# BP VARIABILITY ROLE IN PREDICTION OF ADVERSE CV OUTCOMES

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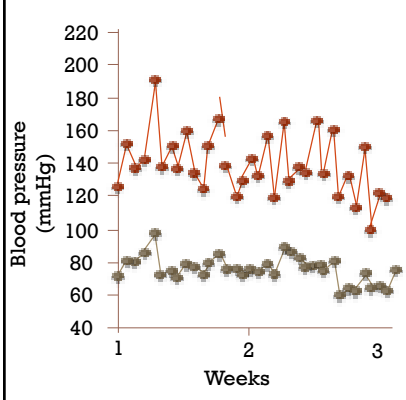
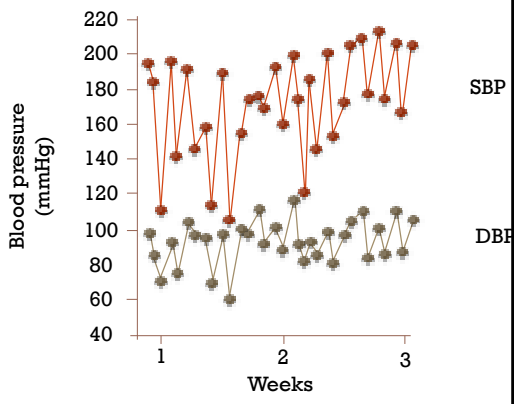
## INTRODUCTION

- BPV is a physiological CVS characteristic
- BP shows marked spontaneous oscillations over:
  - short-term (minutes to days)
  - long-term (month) periods

# DIFFERENCES BETWEEN INDIVIDUALS IN THE EXTENT OF BPV BETWEEN READINGS OVER TIME




Patient 1 with lower BPV




Patient 2 with higher BPV

Rothwell PM. *Lancet*. 2010;375:938-948.

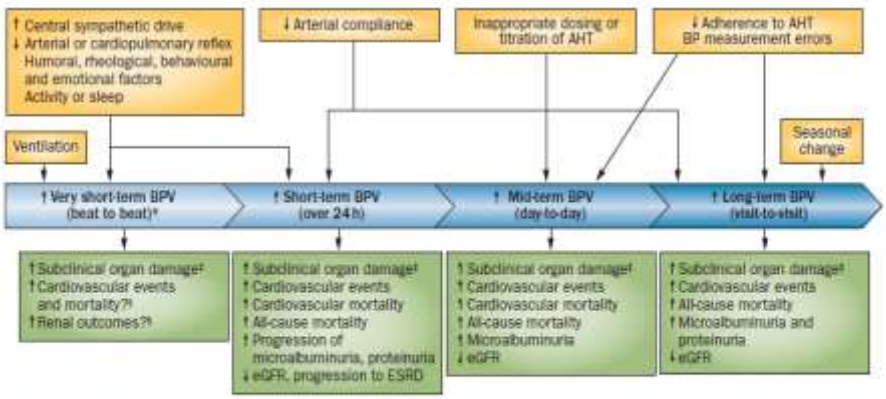
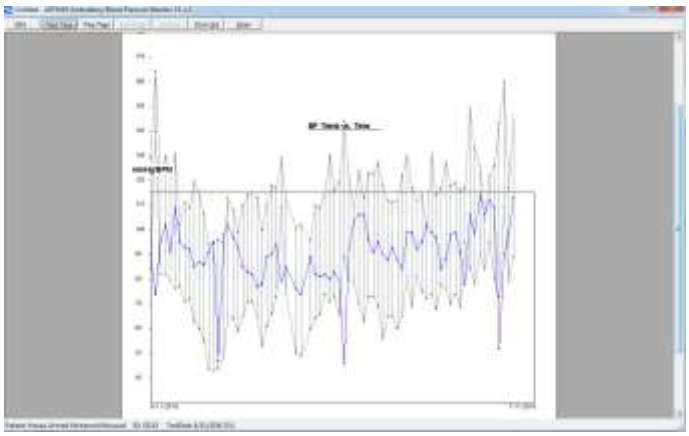



**Figure 1** | Various types of BPV, their determinants, and prognostic relevance for cardiovascular and renal outcomes. *Assessed in laboratory conditions; ‡cardiac, vascular, and renal subclinical organ damage; §BPV on a beat-to-beat basis has not been routinely measured in population studies. Abbreviations: AHT, antihypertensive treatment; BP, blood pressure; BPV, blood-pressure variability; ESRD, end-stage renal disease; eGFR, estimated glomerular filtration rate. Springer and *Current Hypertension Reports*, **14** (5), 2012, 421–431, Blood pressure variability, cardiovascular risk, and risk for renal disease progression, Parati, G., Ochoa, J. E. & Bilo, G. with kind permission from Springer Science and Business Media.

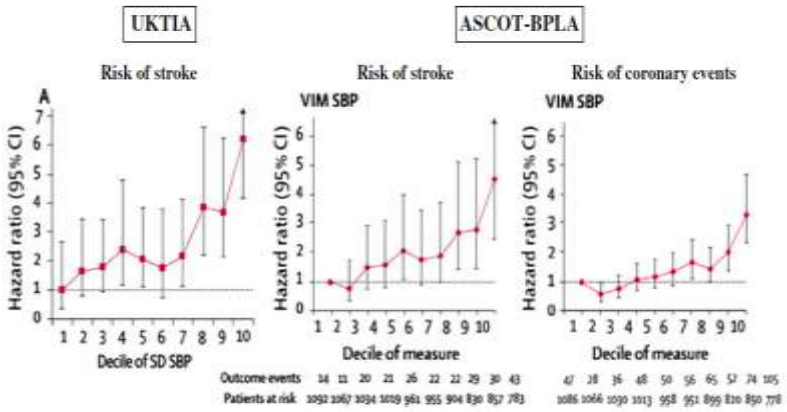
# ABPM

# WCH



# IS BPV IMPORTANT???

# VISIT-TO-VISIT VARIABILITY AND RISK OF STROKE AND CORONARY EVENTS IN UK-TIA AND ASCOT-BPLA




*Rothwell PM et al., Lancet 2010; 375: 895-905*

Table 4: Short-term blood pressure variability and target organ damage and cardiovascular events in patients.

| Study | Study population | Blood pressure variability index | Outcome |
|---|---|---|---|
| Parati et al. [24] | Hospitalized subjects with essential hypertension | 24 h BPV | Increase rate and severity of TOD |
| Palatini et al. [26] | Patients with mild to severe hypertension | Daytime systolic BPV | Higher degree of retinal abnormalities |
| Mancia et al. [27] | Hypertensive patients | 24 h systolic BPV | Increase in carotid intima-media thickness |
| Sega et al. [28] | General population | Overall and residual short-term BPV | Left ventricular mass index |
| Sander et al. [29] | General population | Daytime systolic BPV | Progression of intima-media wall thickness |
| McMullan et al. [30] | Patient with chronic kidney disease | Systolic BPV | Increased overall and cardiovascular mortality |
| Kawai et al. [31] | Hypertensive patients | Daytime systolic BPV<br>Nighttime systolic BPV | Increased renal vascular resistance<br>Increased intima-media thickness and plaque score |
| Iwata et al. [32] | Hypertensive patients | Nighttime systolic BPV | Large arch plaque |
| Schillaci et al. [33] | Hypertensive patients | 24 h BPV | Aortic stiffness |
| Cay et al. [34] | Normotensive patients | Systolic and diastolic 24 h BPV | Higher risk of restenosis after percutaneous coronary intervention |
| Schutte et al. [35] | Normotensive Africans | 24 h systolic BPV | Left ventricular hypertrophy |
| Ozawa et al. [36] | Patients with type 2 diabetes | Nighttime systolic and diastolic BPV | Increased risk of incident cardiovascular disease |
| Sakakura et al. [37] | Elderly patients | Daytime systolic BPV | Cognitive dysfunction and reduction in quality of life |

Table 5: Long-term blood pressure variability and target organ damage and cardiovascular events in patients.

| Study | Study population | Blood pressure variability index | Outcome |
|---|---|---|---|
| Kikuya et al. [50] | General population | Day-to-day systolic BPV | Increased hazard ratios for cardiovascular and stroke mortality |
| Muntner et al. [51] | General population | Visit-to-visit systolic BPV | Increased all-cause mortality |
| Johansson et al. [52] | General population | Day-to-day morning systolic BPV | Increased rate of cardiovascular events |
| Hsieh et al. [53] | Patients with type 2 diabetes | Visit-to-visit systolic and diastolic BPV | Increased all-cause mortality |
| Ushigome et al. [54] | Patients with type 2 diabetes | Day-to-day systolic and diastolic BPV | Development of macroalbuminuria |
| Kilpatrick et al. [55] | Patients with type 1 diabetes | Annual visit-to-visit BPV | Development or progression of nephropathy |
| Di Iorio et al. [56] | Subjects with chronic renal failure | Visit-to-visit systolic BPV | Elevated risk of death |
| Yokota et al. [57] | Patients with nondiabetic chronic kidney disease | Visit-to-visit systolic BPV | Deterioration of renal function |
| Di Iorio et al. [58] | Patients with end stage renal disease under hemodialysis | Dialysis-to-dialysis BPV | Increased cardiovascular mortality |

RESEARCH

OPEN ACCESS

# Blood pressure variability and cardiovascular disease: systematic review and meta-analysis

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**ABSTRACT**

**OBJECTIVE**

To systematically review studies quantifying the associations of long term (clinic), mid-term (home), and short term (ambulatory) variability in blood pressure, independent of mean blood pressure, with cardiovascular disease events and mortality.

**DATA SOURCES**

Medline, Embase, Cinahl, and Web of Science, searched to 15 February 2016 for full text articles in English.

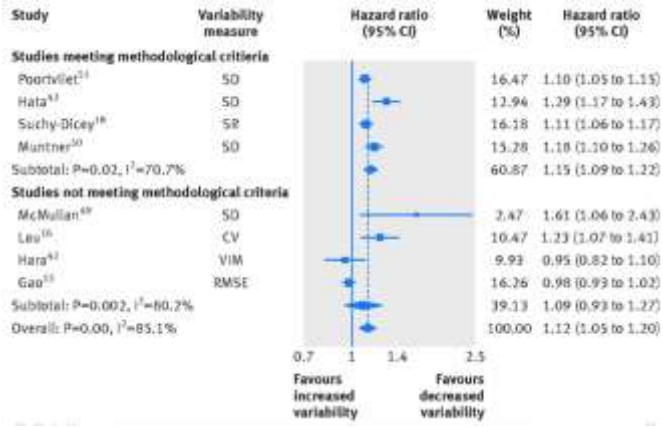
**ELIGIBILITY CRITERIA FOR STUDY SELECTION**

Prospective cohort studies or clinical trials in adults, mortality (hazard ratio 1.15, 95% confidence interval 1.09 to 1.22), cardiovascular disease mortality (1.18, 1.09 to 1.28), cardiovascular disease events (1.18, 1.07 to 1.30), coronary heart disease (1.10, 1.04 to 1.16), and stroke (1.15, 1.04 to 1.27). Increased mid-term and short term variability in daytime systolic blood pressure were also associated with all cause mortality (1.15, 1.06 to 1.26 and 1.10, 1.04 to 1.16, respectively).

**CONCLUSIONS**

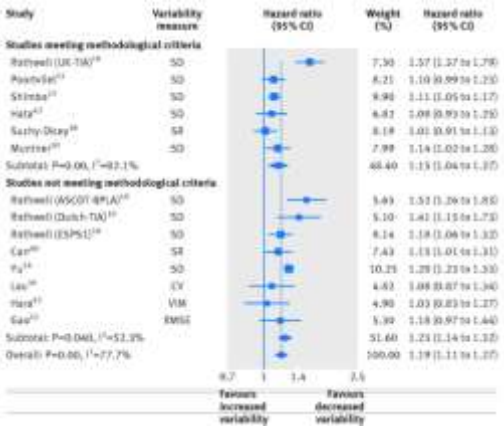
Long term variability in blood pressure is associated with cardiovascular and mortality outcomes, over and above the effect of mean blood pressure. Associations are similar in magnitude to those of cholesterol

# CLINIC BPV EFFECT ALL CAUSE MORTALITY



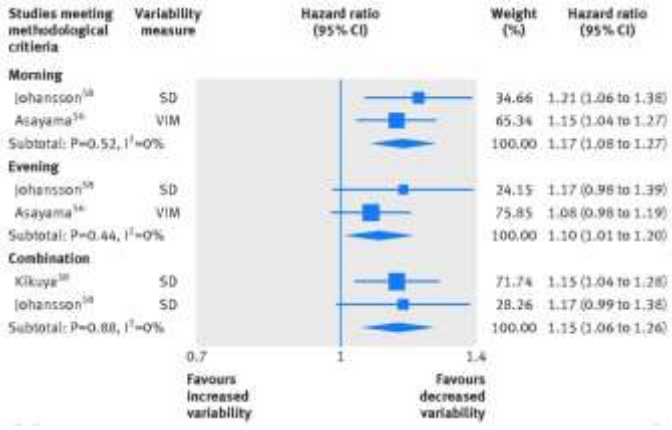

*Stevens et al., BMJ 2016; 354:i4098*

# CLINIC BPV EFFECT
# STROKE



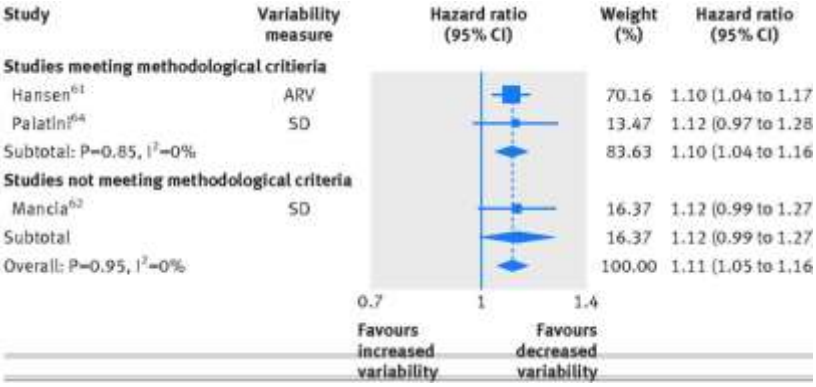

*Stevens et al., BMJ 2016; 354:i4098*

# HOME BPV EFFECT
# ALL CAUSE MORTALITY




*Stevens et al., BMJ 2016; 354:i4098*

# ABPM BPV EFFECT
# ALL CAUSE MORTALITY




*Stevens et al., BMJ 2016; 354:i4098*

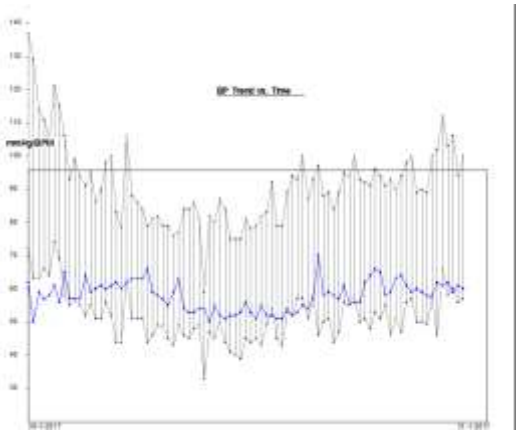
# CIRCADIAN VARIABILITY OF BP

- Beat-to-beat variability

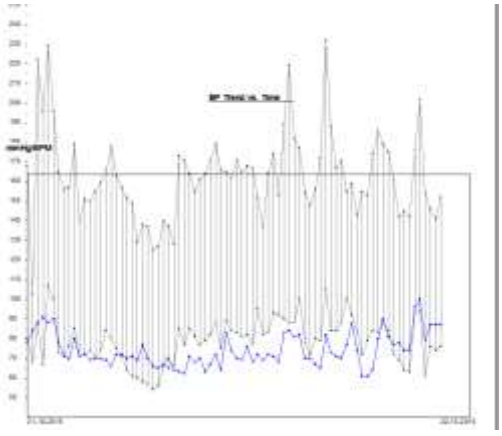
- Day-to-night variability
  - Dippers
  - Non-dippers
  - Reverse dippers/risers
  - Excessive dippers

- Night-to-day variability: morning surge

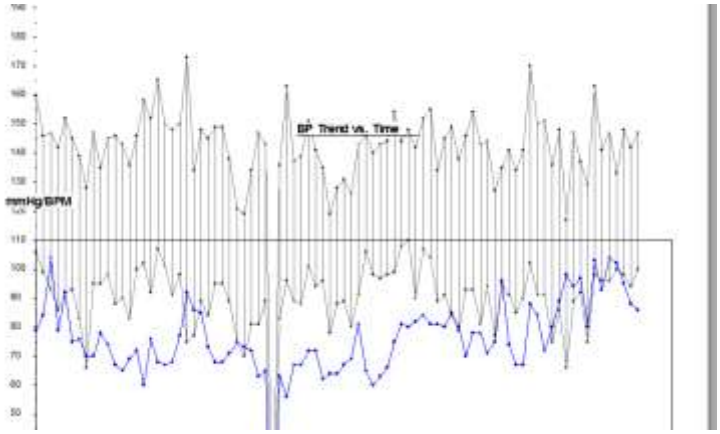
# NORMAL ABPM
# DIPPER
# NORMAL BPV



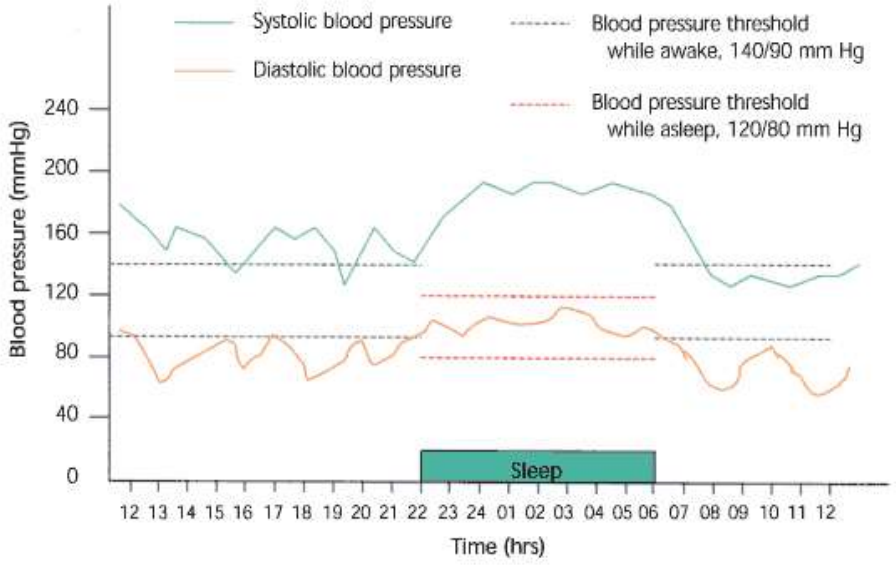
# HYPERTENSIVE TRACING
# HIGH BPV
# DIPPER

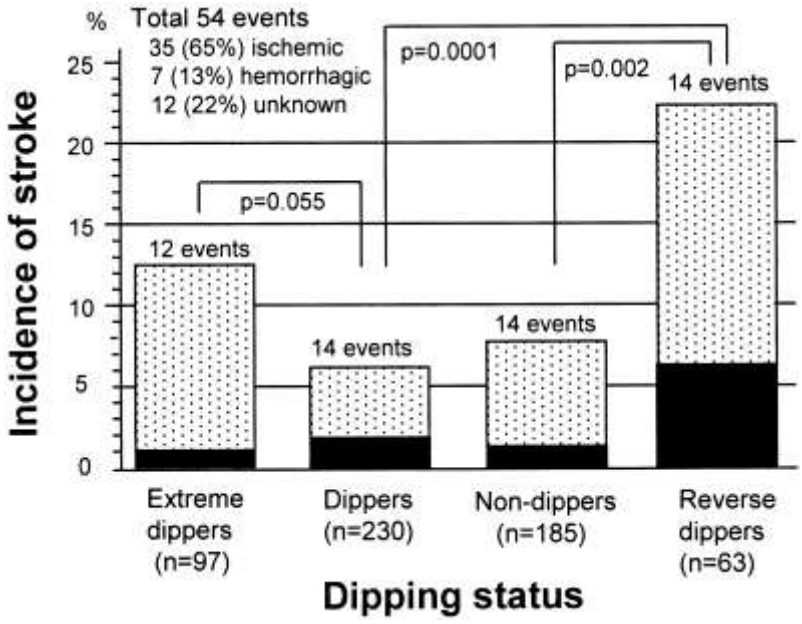


# HYPERTENSIVE NON-DIPPER LOW BPV



# HYPERTENSIVE TRACING REVERSE DIPPER





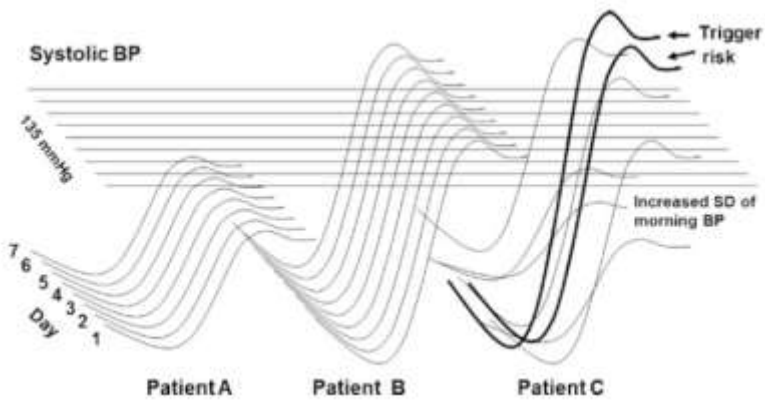
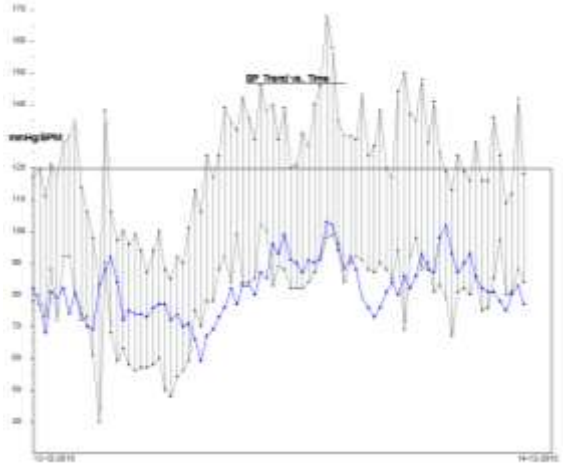
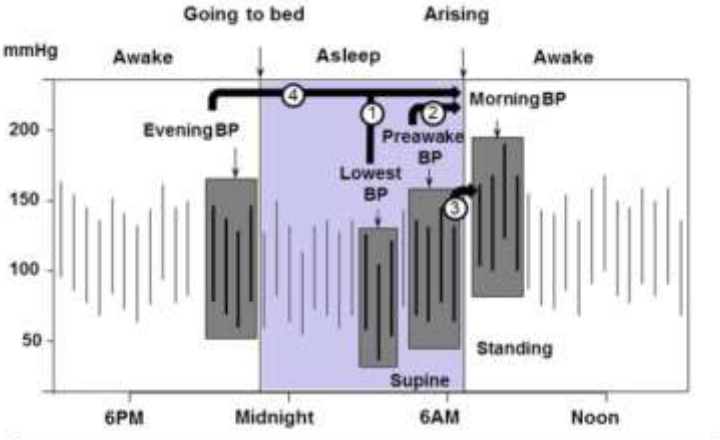




**Fig. 7.6 Reproducibility of morning blood pressure surge and cardiovascular risk. Patient A exhibits an appropriate morning surge; patient B exhibits a reproducible exaggerated surge; patient C exhibits an exaggerated variability of morning surge (irreproducible). BP blood pressure, SD standard deviation.**

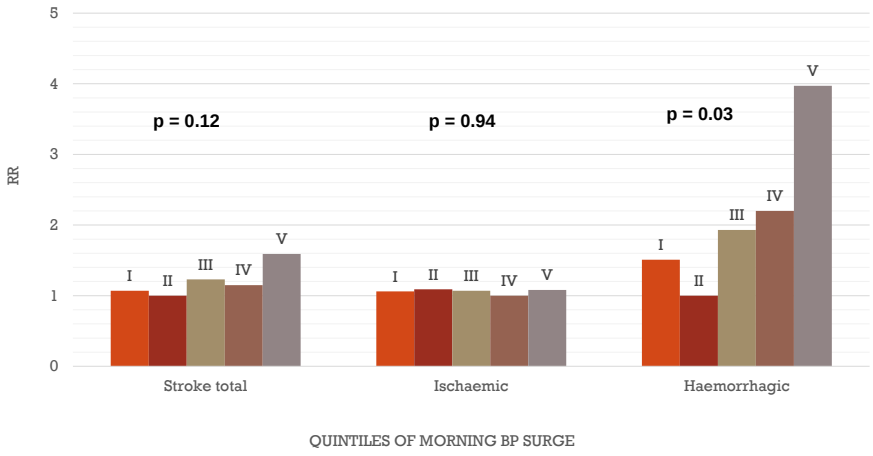
# MORNING SURGE






*Kazuomi Kario, In Special Issues in Hypertension, 2012, A. Berbari and G. Mancia*

## Relation Between Risk of Stroke and Morning BP Surge In The Ohasama Study




Metoki et al. Hypertension 2006

## Effect Of Antihypertensive Drugs On Short Term HRV

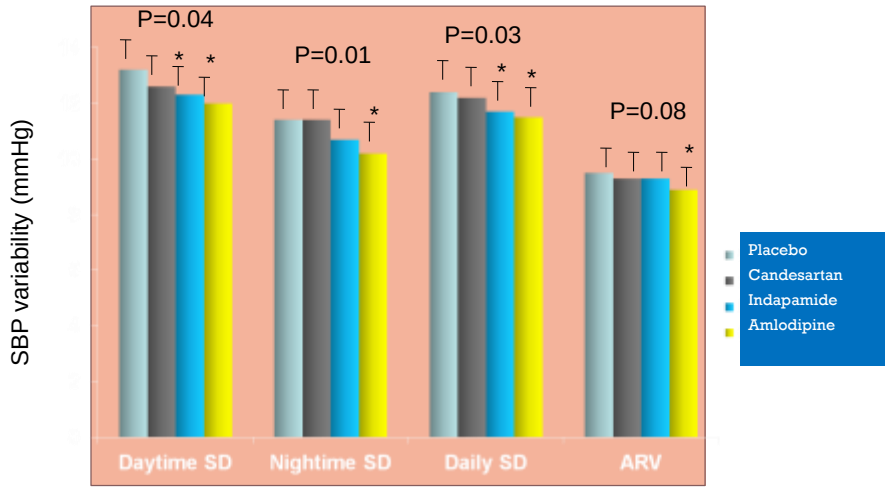
In the ASCOT BPLA:

- Short-term BPV was lower in the amlodipine group than in the atenolol group.

Effect of Antihypertensive Agents on Blood Pressure Variability

The Nutrilic SR Versus Candesartan and Amlodipine in the Reduction of Systolic Blood Pressure in Hypertensive Patients (X-CELLENT) Study

# MRC trial




*Yi Zhang, et al. Hypertension. 2011;58:155-160.*

# Meta-analysis

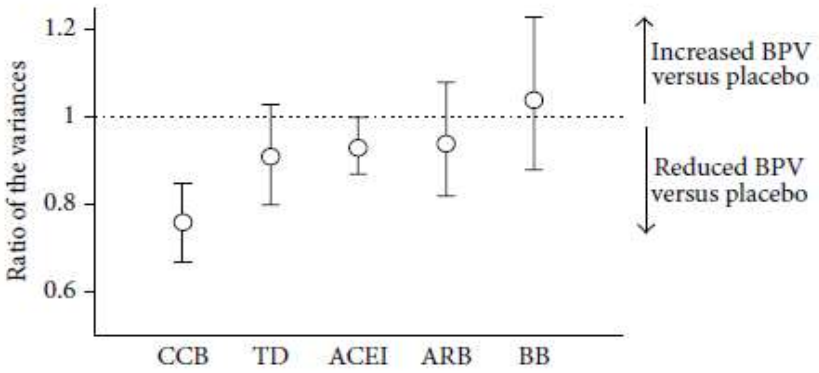
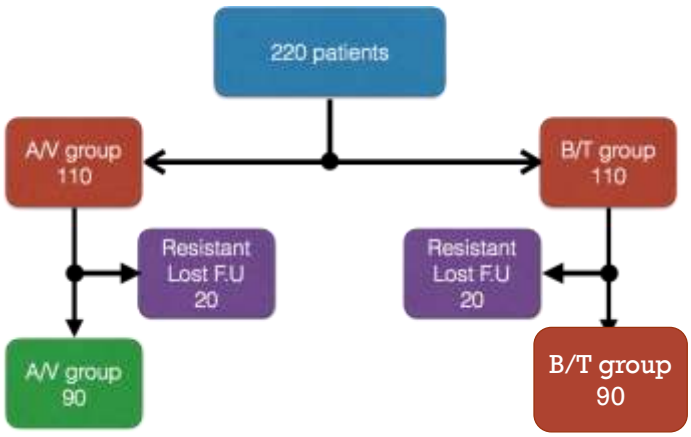



FIGURE 3: Meta-analysis of antihypertensive drug effects on long-term BPV. CCB: calcium channel blockers; TD: thiazide-like diuretics; ACEI: angiotensin converting enzyme inhibitors; ARB: angiotensin receptor blockers; BB: beta blockers. Adapted from Webb et al. [81].

NASSER TAHA, SAYED SHEHATA AND MAHMOUD ABU-ZEID, 2017

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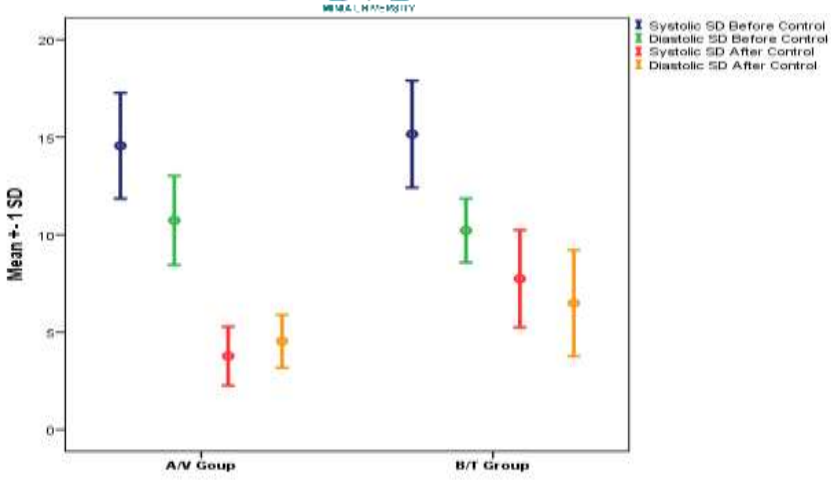

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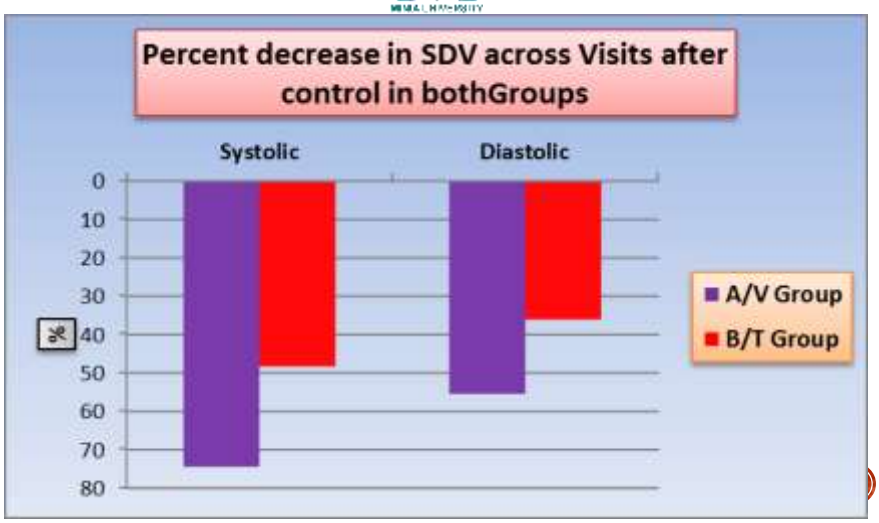


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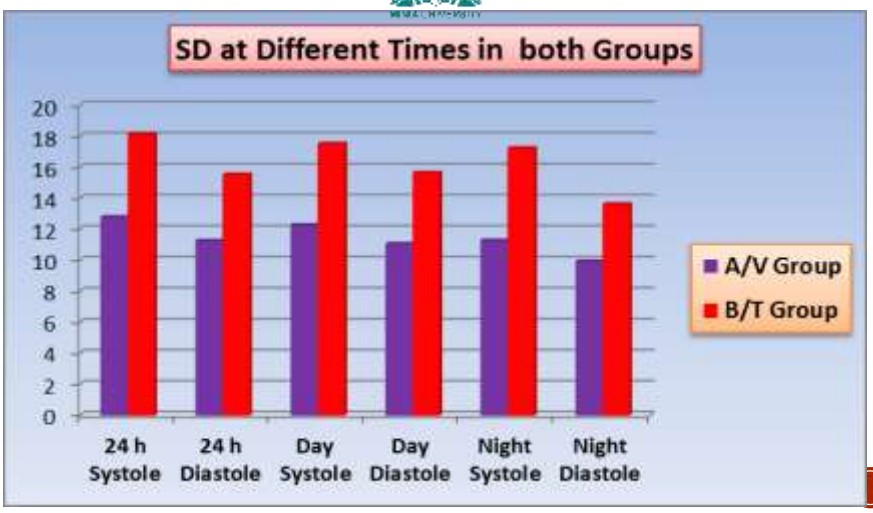

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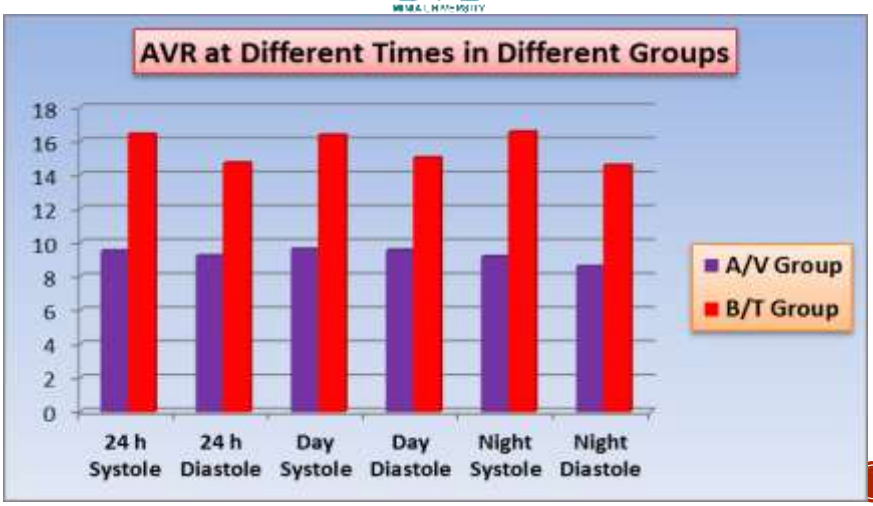


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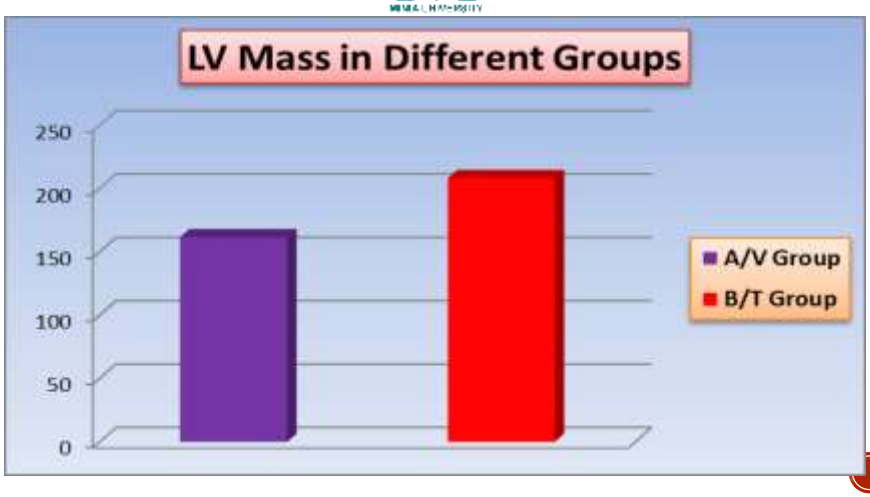

# POINTS TO REMEMBER

- BPV is independently associated with the development, progression, and severity of
  - Cardiac MACE
  - Vascular MACE
  - renal damage
  - increased risk of stroke
    - increased risk of mortality
- Antihypertensive agents have different effects on BPV
- CCB/ARB seems more effective in reducing BPV than BB/HCT
- Whether reducing BPV improves outcome needs verification

Thank you

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