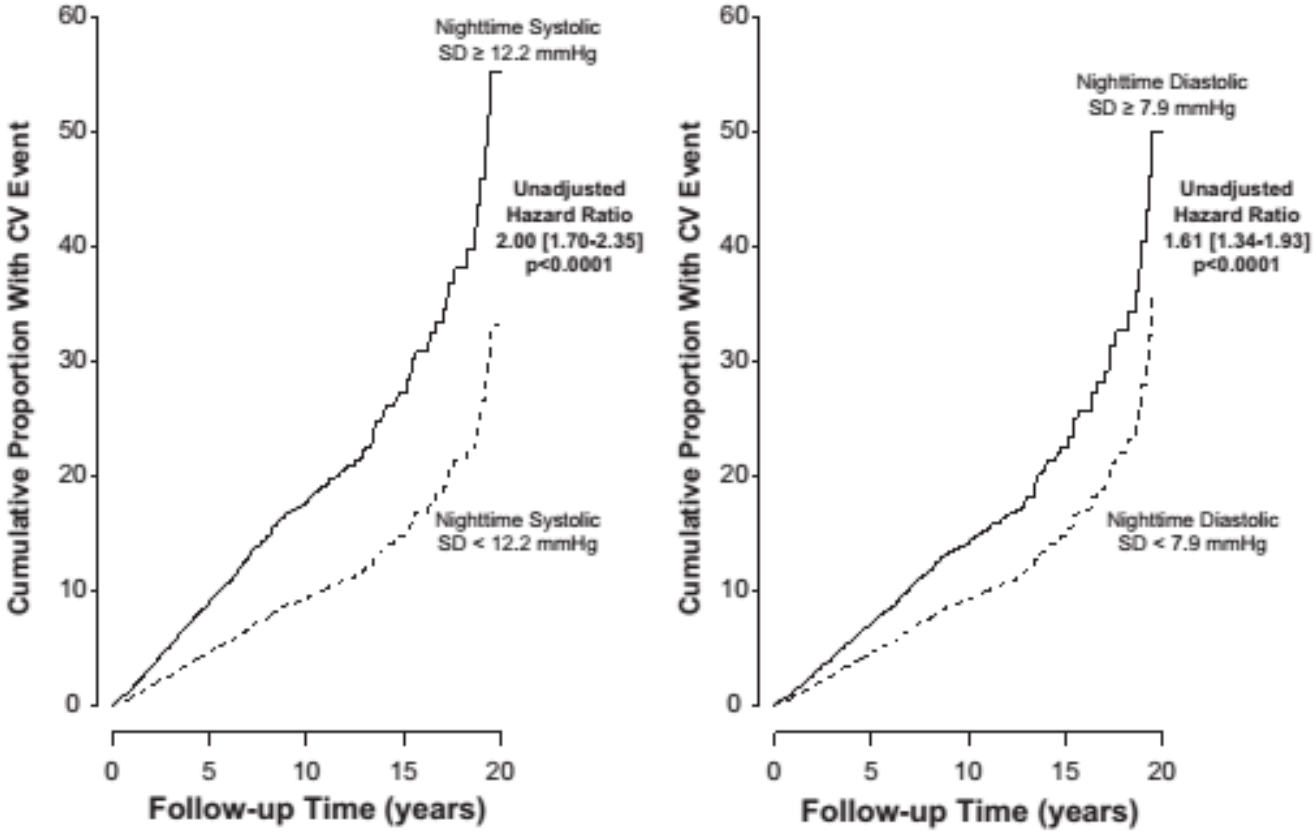


Figure 3—*Kaplan-Meier curves for CV mortality in subjects with day-night DBP difference* (A) *and residual variability* (B) *above (black lines) and below (gray lines) the median value of the population. Modified with permission from Mancia et al. (71).*

PAMELA study: Hypertension 2007;49:1265-70.

Night-time BPV and CV events



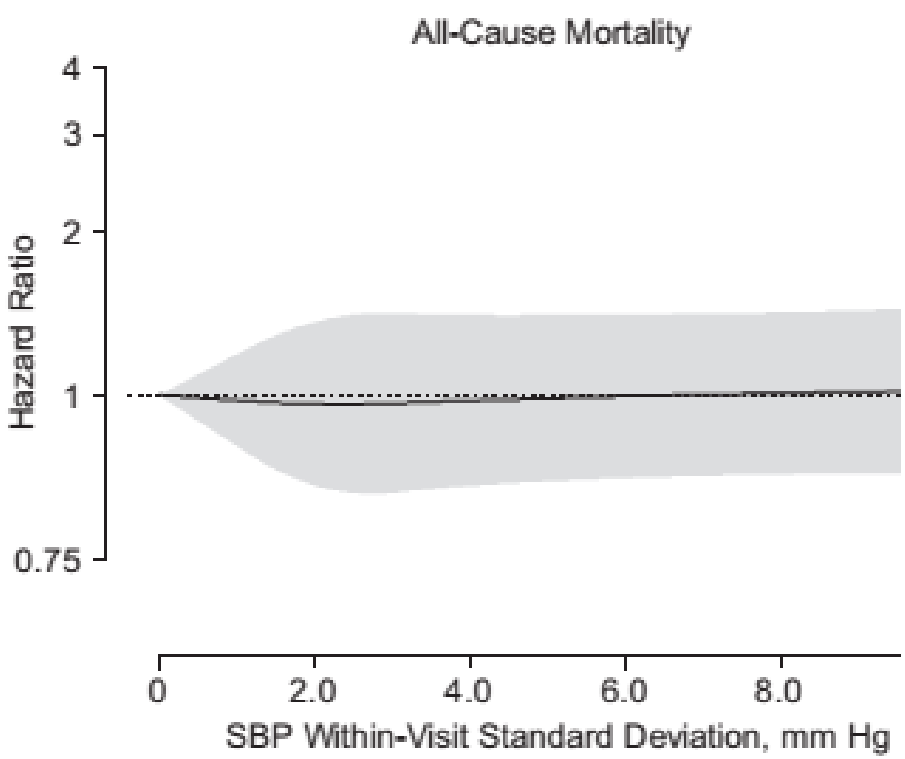
Hypertension 2014;64:487-93.

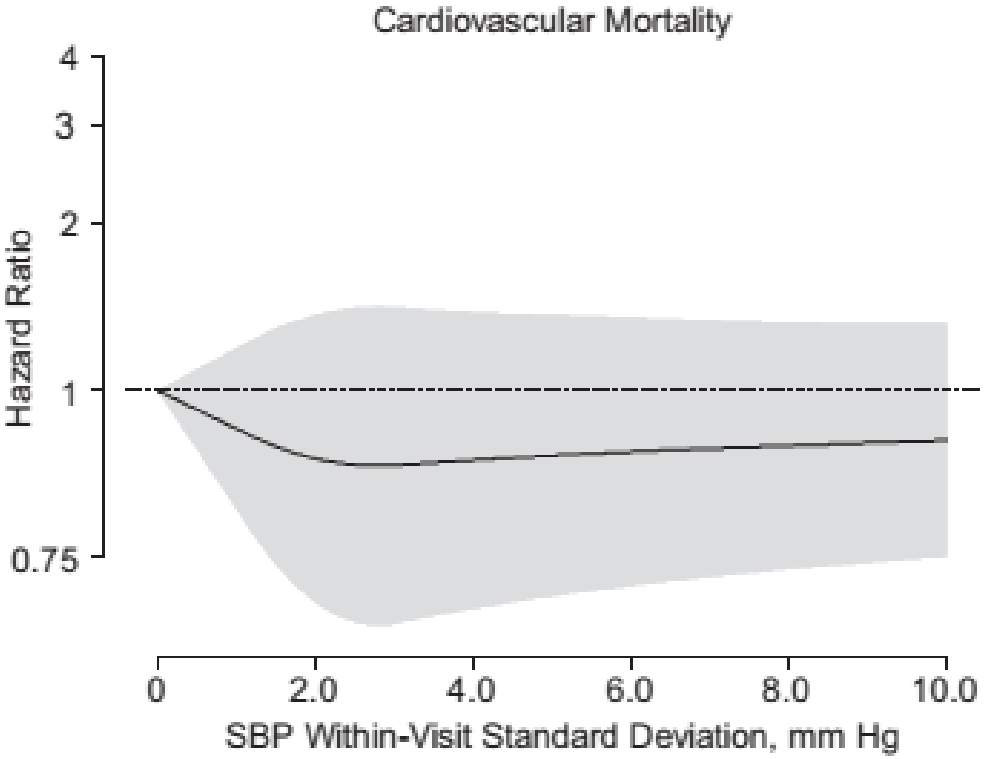
VVV vs. ambulatory variability

- Ambulatory BPV
  - Diet, exercise, change in temperature, sleep, mental stress
- VVV
  - Posture during BP measurement, respiratory cycle, salt intake, alcohol ingestion, physical activity, amount of rest, seasonal temperature
- Variability of BP on ABPM was a weaker predictor of vascular events than visit-to-visit variability.

Am J Hypertens 2013;26:1369-76.

Within-visit variability and CV outcomes





NHANES III. J Clin Hypertens (Greenwich) 2012;14:165-71.

MID TERM(DAY-TO-DAY)

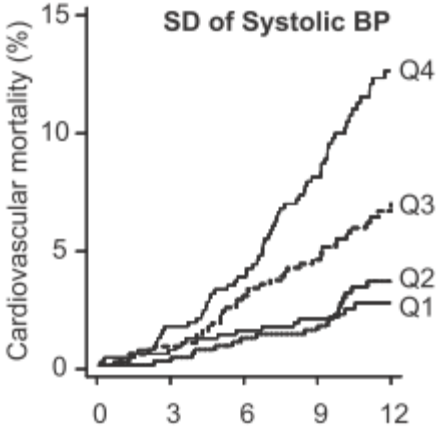
DDV

; a novel indicator of TOD beyond average HBP

	LVMI		Carotid IMT		Log UACR	
Variable	*r*	*P*	*r*	*P*	*r*	*P*
Mean office SBP, mm Hg	0.41	<0.001	0.24	<0.001	0.29	<0.001
Mean office DBP, mm Hg	0.05	0.34	0.03	0.56	0.05	0.34
Mean home SBP, mm Hg	0.46	<0.001	0.31	<0.001	0.30	<0.001
Mean home DBP, mm Hg	0.13	0.02	0.09	0.10	0.08	0.15
Maximum home SBP, mm Hg	0.51	<0.001	0.40	<0.001	0.29	<0.001
Maximum home DBP, mm Hg	0.23	<0.001	0.13	0.012	0.08	0.16
Day-by-day home SBP variability, mm Hg	0.31	<0.001	0.23	<0.001	0.20	<0.001
Day-by-day home DBP variability, mm Hg	0.22	<0.001	0.10	0.07	0.06	0.29

Hypertension 2011;57:1087-93.

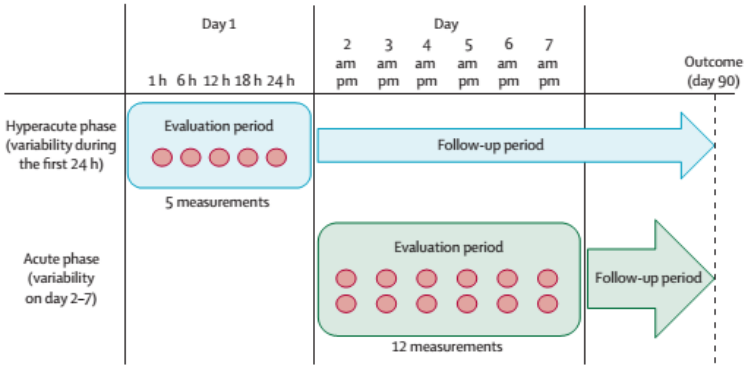
BPV and mortality
; the Ohasama study (HBP)

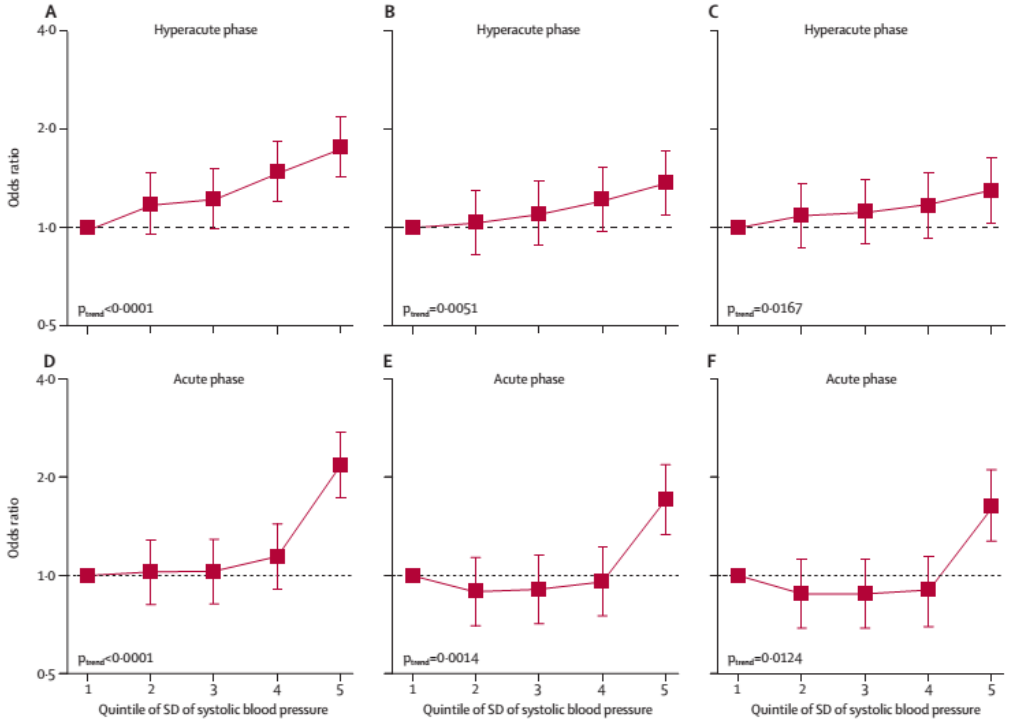


Mortality	Total*	Cardiovascular*	Stroke*
Deaths, n	462	168	83
Base model			
Systolic BP, mm Hg	1.18 (1.07 to 1.31)‖	1.33 (1.13 to 1.57)‖	1.43 (1.13 to 1.80)§
Heart rate, bpm	1.21 (1.11 to 1.31)‖	1.24 (1.08 to 1.42)§	1.27 (1.06 to 1.53)§
Adjusted			
SD of systolic BP, mm Hg	1.21 (1.10 to 1.32)‖	1.27 (1.09 to 1.47)§	1.41 (1.15 to 1.73)‖
SD of heart rate, bpm	1.11 (1.02 to 1.21)‡	1.24 (1.09 to 1.41)§	1.17 (0.96 to 1.43)
Fully adjusted			
Systolic BP, mm Hg	1.13 (1.01 to 1.25)‡	1.26 (1.06 to 1.49)§	1.29 (1.01 to 1.64)‡
Heart rate, bpm	1.19 (1.09 to 1.30)‖	1.16 (1.01 to 1.34)‡	1.25 (1.02 to 1.52)‡
SD of systolic BP, mm Hg	1.18 (1.07 to 1.31)‖	1.20 (1.02 to 1.40)‡	1.38 (1.12 to 1.72)§
SD of heart rate, bpm	1.05 (0.96 to 1.16)	1.18 (1.02 to 1.36)‡	1.06 (0.84 to 1.33)

Hypertension 2008;52:1045-50.

Outcome after acute ICH



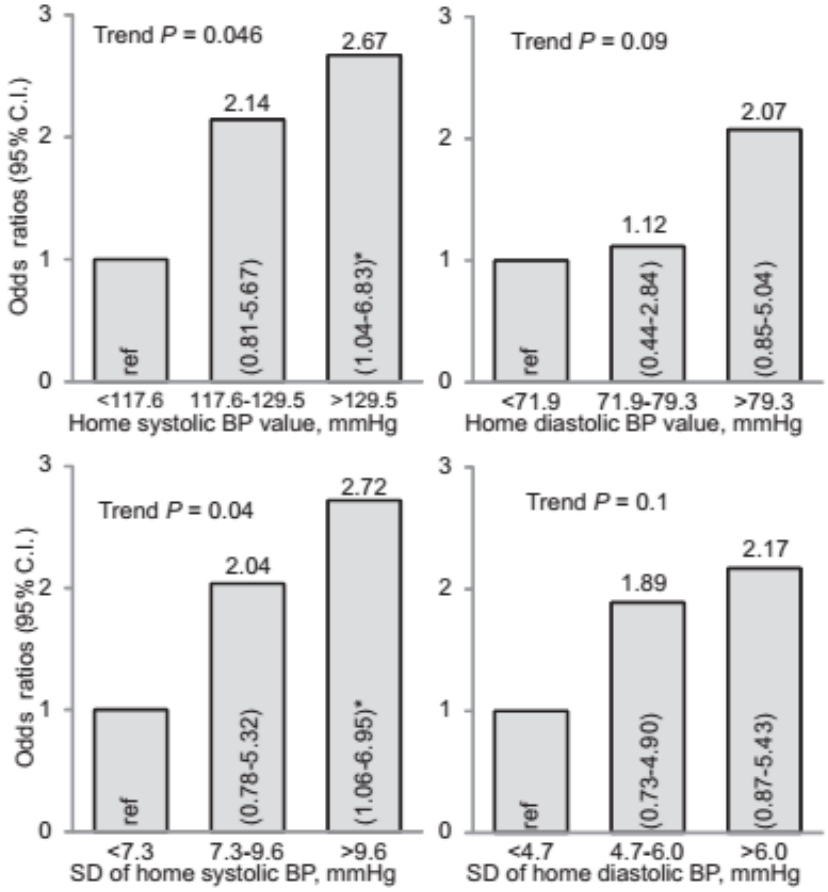


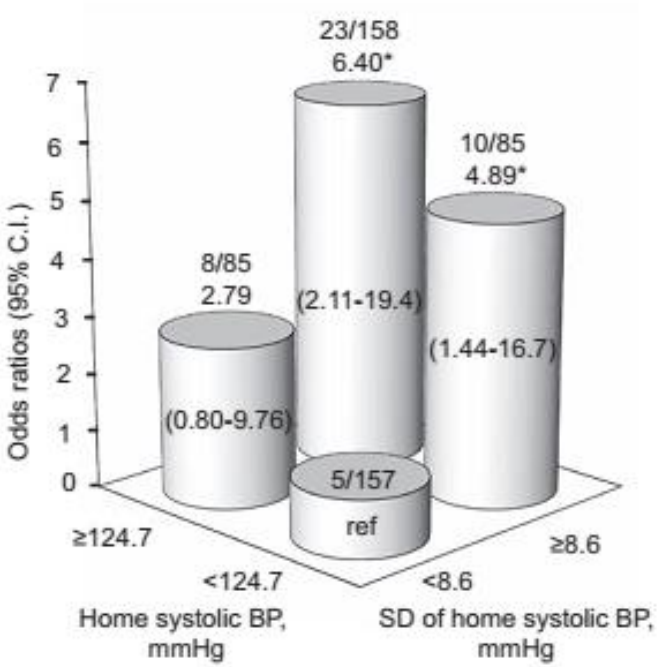
The benefits of early treatment to reduce systolic blood pressure to 140 mm Hg might be enhanced by smooth and sustained control, and particularly by avoiding peaks in systolic blood pressure.

Lancet Neurol 2014;13:364-73.

Combination of mean SBP with DDV

- cognitive decline -





Hypertension 2014;63:1333-8.

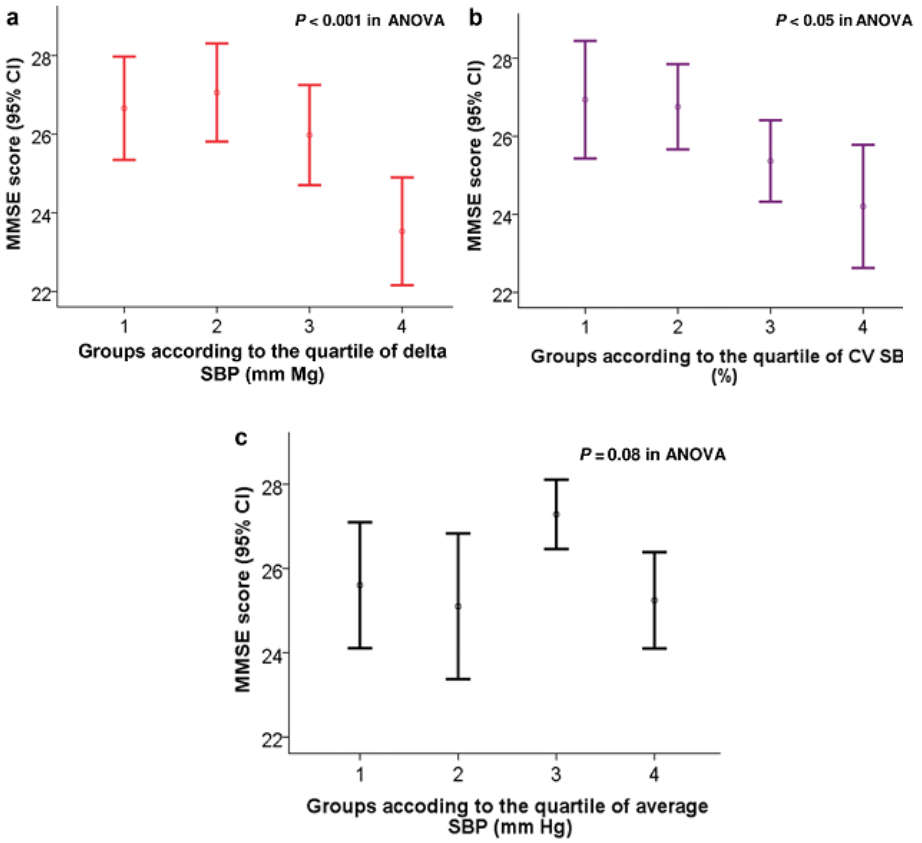
LONG TERM(VISIT-TO-VISIT)

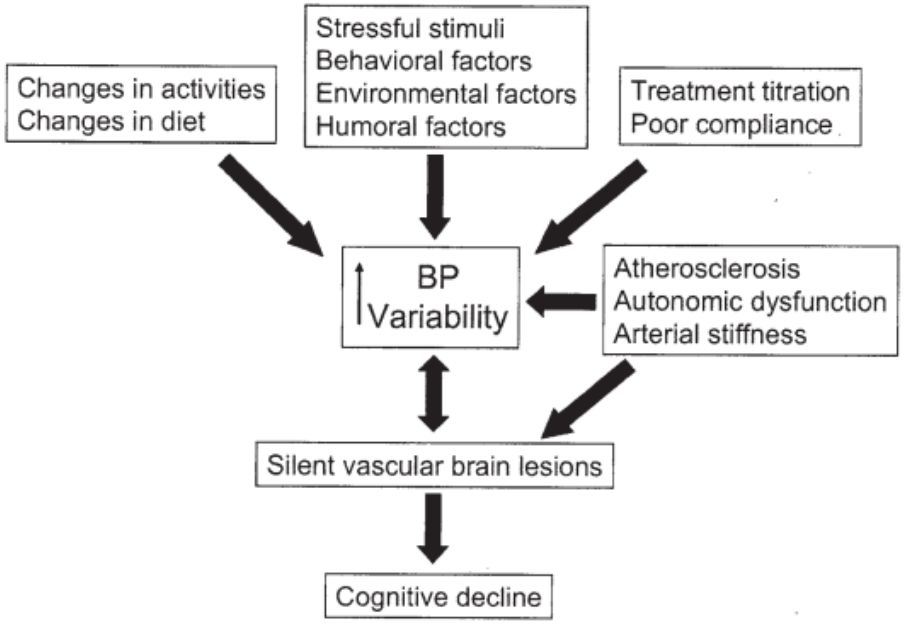
VVV correlates with systemic atherosclerotic change

	Total	SD of SBP		P	SD of SBP		P
		<8.1	≥8.1		<13.7	≥13.7	
PWV (m/s)	8.94 ± 1.69	8.53 ± 1.58	9.08 ± 1.71	<0.001	8.73 ± 1.62	9.45 ± 1.77	<0.001
Carotid Doppler examination							
IMT (mm)	0.82 ± 0.21	0.77 ± 0.14	0.83 ± 0.22	0.022	0.81 ± 0.20	0.85 ± 0.22	0.094
Plaque score	2.95 ± 4.73	1.72 ± 2.88	3.25 ± 5.04	0.006	2.52 ± 4.22	3.77 ± 5.53	0.513
Resistive index	0.76 ± 0.07	0.75 ± 0.06	0.76 ± 0.08	0.223	0.75 ± 0.08	0.78 ± 0.06	0.003
Ultrasound echocardiography							
LVMI (g/m^2)	126.2 ± 40.4	116.7 ± 30.4	129.2 ± 42.7	0.004	120.9 ± 37.0	137.6 ± 45.1	0.001
eGFR (ml/min per 1.73 m^2)	72.5 ± 24.9	76.7 ± 20.8	71.1 ± 26.0	0.009	74.0 ± 25.9	68.8 ± 21.7	0.014
Reactive hyperemia	1.61 ± 0.77	1.52 ± 0.64	1.64 ± 0.81	0.072	1.59 ± 0.70	1.65 ± 0.92	0.264

J Hypertens 2013;31:1387–95.

Cognitive function; silent cerebral injury





Hypertens 2012;30:1556–63.
Hypertension 2014;63:1163-5.

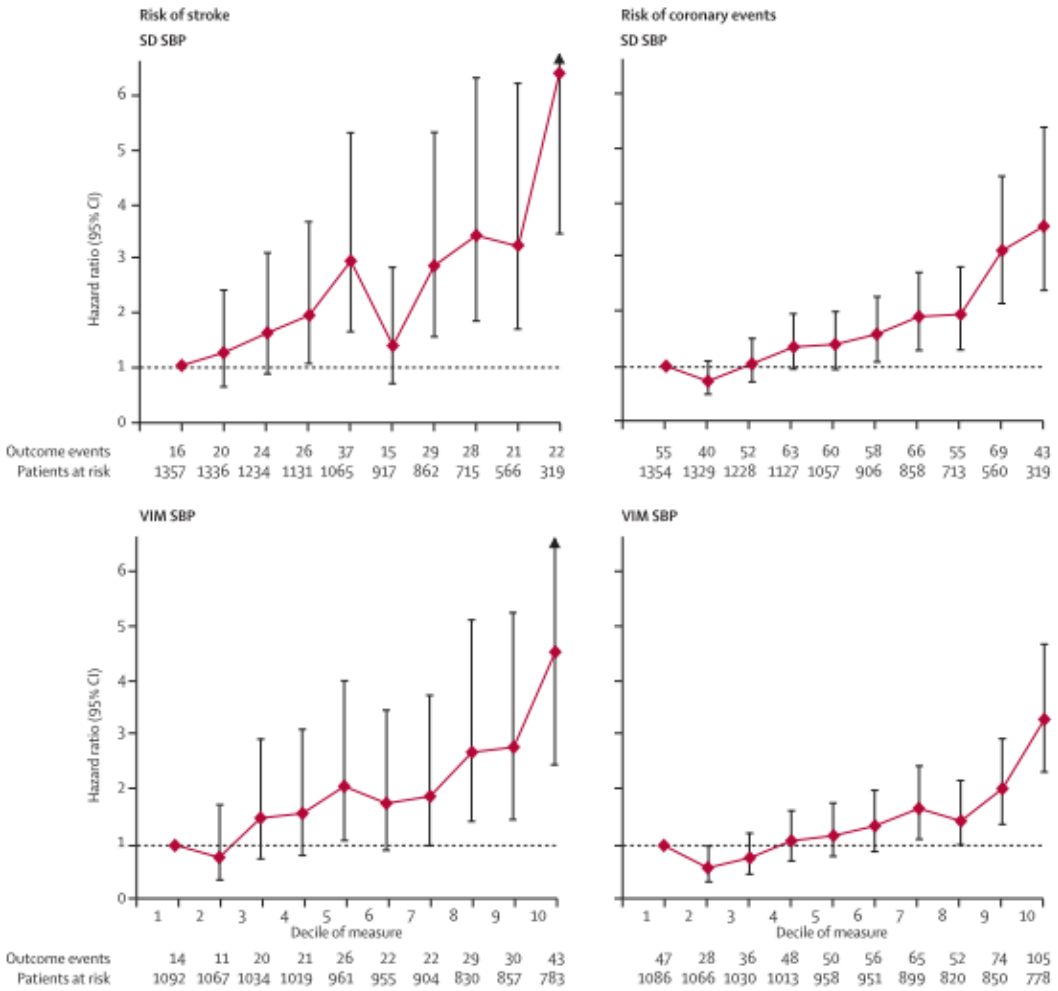
Compared with established surrogate markers

Hazards ratios of high systolic BPV and vascular markers in prediction of MACE.

	Model 1 HR (95% CI)	Model 2 HR (95% CI)	Model 3 HR (95% CI)
High systolic BPV	2.42 (1.70–3.45)**	1.53 (1.05–2.23)*	1.67 (1.14–2.43)**
FMD ≤ 1.2%	1.56 (1.06–2.31)*	1.42 (9.96–2.10)	1.48 (1.00–2.21)
IMT >1.1 mm	3.11 (2.18–4.46)**	2.07 (1.43–3.00)**	1.75 (1.18–2.59)**
Carotid plaque	2.38 (1.57–3.62)**	1.57 (1.03–2.40)*	1.47 (0.96–2.26)
ABI ≤0.9	1.45 (0.71–2.96)	1.12 (0.54–2.30)	1.09 (0.52–2.29)
baPWV >1821 cm/s	2.96 (2.01–4.38)**	1.64 (1.09–2.48)*	1.75 (1.15–2.65)**

Atherosclerosis 2014;235:230-5.

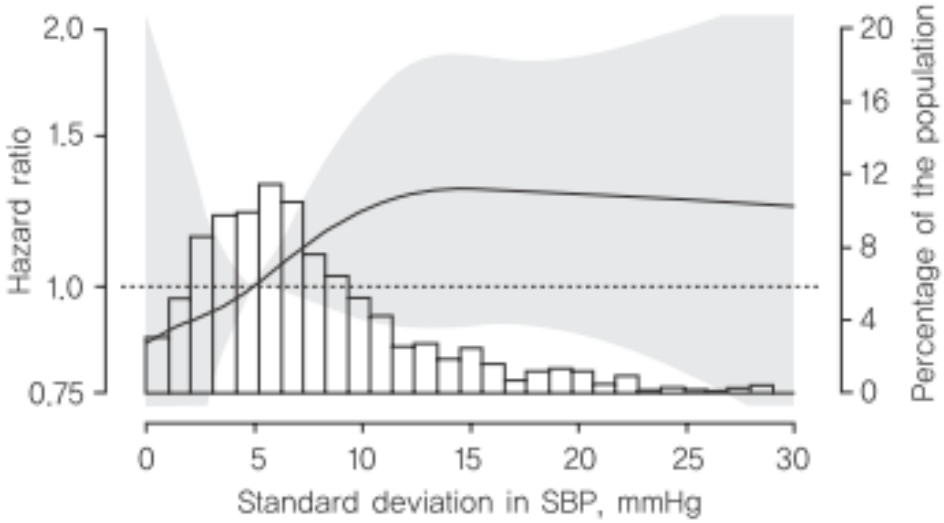
Strong predictor of stroke and coronary events independent of mean BP

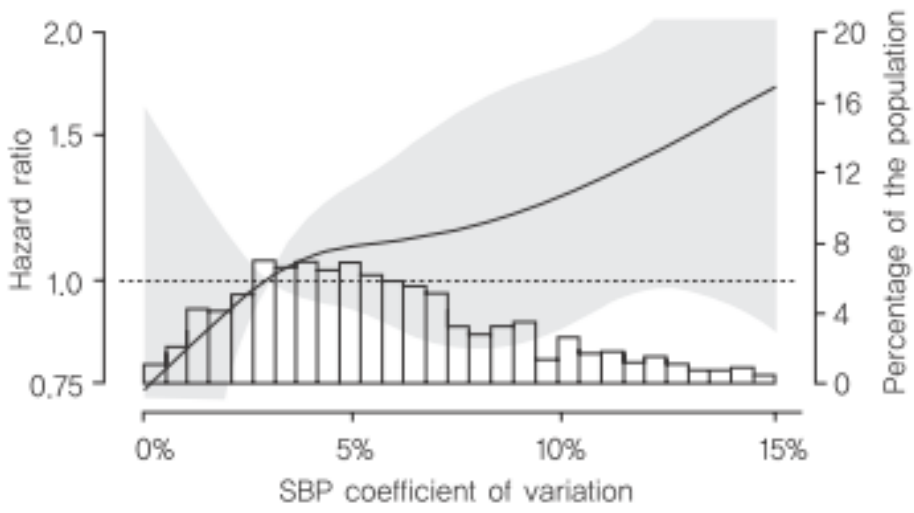


The UK-TIA aspirin trial; high-risk population

Lancet 2010;375:895-905.

Visit-to-visit variability in the general population ; from NHANES III (OBP)





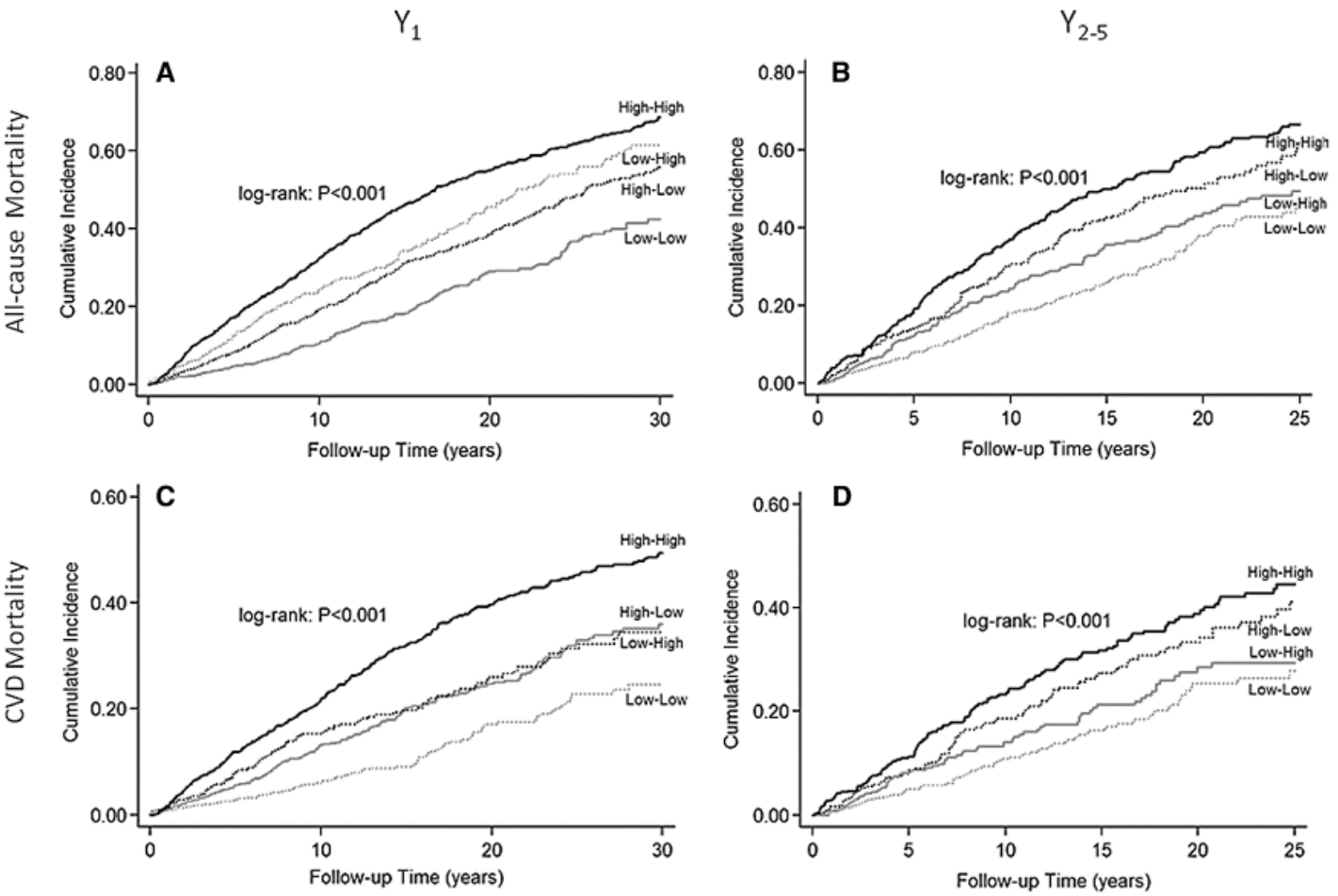
Visit-to-visit variability for DBP was not associated with mortality.

Visit-to-visit variability has only a weak relation(r=0.29 to 0.38) with the SD of daytime BP on ambulatory monitoring.

Hypertension 2011;57:160-6.

Long-term and very long-term BPV

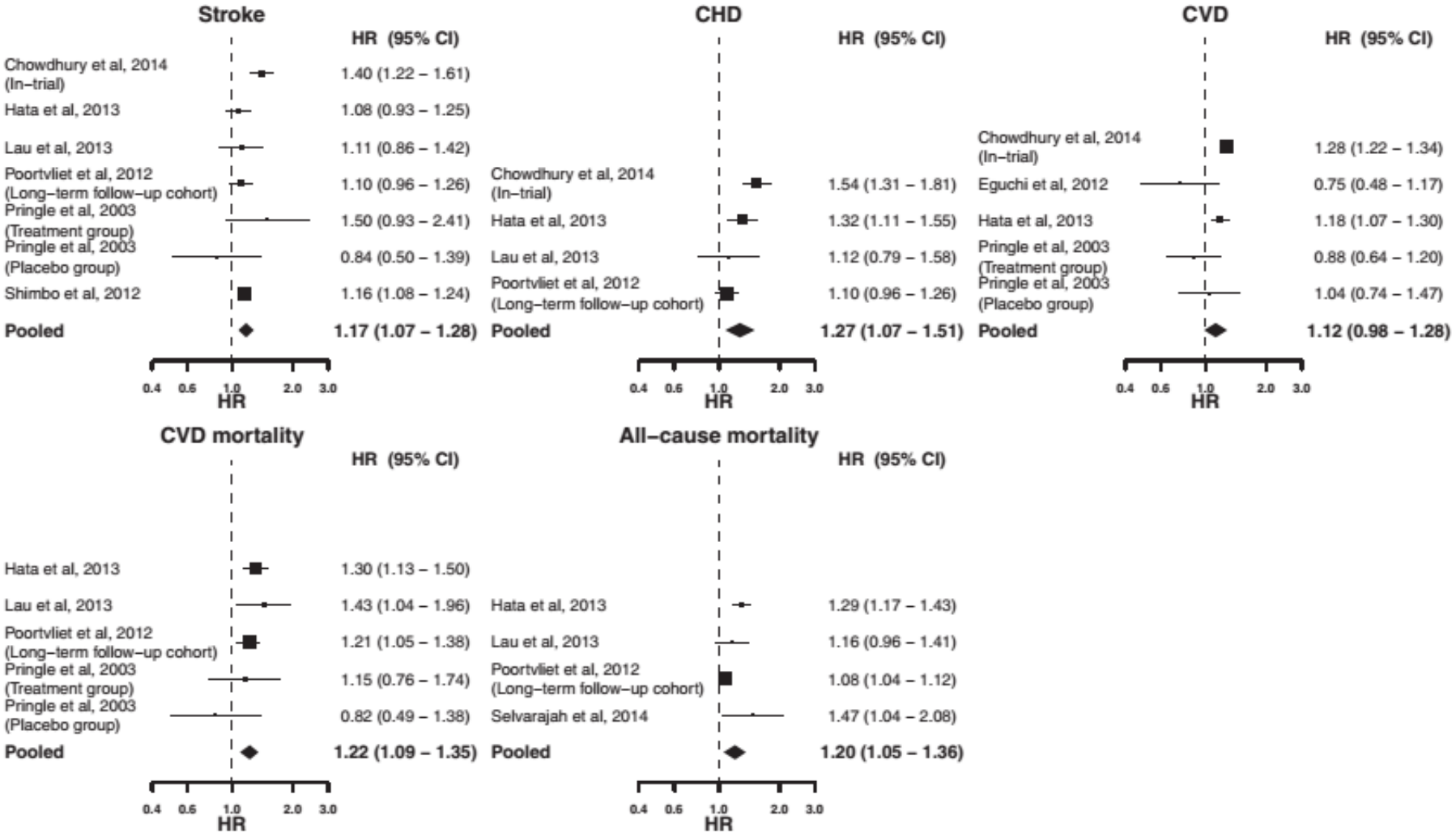
- data from Glasgow BP clinic since 1968 -



long-term; 1-5 years/ultra long-term; >5 years

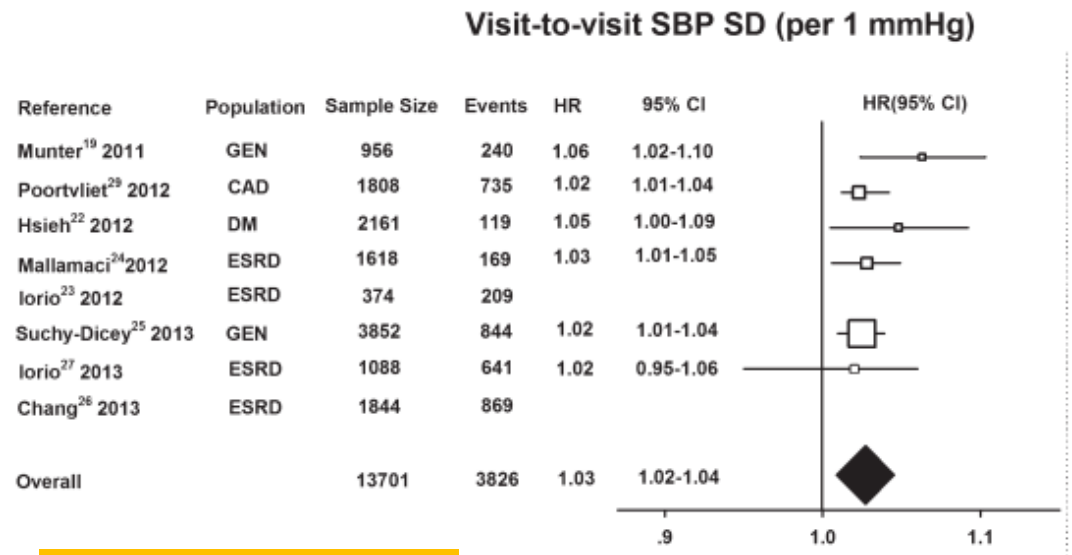
Hypertension 2013;62:698-705.

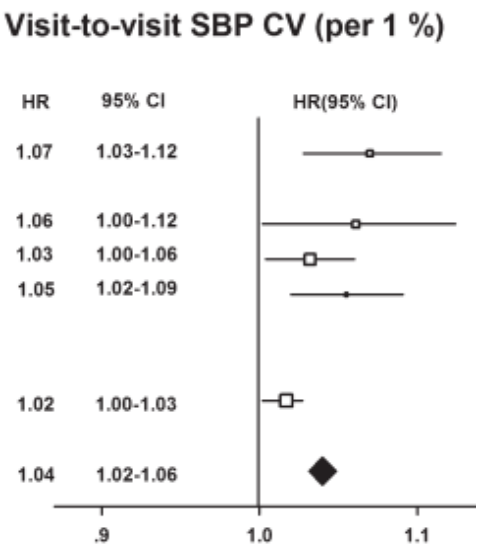
VVV and CVD (meta-analysis)



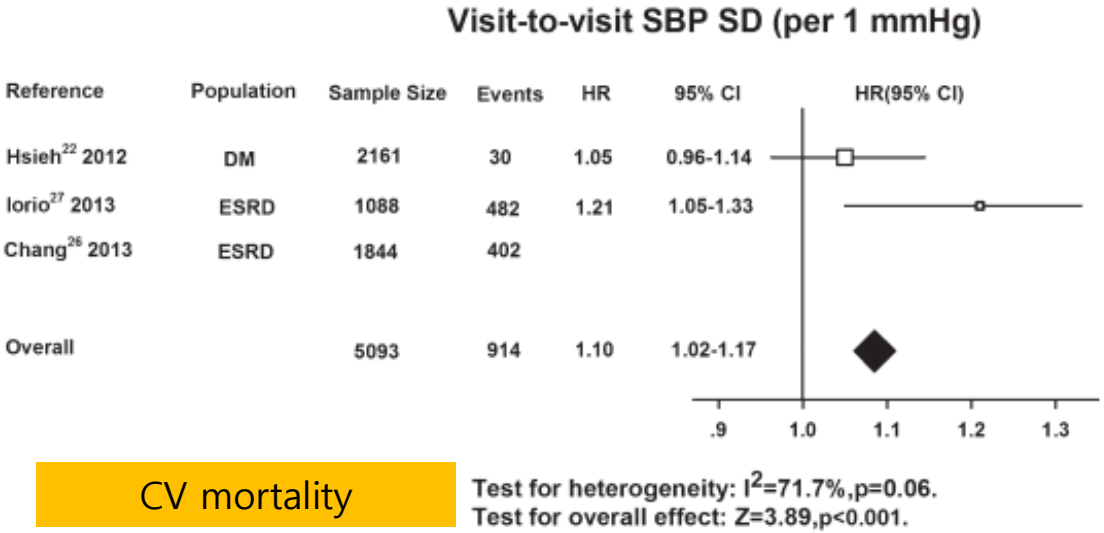
Hypertension 2014;64:965-82.

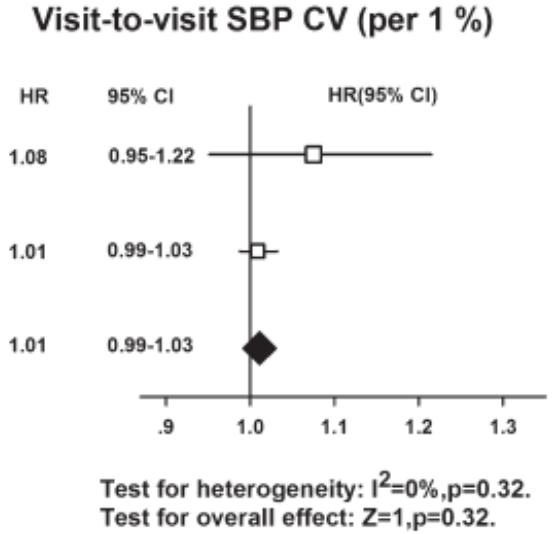
A meta-analysis of 77,299 patients





All-cause mortality





CV mortality

Hypertension 2013;62:698-705.

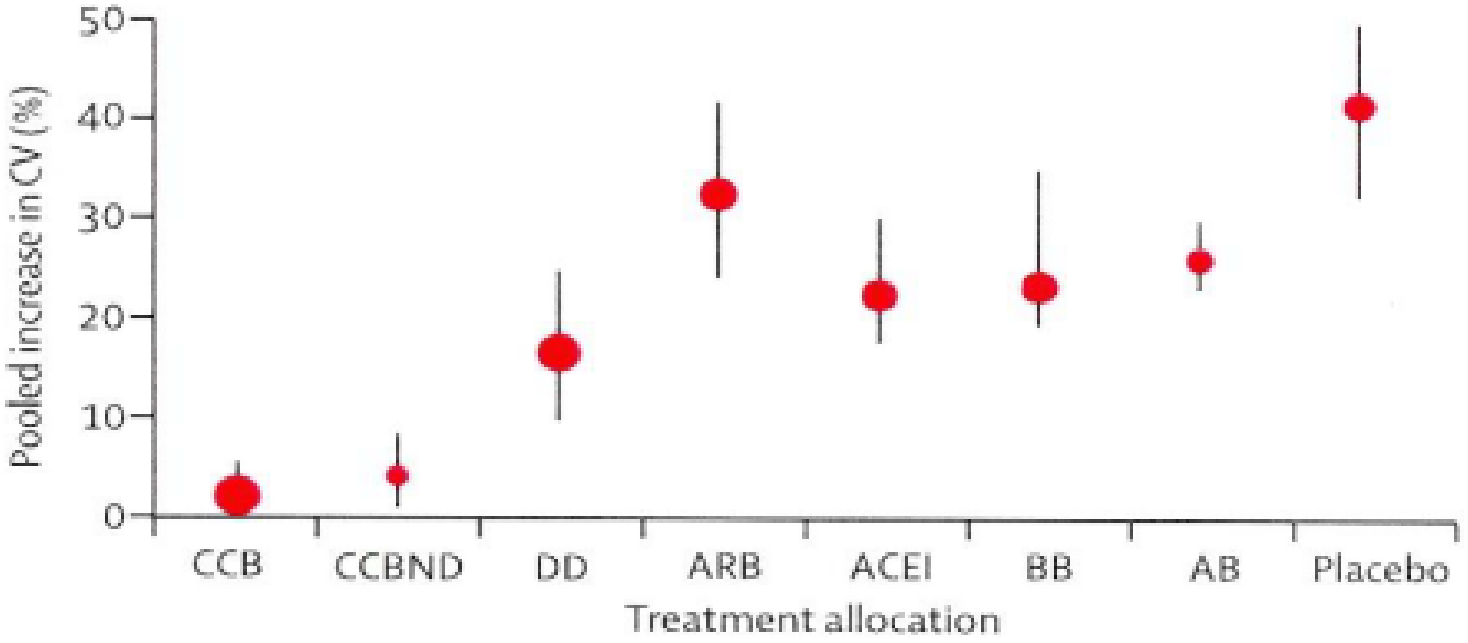
Weight loss/sodium reduction and VVV

Variable	Weight loss ($n=456$)	Sodium reduction ($n=452$)	Combined ($n=449$)	Usual care ($n=463$)	*P*-value		
					P_1	P_2	P_3
VVV of SBP (mmHg)	7.2 ± 3.1	7.1 ± 3.0	6.9 ± 2.9	6.9 ± 2.9	–	–	–
Unadjusted	0.3 ± 0.2	0.2 ± 0.2	0.0 ± 0.2	0 (ref)	0.12	0.29	0.87
Model 1[a]	0.2 ± 0.2	0.1 ± 0.2	0.0 ± 0.2	0 (ref)	0.29	0.62	0.81
Model 2[b]	0.3 ± 0.2	0.2 ± 0.2	0.1 ± 0.2	0 (ref)	0.10	0.29	0.62
Model 3[c]	0.4 ± 0.2	0.3 ± 0.2	0.2 ± 0.2	0 (ref)	0.05	0.13	0.38
VVV of DBP (mmHg)	5.4 ± 2.2	5.5 ± 2.3	5.3 ± 2.1	5.5 ± 2.2	–	–	–
Unadjusted	−0.1 ± 0.1	−0.1 ± 0.1	−0.2 ± 0.1	0 (ref)	0.41	0.62	0.13
Model 1[a]	−0.1 ± 0.1	−0.1 ± 0.1	−0.2 ± 0.1	0 (ref)	0.36	0.64	0.09
Model 2[b]	−0.1 ± 0.1	0.0 ± 0.1	−0.1 ± 0.1	0 (ref)	0.72	0.92	0.34
Model 3[c]	0.0 ± 0.1	0.0 ± 0.1	−0.1 ± 0.1	0 (ref)	0.75	0.89	0.36

May not be effective interventions for lowering VVS

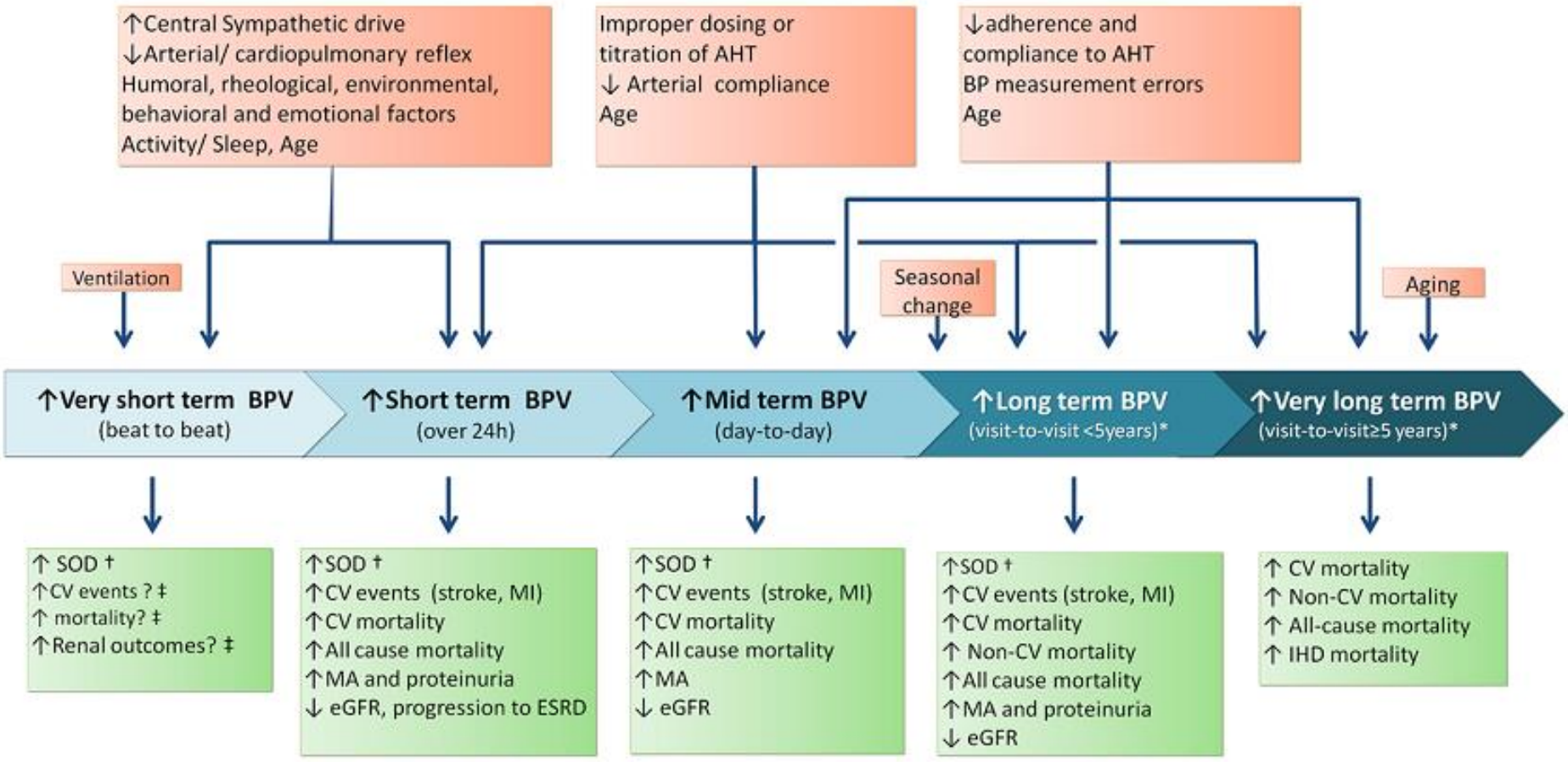
J Hypertens 2014;32:840–8.

SBP variability btw antihypertensives



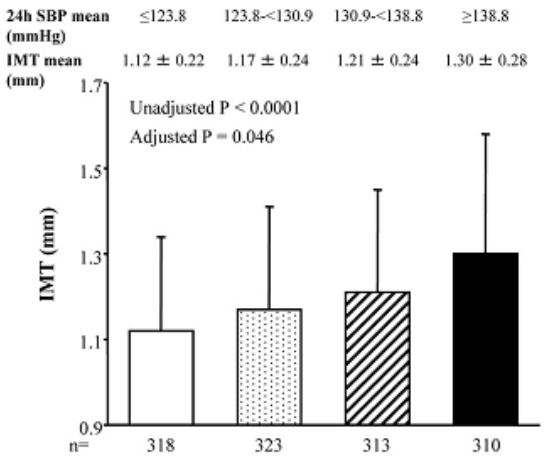
Peter Sever. BHS Primary Care Meeting 2011
Lancet 2010;375:895-905.

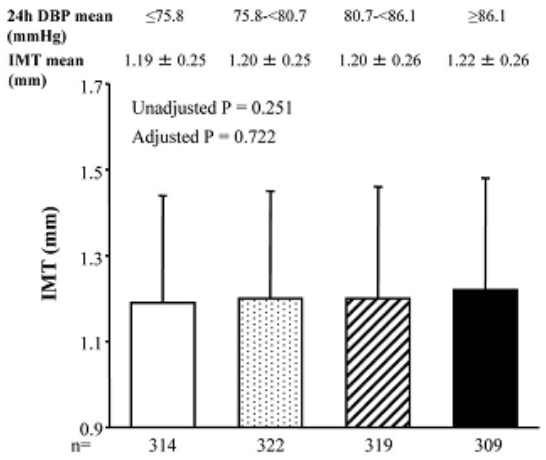
Different types of BPV and prognostic relevance

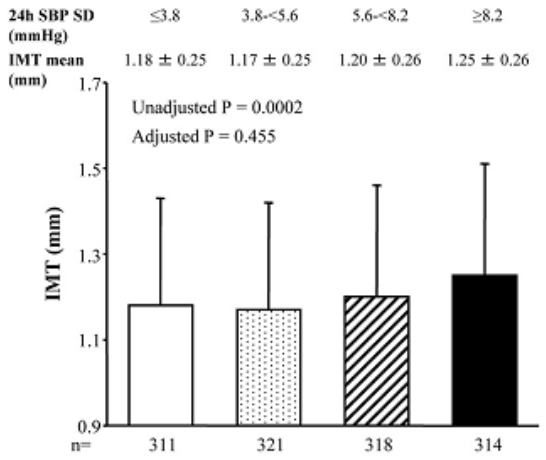


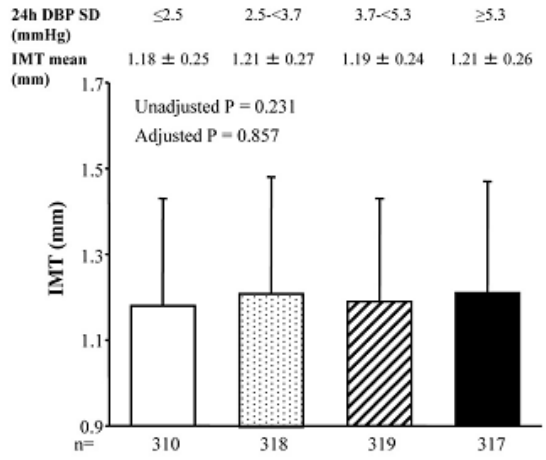
Hypertension 2013;62:682-4.

VVV in uncomplicated HTN





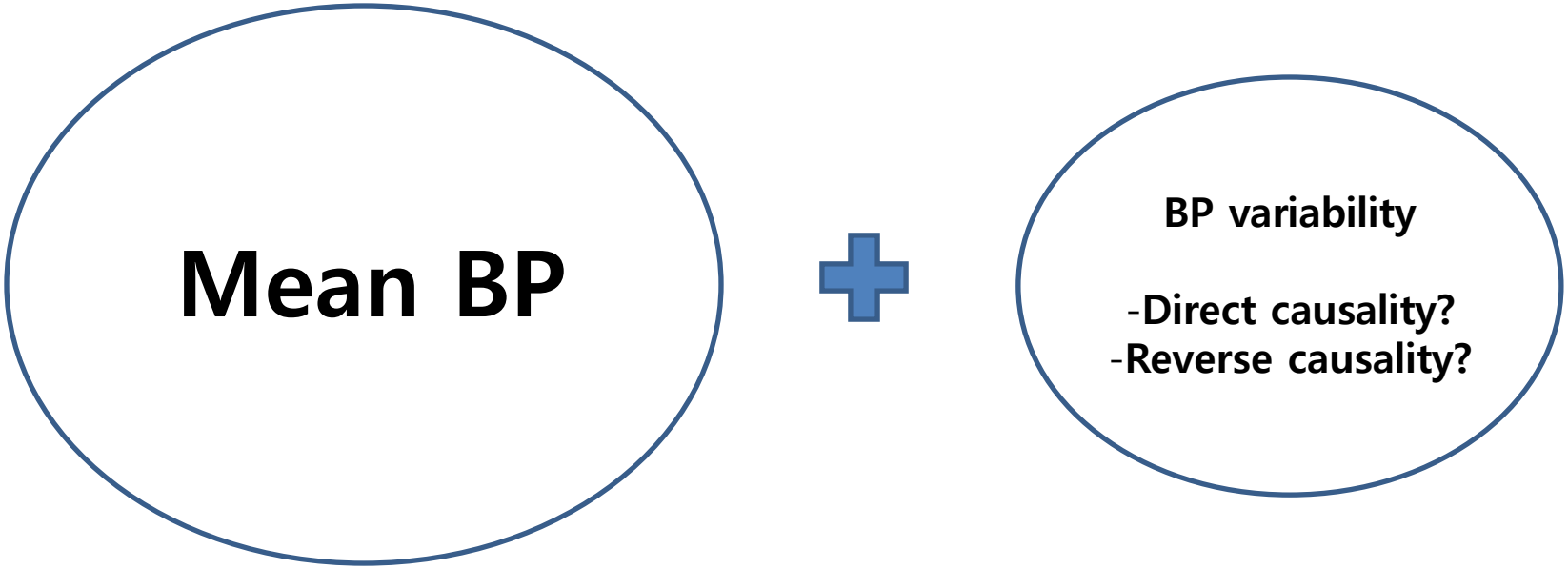




No significant association btw VVV and carotid IMT or CV outcomes.

Circulation 2012;126:569-78.

More precise risk prediction



Physicians are frequently concerned by the possibility that BP fluctuations occurring in daily life, which often rise well above the average BP level, might cause additional hemodynamic stress on the heart and vasculature, increasing the risk of organ damage.

경청해 주셔서 감사합니다.

VVV

device, number and timing of measurements

Number of Visits	Mean of 3 Automated Measurements	First Automated Measurement	Mean of 3 Manual Measurements	First Manual Measurement
3	6.2 (3.6)	6.9 (3.8)	5.6 (3.2)	6.4 (3.7)
4	6.7 (3.5)	7.3 (3.5)	6.0 (3.1)	6.7 (3.4)
5	7.1 (3.3)	7.7 (3.3)	6.3 (2.9)	6.9 (3.1)
6	7.5 (3.2)	8.1 (3.2)	6.7 (2.9)	7.3 (3.0)
7	7.5 (3.0)	8.2 (2.9)	6.8 (2.6)	7.4 (2.7)
8	7.7 (2.9)	8.4 (2.9)	7.0 (2.9)	7.6 (3.0)
9	7.8 (2.7)	8.5 (2.7)	7.1 (2.8)	7.7 (2.8)
10	7.9 (2.6)	8.5 (2.6)	7.0 (2.6)	7.7 (2.7)
11	7.9 (2.5)	8.6 (2.5)	7.1 (2.5)	7.7 (2.6)
12	8.0 (2.5)	8.6 (2.4)	7.1 (2.5)	7.7 (2.5)
13	8.1 (2.6)	8.7 (2.5)	7.2 (2.5)	7.8 (2.5)
14	8.2 (2.6)	8.8 (2.5)	7.3 (2.5)	7.9 (2.5)
15	8.3 (2.6)	8.9 (2.5)	7.4 (2.5)	8.0 (2.4)
16	8.3 (2.6)	8.9 (2.5)	7.6 (2.4)	8.1 (2.4)
17	8.4 (2.6)	9.0 (2.5)	7.6 (2.5)	8.2 (2.4)
18	8.5 (2.6)	9.1 (2.5)	7.7 (2.5)	8.2 (2.4)
P for trend	< .001	< .001	< .001	<.001

Values are expressed as mean intra-individual standard deviation (standard deviation of the intra-individual standard deviation).

J Clin Hypertens (Greenwich) 2012;14:744-50.

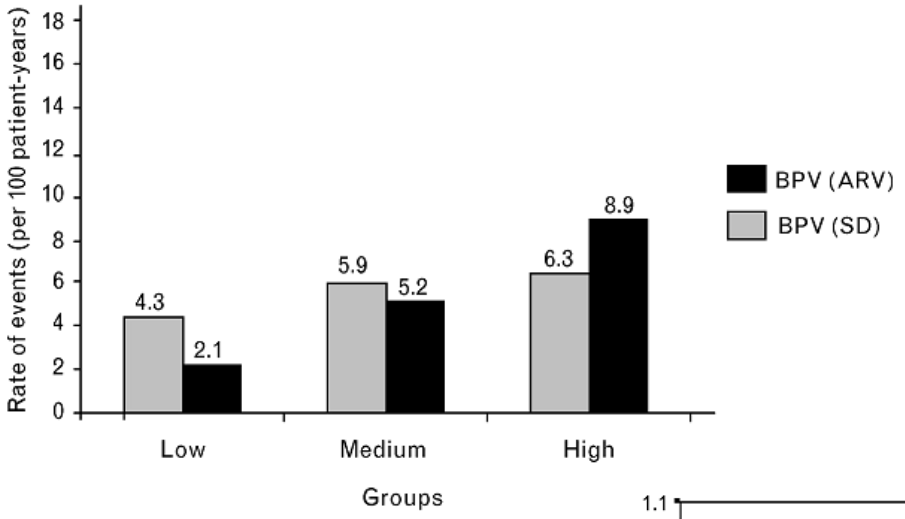
4. Short-Term Blood Pressure Variability

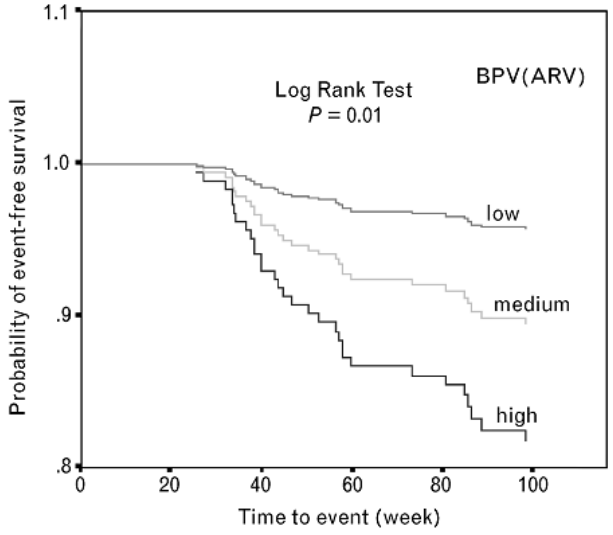
Short-term blood pressure variability is usually defined as the oscillation of blood pressure within 24 hours [13]. Fluctuation of blood pressure in a time range from minutes to hours mainly reflects the influence of central and autonomic modulation and the elastic properties of arteries [13]. In this way, the reduction of the ability of the arterial and cardiopulmonary reflexes to buffer changes in blood pressure due to behavioral or postural challenges and the alteration of arterial compliance can result in enhanced short-term BPV [13].

A myriad of indices have been used to assess short-term BPV in preclinical and clinical trials, including 24 hours, daytime and nighttime standard deviation (SD), and coefficient of variation (CV) of systolic and diastolic blood pressure [13]. As BPV largely depends from mean blood pressure values, average SD can be divided by the corresponding mean arterial pressure to normalize short-term BPV as CV [13]. Although estimation of short-term BPV theoretically requires continuous blood pressure recording, its assessment is also possible through the use of intermittent, noninvasive 24 h ambulatory blood pressure monitoring (ABPM) [13]. Nevertheless, due to the intermittent nature of blood pressure monitoring by ABPM, estimation of short-term BPV using this device is less accurate [13].

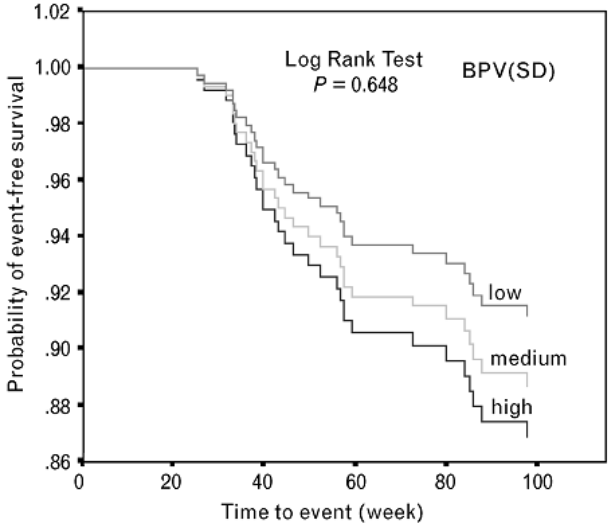
SD has been questioned as an appropriate index of short-term BPV, considering that SD only reflects the dispersion of values around the mean, does not account for the order in which BP measurements are obtained, and is sensitive to the low sampling frequency of ABPM [16]. In order to improve the prognostic value of short-term BPV, the average real variability (ARV) of daytime and nighttime BP has been introduced as a new index of BPV. ARV is the average of the absolute differences of consecutive measurements; therefore, this statistical parameter is sensitive to the individual BP measurement order and less sensitive to low sampling frequency of ABPM [16]. Different studies have shown that ARV better predicts cardiovascular risk in hypertensive patients in comparison to the traditional SD of short-term BPV [16, 17].

Index reliability





Event-free survival curves by groups according to blood pressure variability level measured using average real variability [BPV(ARV)].



Event-free survival curves by groups according to blood pressure variability level measured using standard deviation [BPV(SD)].

J Hypertens 2005;23:505-11.

Am J Hypertens. 2014 Jan;27(1):46-55. doi: 10.1093/ajh/hpt142. Epub 2013 Aug 16.

How many measurements are needed to estimate blood pressure variability without loss of prognostic information?

Mena LJ[1], Maestre GE, Hansen TW, Thijs L, Liu Y, Boggia J, Li Y, Kikuya M, Björklund-Bodegård K, Ohkubo T, Jeppesen J, Torp-Pedersen C, Dolan E, Kuznetsova T, Stolarz-Skrzypek K, Tikhonoff V, Malyutina S, Casiglia E, Nikitin Y, Lind L, Sandoya E, Kawecka-Jaszcz K, Filipovsky J, Lmai Y, Wang J, O'Brien E, Staessen JA; International Database on Ambulatory Blood Pressure in Relation to Cardiovascular Outcomes (IDACO) Investigators.

⊕ Author information

Abstract

BACKGROUND: Average real variability (ARV) is a recently proposed index for short-term blood pressure (BP) variability. We aimed to determine the minimum number of BP readings required to compute ARV without loss of prognostic information.

METHODS: ARV was calculated from a discovery dataset that included 24-hour ambulatory BP measurements for 1,254 residents (mean age = 56.6 years; 43.5% women) of Copenhagen, Denmark. Concordance between ARV from full (≥80 BP readings) and randomly reduced 24-hour BP recordings was examined, as was prognostic accuracy. A test dataset that included 5,353 subjects (mean age = 54.0 years; 45.6% women) with at least 48 BP measurements from 11 randomly recruited population cohorts was used to validate the results.

RESULTS: In the discovery dataset, a minimum of 48 BP readings allowed an accurate assessment of the association between cardiovascular risk and ARV. In the test dataset, over 10.2 years (median), 806 participants died (335 cardiovascular deaths, 206 cardiac deaths) and 696 experienced a major fatal or nonfatal cardiovascular event. Standardized multivariable-adjusted hazard ratios (HRs) were computed for associations between outcome and BP variability. Higher diastolic ARV in 24-hour ambulatory BP recordings predicted ($P < 0.01$) total (HR = 1.12), cardiovascular (HR = 1.19), and cardiac (HR = 1.19) mortality and fatal combined with nonfatal cerebrovascular events (HR = 1.16). Higher systolic ARV in 24-hour ambulatory BP recordings predicted ($P < 0.01$) total (HR = 1.12), cardiovascular (HR = 1.17), and cardiac (HR = 1.24) mortality.

CONCLUSIONS: Forty-eight BP readings over 24 hours were observed to be adequate to compute ARV without meaningful loss of prognostic information.

Blood Press Monit. 2014 Apr;19(2):98-102. doi: 10.1097/MBP.0000000000000019.

Blood pressure variability of two ambulatory blood pressure monitors.

Kallem RR[1], Meyers KE, Cucchiara AJ, Sawinski DL, Townsend RR.

Author information

Abstract

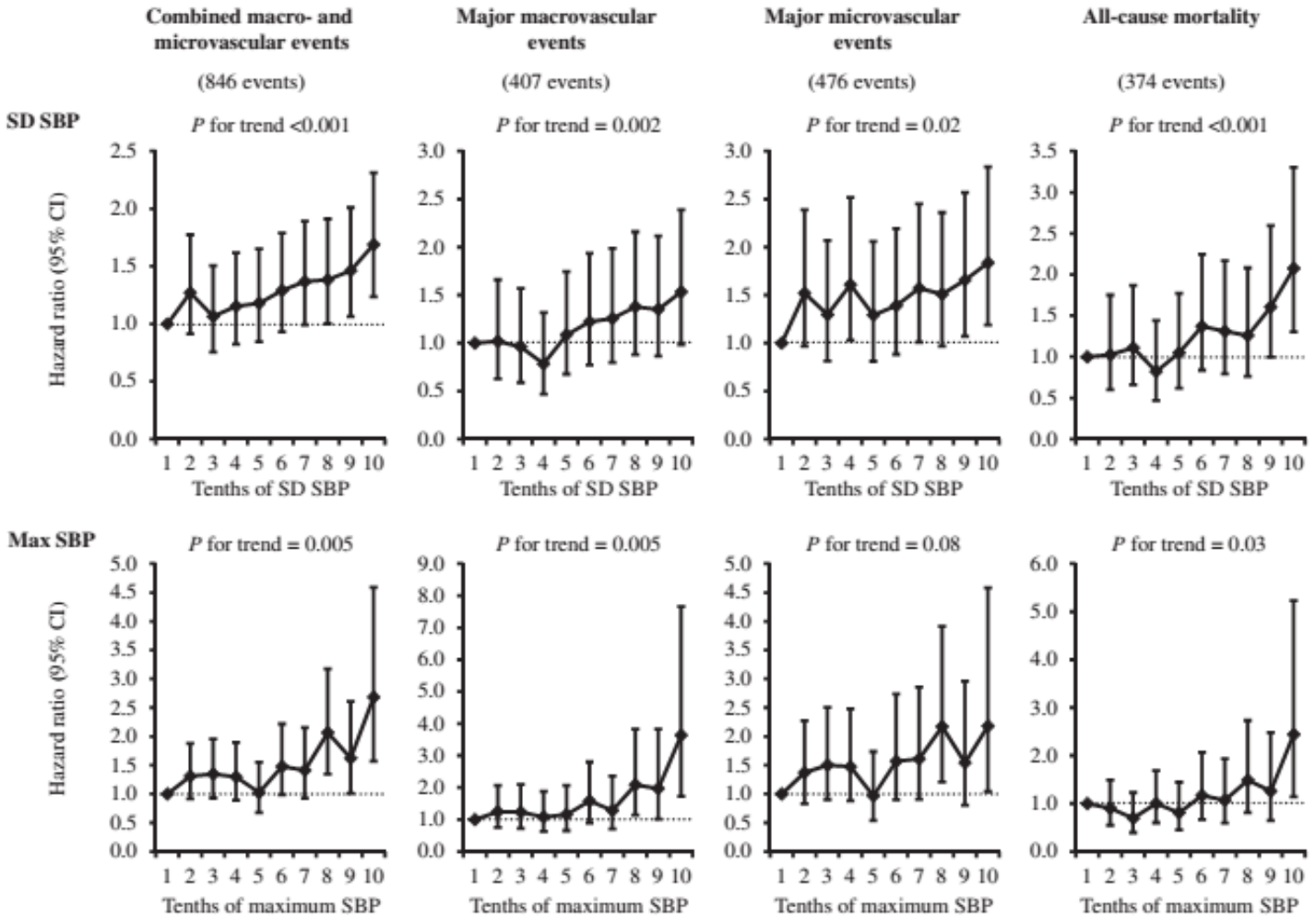
OBJECTIVE: There are no data on the evaluation of blood pressure (BP) variability comparing two ambulatory blood pressure monitoring monitors worn at the same time. Hence, this study was carried out to compare variability of BP in healthy untreated adults using two ambulatory BP monitors worn at the same time over an 8-h period.

METHODS: An Accutorr device was used to measure office BP in the dominant and nondominant arms of 24 participants.Simultaneous 8-h BP and heart rate data were measured in 24 untreated adult volunteers by Mobil-O-Graph (worn for an additional 16 h after removing the Spacelabs monitor) and Spacelabs with both random (N=12) and nonrandom (N=12) assignment of each device to the dominant arm. Average real variability (ARV), SD, coefficient of variation, and variation independent of mean were calculated for systolic blood pressure, diastolic blood pressure, mean arterial pressure, and pulse pressure (PP).

RESULTS: Whether the Mobil-O-Graph was applied to the dominant or the nondominant arm, the ARV of mean systolic (P=0.003 nonrandomized; P=0.010 randomized) and PP (P=0.009 nonrandomized; P=0.005 randomized) remained significantly higher than the Spacelabs device, whereas the ARV of the mean arterial pressure was not significantly different. The average BP readings and ARVs for systolic blood pressure and PP obtained by the Mobil-O-Graph were considerably higher for the daytime than the night-time.

CONCLUSION: Given the emerging interest in the effect of BP variability on health outcomes, the accuracy of its measurement is important. Our study raises concerns about the accuracy of pooling international ambulatory blood pressure monitoring variability data using different devices.

Independent risk factors for macrovascular and microvascular complication in type 2 diabetes



Circulation 2013;128:1325-34.