Les différentes mesures de la PA

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PARIS DESCARTES

DISCLOSURE

Stéphane LAURENT, MD, PhD

Potential conflict of interest
Research grant, advisory board, honorarium as speaker or chairman

Manufacturers

ALAM MEDICAL
ATCOR-HOGIMED
AXELIFE
ESAOTE-PIE MEDICAL
FUKUDA-DENSHI
HEMO SAPIENS
OMRON
TENSIOMED

Les différentes mesures de la PA

- PA humérale/brachiale
  - au cabinet de consultation
  - en ambulatoire: MAPA
  - au domicile: automesure

- PA centrale
  - au cabinet de consultation?
  - en salle d'investigation clinique
  - en ambulatoire

Les différentes mesures de la PA

- ❑ PA humérale/brachiale
  - o au cabinet de consultation
  - o en ambulatoire: MAPA
  - o au domicile: automesure
- ❑ PA centrale
  - o au cabinet de consultation?
  - o en salle d'investigation clinique
  - o en ambulatoire

- ✓ PAS, PAD, PAM, PP
- ✓ Variabilité
  - ▪ Intravisite / 24h
  - ▪ Intervisite

Les différentes mesures de la PA

- PA au cabinet de consultation
- Variabilité
- PA centrale

Les différentes mesures de la PA

- **Quelle PA au cabinet de consultation?**
- Quelle variabilité?
- Quelle PA centrale?

2013 ESH/ESC Guidelines for the management of arterial hypertension

Usual BP: mean of office BP readings over several visits

3.1 Bood pressure measurement

3.1.1 Office or clinic blood pressure

At present, BP can no longer be estimated using a mercury sphygmomanometer in many—although not all—European countries. Auscultatory or oscillometric semiautomatic sphygmomanometers are used instead. These devices should be validated according to standardized protocols and their accuracy should be checked periodically through calibration in a technical laboratory.

2013 ESH/ESC Guidelines for the management of arterial hypertension

In elderly subjects, diabetic patients and in other conditions in which orthostatic hypotension may be frequent or suspected, it is recommended that BP be measured 1 min and 3 min after assumption of the standing position. Orthostatic hypotension—defined as a reduction in SBP of ≥20 mmHg or in DBP of ≥10 mmHg within 3 min of standing—has been shown to carry a worse prognosis for mortality and CV events.

2013 ESH/ESC Guidelines for the management of arterial hypertension

If feasible, automated recording of multiple BP readings in the office with the patient seated in an isolated room, though providing less information overall, might be considered as a means to improve reproducibility and make office BP values closer to those provided by daytime ABPM or HBPM,

Office BP

Médecin
Auscult. Sphygmoman.

Médecin
Mes. oscillométrique

Infirmière
Mes. oscillométrique

Patient seul
Mes. oscillométrique

Office BP

Médecin
Auscult. Sphygmoman.

Médecin
Mes. oscillométrique

Infirmière
Mes. oscillométrique

Patient seul
Mes. oscillométrique

Use of automated office blood pressure measurement to reduce the white coat response

Martin G. Myers[a,c], Miguel Valdivieso[a] and Alexander Kiss[b]

Myers M et al. J Hypertens 2009

	Mean blood pressure			
Blood pressure measure	Systolic BP	*P*	Diastolic BP	*P*
Automated BpTRU office BP	132 ± 19	0.01	75 ± 12	<0.001
Manual technician office BP	140 ± 17	<0.001	80 ± 11	<0.001
Family physician routine office BP	152 ± 18	<0.001	87 ± 11	<0.001
Mean awake ABP (reference)	134 ± 13	–	77 ± 10	–

Office BP

Médecin
Auscult. Sphygmoman.

Médecin
Mes. oscillométrique

Infirmière
Mes. oscillométrique

Patient seul
Mes. oscillométrique

Très grande majorité des études

- physiopathologiques
- épidémiologiques
- pharmacologiques
- grands essais thérapeutiques

Restera toujours la PA privilégiée par les recommandations internationales

Office BP

Médecin
Auscult. Sphygmoman.

Médecin
Mes. oscillométrique

Infirmière
Mes. oscillométrique

Unobserved/ unattended automated BP measurement

Δ = 8-10 mmHg

Δ = 8-10 mmHg

Δ = 16-20 mmHg

SPRINT study

ORIGINAL ARTICLE

A Randomized Trial of Intensive versus Standard Blood-Pressure Control

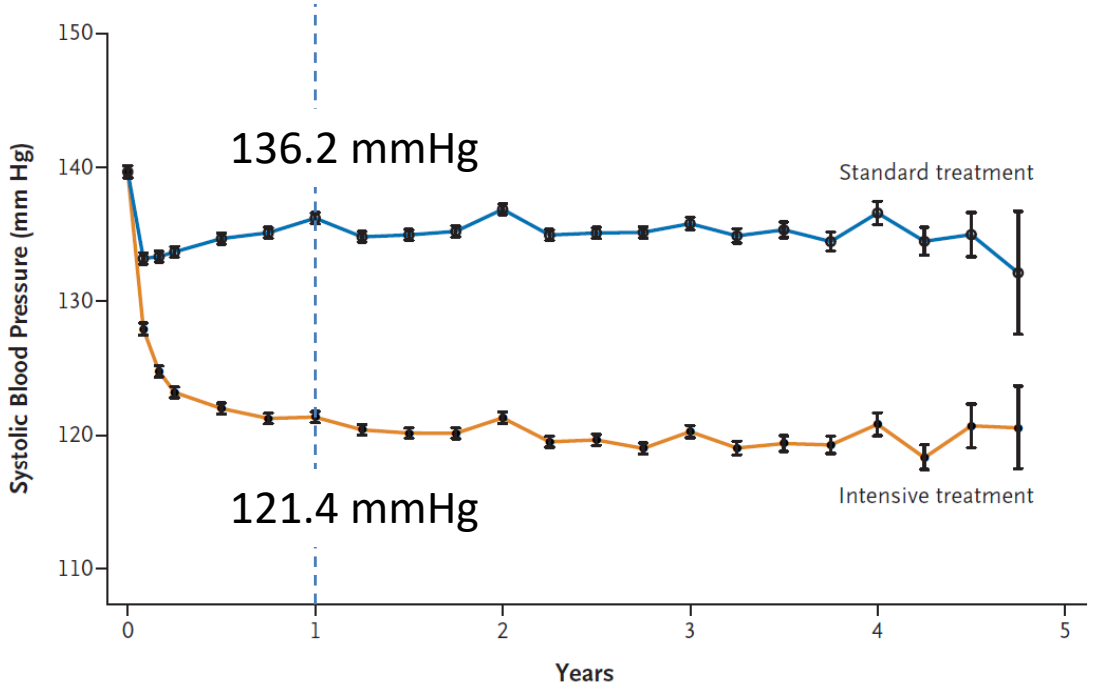
The SPRINT Research Group*

Unobserved/unattended automated BP measurement

NEJM 2015

n=9360

Target SBP
< 140 mmHg
vs
< 120 mmHg



No. with Data										
Standard treatment	4683	4345	4222	4092	3997	3904	3115	1974	1000	274
Intensive treatment	4678	4375	4231	4091	4029	3920	3204	2035	1048	286
Mean No. of Medications										
Standard treatment	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9
Intensive treatment	2.3	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3.0

SPRINT study

ORIGINAL ARTICLE

A Randomized Trial of Intensive versus Standard Blood-Pressure Control

The SPRINT Research Group*

NEJM 2015

Outcome	Intensive Treatment		Standard Treatment		Hazard Ratio (95% CI)	P Value
	no. of patients (%)	*% per year*	*no. of patients (%)*	*% per year*		
All participants	**(N=4678)**		**(N=4683)**			
Primary outcome†	243 (5.2)	1.65	319 (6.8)	2.19	0.75 (0.64–0.89)	<0.001
Secondary outcomes						
Myocardial infarction	97 (2.1)	0.65	116 (2.5)	0.78	0.83 (0.64–1.09)	0.19
Acute coronary syndrome	40 (0.9)	0.27	40 (0.9)	0.27	1.00 (0.64–1.55)	0.99
Stroke	62 (1.3)	0.41	70 (1.5)	0.47	0.89 (0.63–1.25)	0.50
Heart failure	62 (1.3)	0.41	100 (2.1)	0.67	0.62 (0.45–0.84)	0.002
Death from cardiovascular causes	37 (0.8)	0.25	65 (1.4)	0.43	0.57 (0.38–0.85)	0.005
Death from any cause	155 (3.3)	1.03	210 (4.5)	1.40	0.73 (0.60–0.90)	0.003
Primary outcome or death	332 (7.1)	2.25	423 (9.0)	2.90	0.78 (0.67–0.90)	<0.001

Unobserved automated office blood pressure measurement in the Systolic Blood Pressure Intervention Trial (SPRINT): systolic blood pressure treatment target remains below 140 mmHg

Kjeldsen and Mancia. EHJ 2016

Sverre E. Kjeldsen[1]* and Giuseppe Mancia[2]

Table. Automated/Semiautomated Devices Used for Measurements of Blood Pressure in Large Outcome Trials That Have Used the Automated Office Blood Pressure Measurement Technique

Trial	Device	Status of Observation	References
ACCORD	Model 907, Omron Healthcare, Lake Forest, IL	Attended	The ACCORD Study Group[2]
SPS3	Colin BP-8800C, Press Mate, Meena Medical Inc, Bedford, TX	Attended	The SPS3 Study Group[3]
SPRINT	Model 907, Omron Healthcare, Lake Forest, IL	Unattended	The SPRINT Research Group[7]
HOT	Visomat OZ, D2 International, Hestia Pharma GmbH, Germany	Attended	Hansson et al[9]
TROPHY	HEM-705CP, Omron Healthcare, Lake Forest, IL	Attended	Julius et al[19]
ONTARGET	HEM-757, Omron Corporation, Tokyo, Japan	Attended	Verdecchia et al[20]
TRANSCEND	HEM-757, Omron Corporation, Tokyo, Japan	Attended	Verdecchia et al[20]

Unattended vs attended: 10-20 mmHg difference in SBP

SPRINT study

ORIGINAL ARTICLE

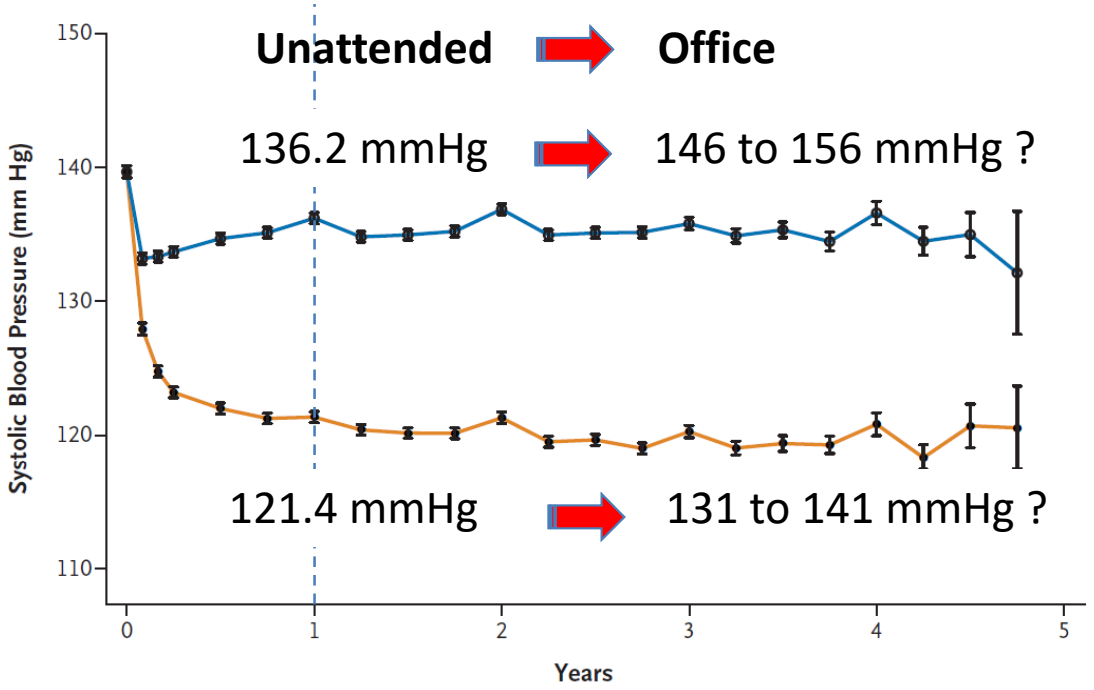
A Randomized Trial of Intensive versus Standard Blood-Pressure Control

NEJM 2015

n=9360

Target SBP
< 140 mmHg
vs
< 120 mmHg

What is the true « office » achieved SBP ?



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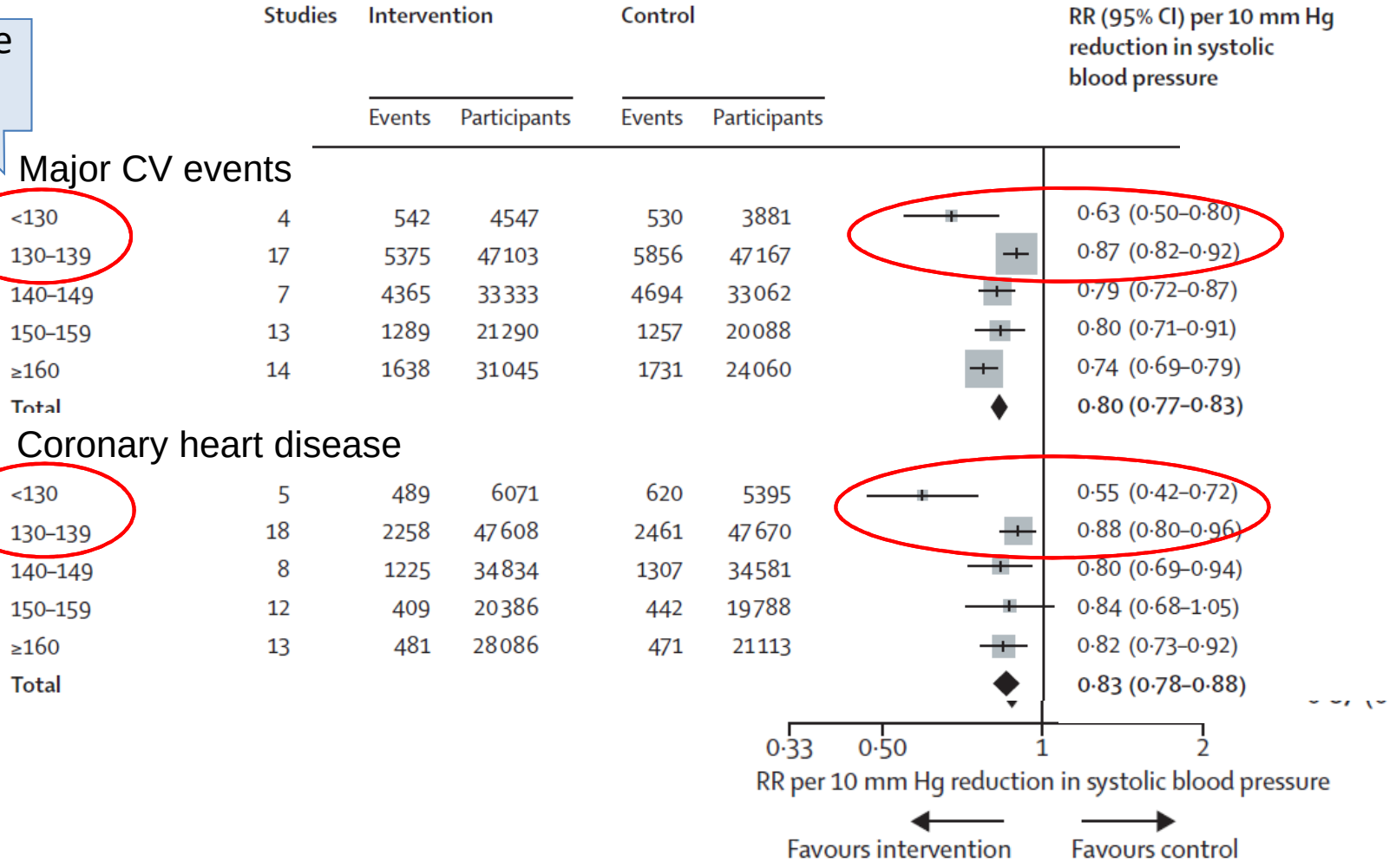
Blood pressure lowering for prevention of cardiovascular disease and death: a systematic review and meta-analysis

Dena Ettehad, Connor A Emdin, Amit Kiran, Simon G Anderson, Thomas Callender, Jonathan Emberson, John Chalmers, Anthony Rodgers, Kazem Rahimi

Ettehad D et al. Lancet 2015

It is safe to lower SBP below 130 mmHg

Baseline SBP



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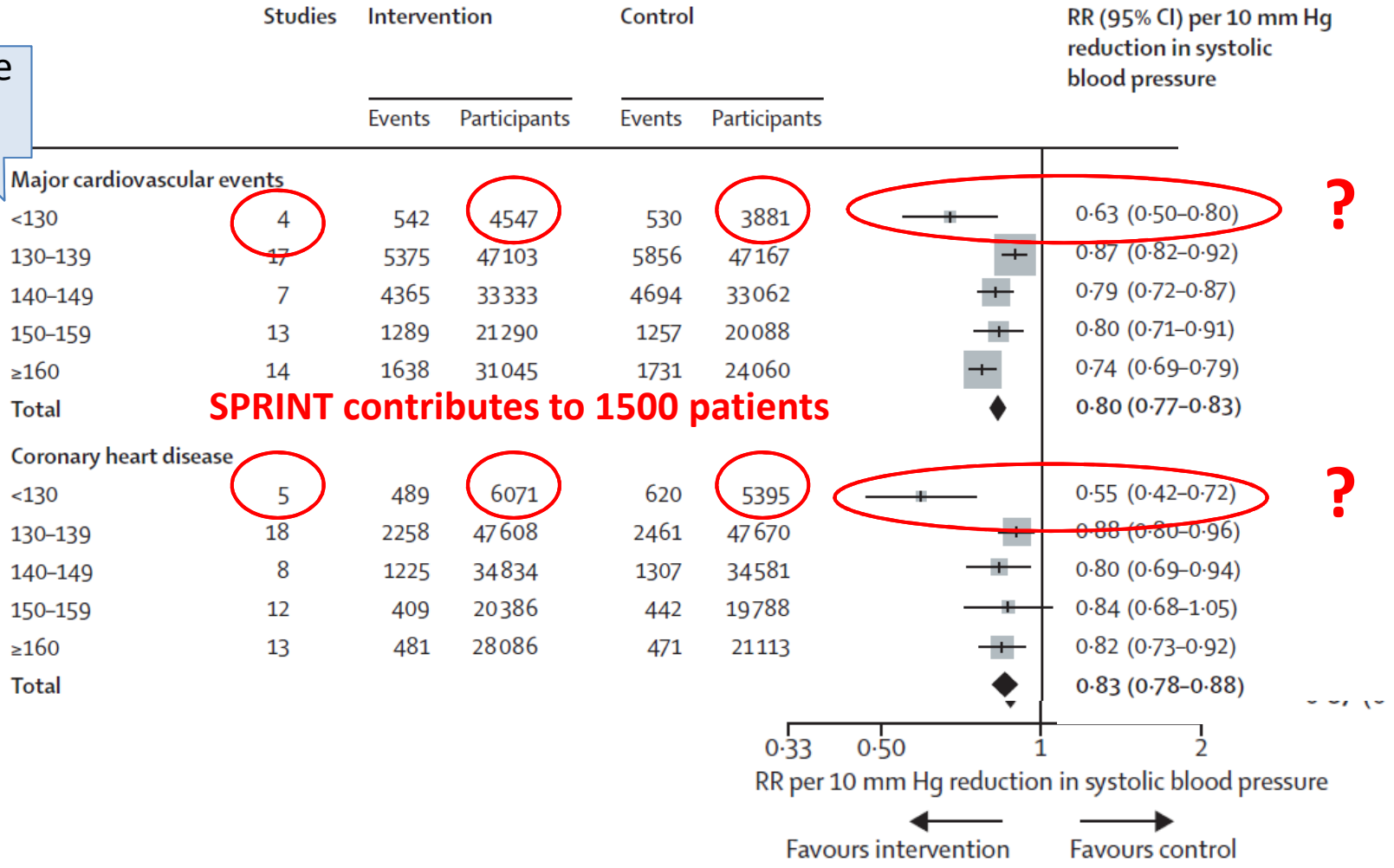


SPRINT contributes to 1500 patients

?

?

Les différentes mesures de la PA

- Quelle PA au cabinet de consultation?
- **Quelle variabilité?**
- Quelle PA centrale?

How to Best Assess Blood Pressure?

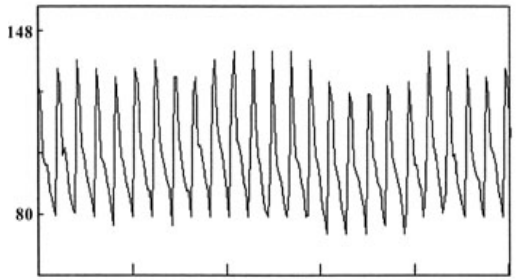
The Ongoing Debate on the Clinical Value of Blood Pressure Average and Variability

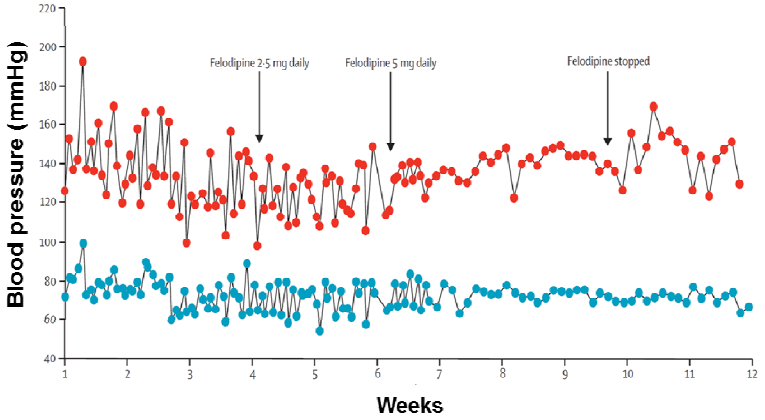
George S. Stergiou, Gianfranco Parati

Stergiou et al. Hypertension 2012

Parati G, Bilo G. Hypertension 2012

Very short term (beat-by-beat) *	Short term (24 h)	BPV	Day-by-day	Visit-to-visit





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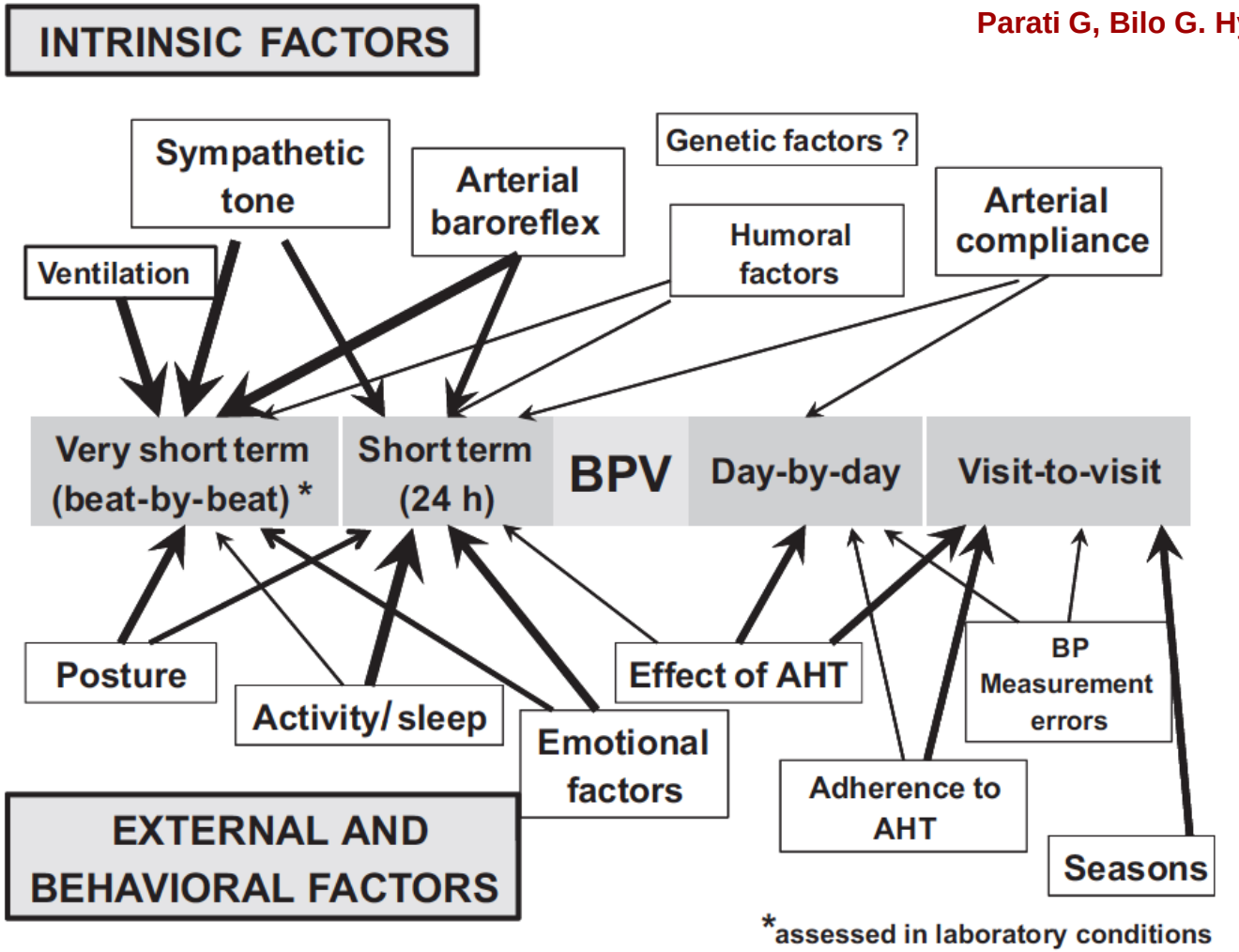

BP variability

24h BP variability
- is associated with target organ damage [1]
- is associated (a residual component) with CV mortality in a general population [2]

1.Parati et al. J Hypertens 1987
2.Mancia et al. Hypertension 2007

Very short term (beat-by-beat) *	Short term (24 h)	BPV	Day-by-day	Visit-to-visit

Methods

1. SD (day-SD, night-SD)

2. Weighted 24h BP SD = SD ***/*** duration (hours) of each time period

3. Average real variability (ARV), with N=nb of valid measurements

$$ARV = \frac{1}{N-1} \sum_{k=1}^{N-1} |BP_{k+1} - BP_k|$$

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Very short term (beat-by-beat) *	Short term (24 h)	BPV	Day-by-day	Visit-to-visit

Day-by-day variability in home SBP
- is associated with target organ damage [1-2]
- is associated with CV mortality in a general population [3]

1.Matsui et al. Hypertension 2011;
2.Ushigome et al. Hypertens Res 2011
3.Kikuya et al. Hypertension 2008

BP variability

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Day-by-day
-is associat
-is associat
population [

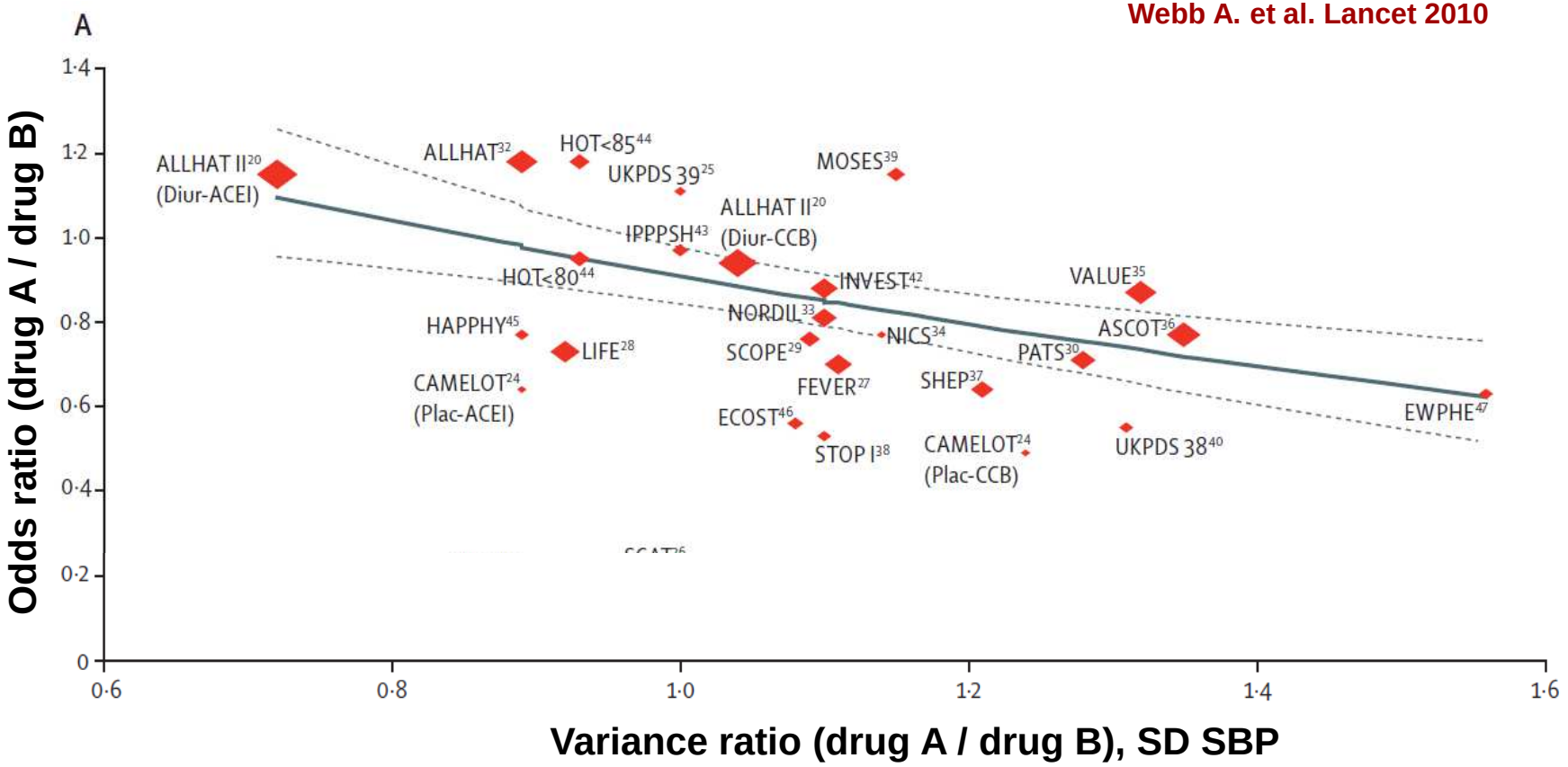
1.Matsui et al. Hy
2.Ushigome et al.
3.Kikuya et al. Hy

Visit-to-visit variability in SBP
- is associated with target organ damage
- is a powerful predictor of CV events independently of mean SBP

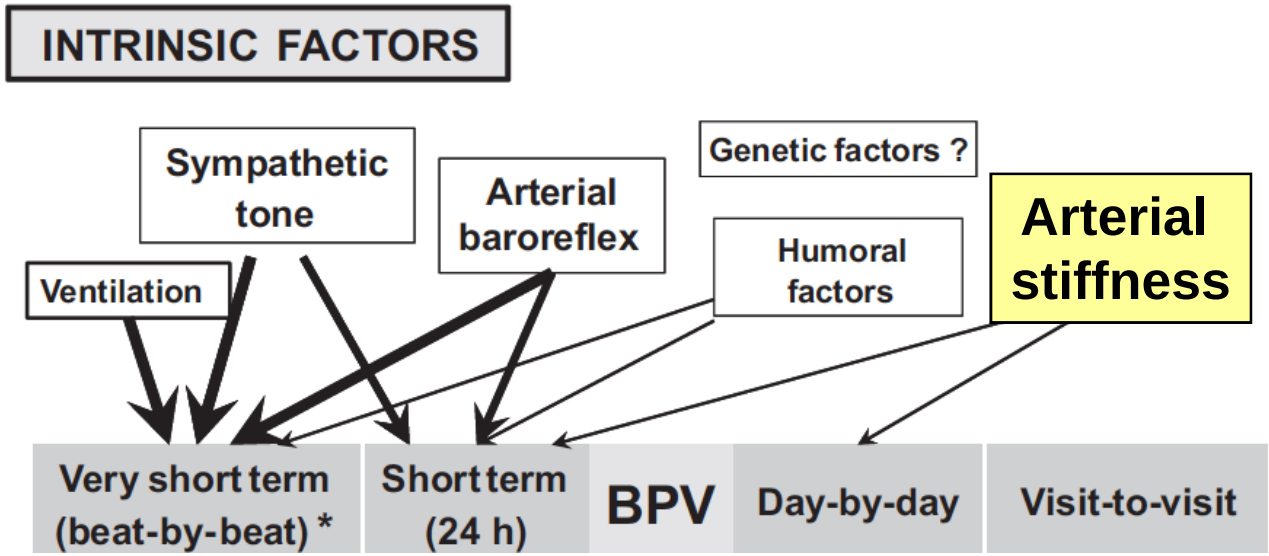
1. Rothwell PM, et al. Lancet. 2010
2. Muntner P, et al. Hypertension. 2011
3. Poortvliet RK et al. PLoS ONE 2012
4. Shimbo D et al. Hypertension 2012
5. Hastie CE et al. Hypertension 2013
6. Hata J et al. Circulation 2013
7. Suchy-Dicey AM et al. Am J Hypertens 2013
8. Chowdbury EK et al. J Hypertens 2014
9. Diaz Km et al. Hypertension 2014
10. Vishram JK et al. J Hypertens 2015
11. Stevens SL et al. BMJ 2016
12. Berge E et al. Eur Heart 2017, in press

Antihypertensive TX associated with less visit-to-visit variability are associated with less stroke risk: A meta-analysis of 389 trials

Webb A. et al. Lancet 2010



Arterial stiffness and BP variability



Aortic stiffening can increase the variability in SBP **by impairing the attenuation of SBP fluctuations** generated by the changes in

- **left ventricle ejection**
- **heart rate (**uncoupling between forward and reflected waves)
- **vasomotor tone** (impedance mismatch)

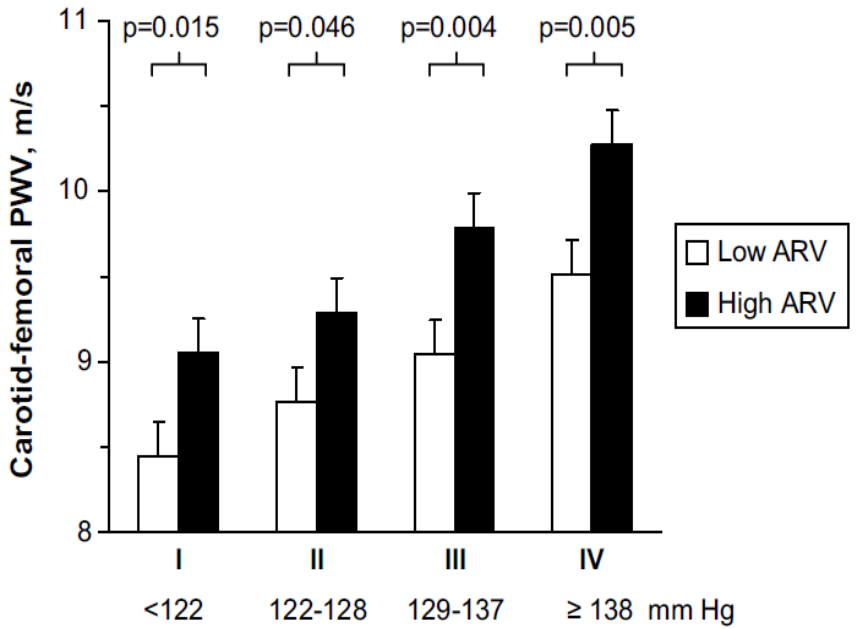
Relationship Between Short-Term Blood Pressure Variability and Large-Artery Stiffness in Human Hypertension : Findings From 2 Large Databases

Giuseppe Schillaci, Grzegorz Bilo, Giacomo Pucci, Stéphane Laurent, Isabelle Macquin-Mavier, Pierre Boutouyrie, Francesca Battista, Laura Settimi, Gaëlle Desamericq, Guillaume Dolbeau, Andrea Faini, Paolo Salvi, Elmo Mannarino and Gianfranco Parati

Schillaci G et al. Hypertension 2012

1. Learning population, n=911

« Perugia » and « International study »



$$ARV = \frac{1}{N-1} \sum_{k=1}^{N-1} |BP_{k+1} - BP_k|$$

where N denotes the number of valid BP measurements in the ABPM data corresponding with a given subject.

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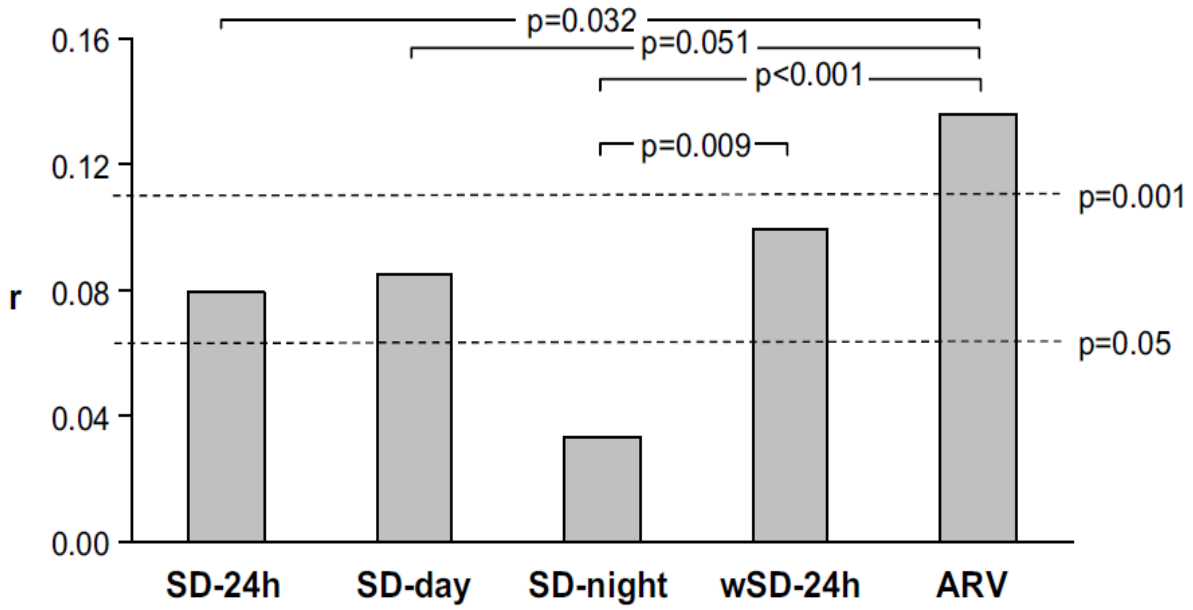
Schillaci G et al. Hypertension 2012

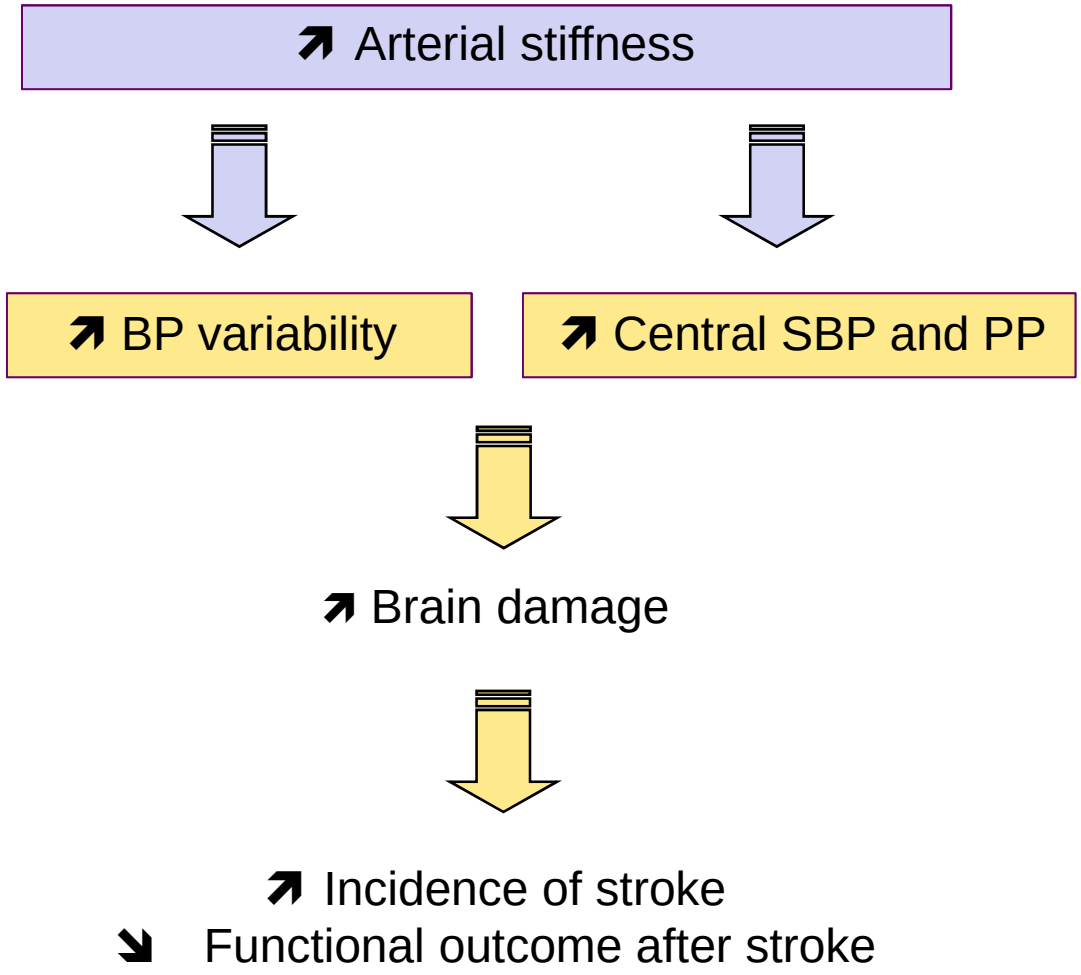
2. Test population, n=2089

« Paris-Creteil, France »



Partial correlation coefficients of PWVwith different measures of BP variability
(comparison: z test)

Predictive value of aortic stiffness for stroke and functional outcome after stroke



2013 ESH/ESC Guidelines for the management of arterial hypertension

3.1.2.1.3 Additional analyses A number of additional indices may be derived from ABPM recordings.[75–81] They include: BP variability,[75] morning BP surge,[76,77,81] blood pressure load,[78] and the ambulatory arterial stiffness index.[79,80] However, their added predictive value is not yet clear and they should thus be regarded as experimental, with no routine clinical use.

2013 ESH/ESC Guidelines for the management of arterial hypertension

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2018 ESH / ESC Guidelines ?

June 2018

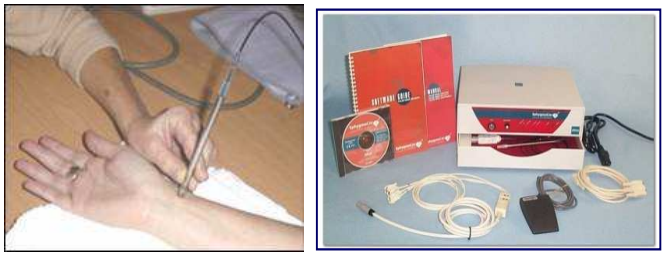
Les différentes mesures de la PA

- Quelle PA au cabinet de consultation?
- Quelle variabilité?
- **Quelle PA centrale?**

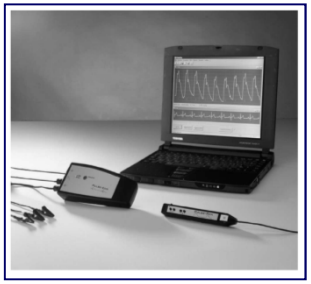
What is the best method to evaluate central blood pressure?

Laurent S and Boutouyrie P.
Dialogues in Cardiovascular Medicine - Vol 20 . No. 3 . 2015

Year of first publication	Device	Method	Company	Parameters	References
Radial artery pressure waveform					
1990	SphygmoCor®*	Tonometer, GTF	AtCor Medical	cSBP, cPP, cAIx	19-27
1997	Cardiovascular Engineering, Inc®*	Tonometer, cardiac echo, impedence	Cardiovascular Engineering, Inc	cSBP, cPP, cAIx, Zc, Pf, Pb	16
2004	PulsePen®	Tonometer, direct	DiaTecne	cSBP, cPP, cAIx	36
2009	Omeron HEM-9001AI®	Tonometer	Omron Healthcare, Inc	cSBP, rAIx	29,30
2012	BPro	Tonometer	HealthSTATS	rAIx	37



Sphygmocor ®



Pulse Pen ®

Omron HDI-9000AI ®

Best method: precision, true relationship with physiology and pathophysiology, lesser degree of assumption, feasability, repetability,

What is the best method to evaluate central blood pressure?

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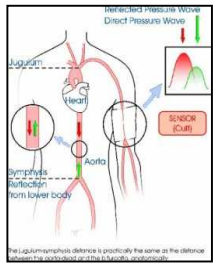
Year of first publication	Device	Method	Company	Parameters	References
Brachial artery pressure waveform					
2010	Arteriograph®	Oscillometric, Add. Infl.	TensioMed	cSBP, cPP, cAIx	35
2010	Mobil-O-Graph®	Oscillom., ARCSolver, PVP	IEM	cSBP, cPP, cAIx, Zc, Pf, Pb	31,32,34
2010	Vasotens®	Oscillometric	BPLab	cSBP, cPP, cAIx	38
2012	Centron cBP301	Oscillometric	Centron Diagnostics	cSBP, cPP, cAIx	39
2012	CardioScope II	Oscillometric, Add. Infl.	Pulsecor	cSBP, cPP, cAIx	40
2013	Vicorder®	Oscillometric	Skidmore Medical	cSBP, cPP, cAIx	41
Carotid artery pressure waveform					
1984	Millar strain gauge®*	Tonometer, direct	Millar	cSBP, cPP, cAIx	19-27
2004	PulsePen®	Tonometer, direct	DiaTecne	cSBP, cPP, cAIx	36

*Bapparatus used in pioneering epidemiological studies showing the predictive value of central BP for cardiovascular events

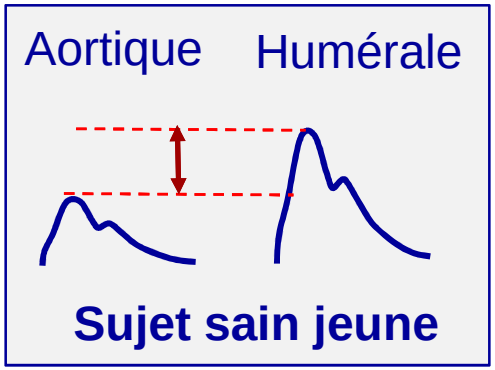
Mobil-O-Graph ®



Arteriograph ®

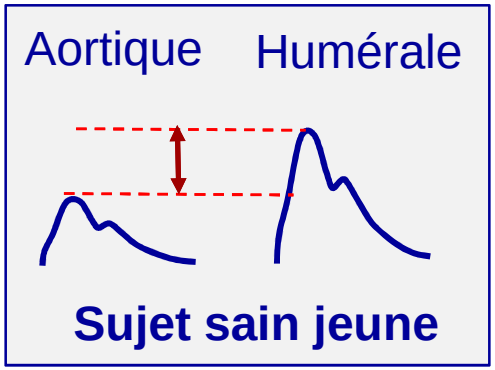
La PA humérale ne reflète pas toujours la PA aortique

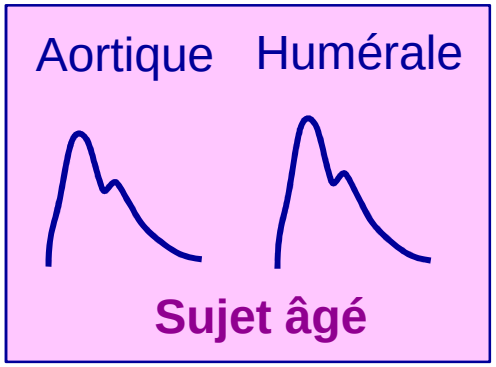
Amplification =
Humérale *moins* Aortique



La PA humérale ne reflète pas toujours la PA aortique

Amplification =
Humérale *moins* Aortique





La PA humérale ne reflète pas toujours la PA aortique

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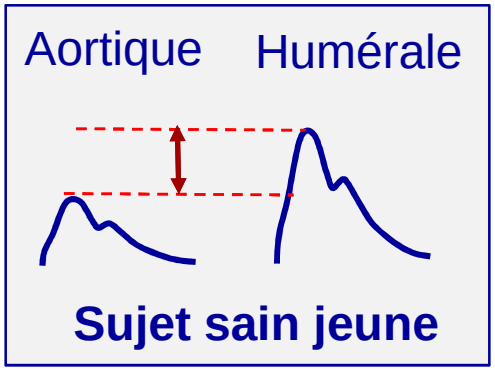
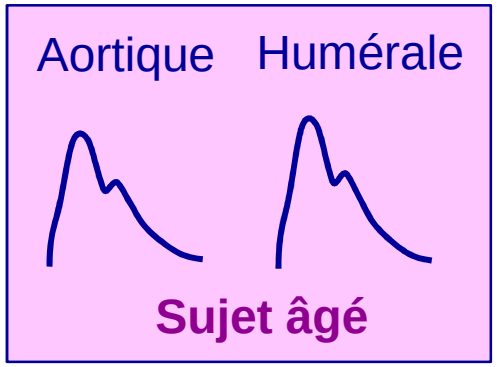
Humérale *moins* Aortique





↗ SBP and PP aortique

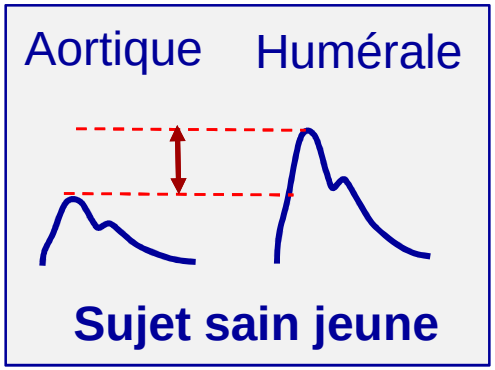
↗ Atteinte des organes cibles

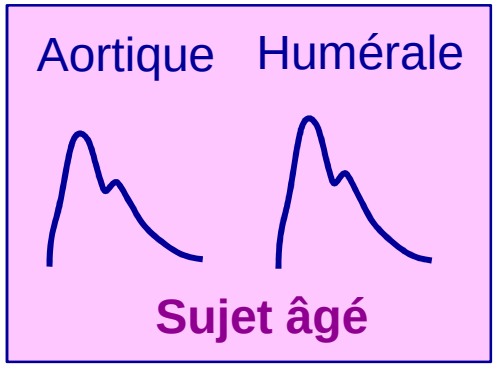
Meilleure corrélation
PP Ao > PP hum

↗ Complications CV et rénales

La PA humérale ne reflète pas toujours la PA aortique

Amplification =
Humérale *moins* Aortique





Meilleure valeur prédictive
PP Ao > PP hum?

non

↗ SBP and PP aortique

↗ Atteinte des organes cibles

↗ Complications CV et rénales

Meilleure corrélation
PP Ao > PP hum

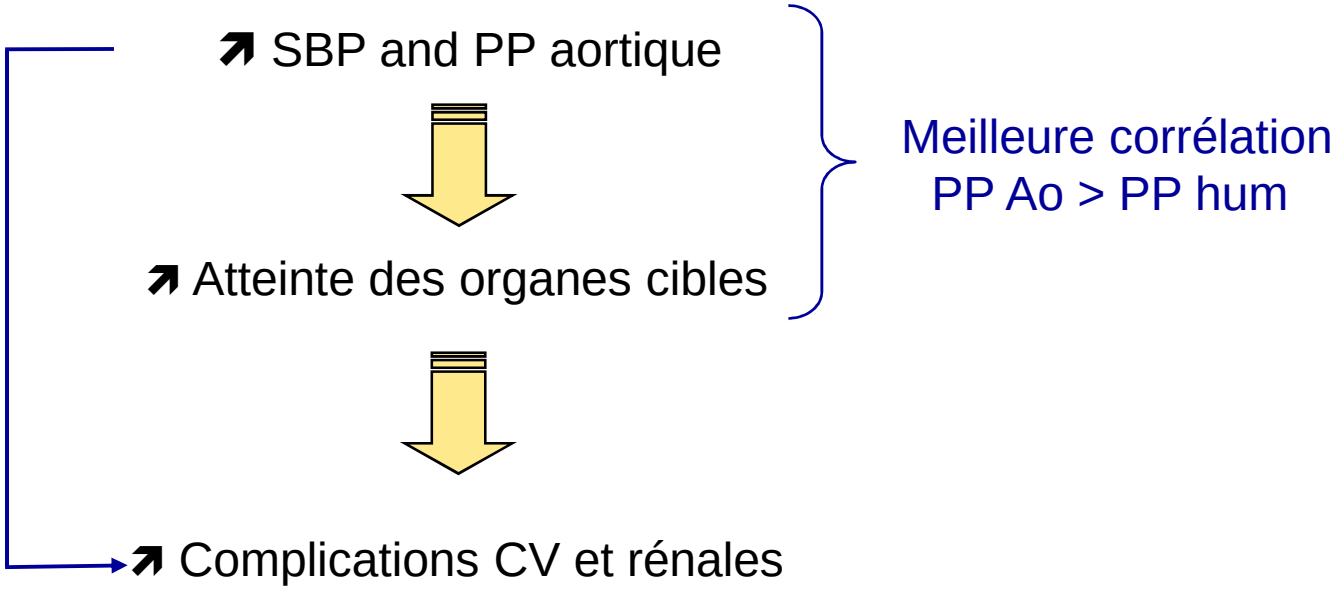
La PA humérale ne reflète pas toujours la PA aortique

Les valeurs absolues de PAS et PP aortique ne sont pas adéquates

- ❑ Indices de réflexion d'ondes de pression (Reflection magnitude, AIx, amplification)
- ❑ Mesure de la PAS aortique sur les 24h
- ❑ **Meilleure calibration de PAS et PP aortique**

Meilleure valeur prédictive PP Ao > PP hum?

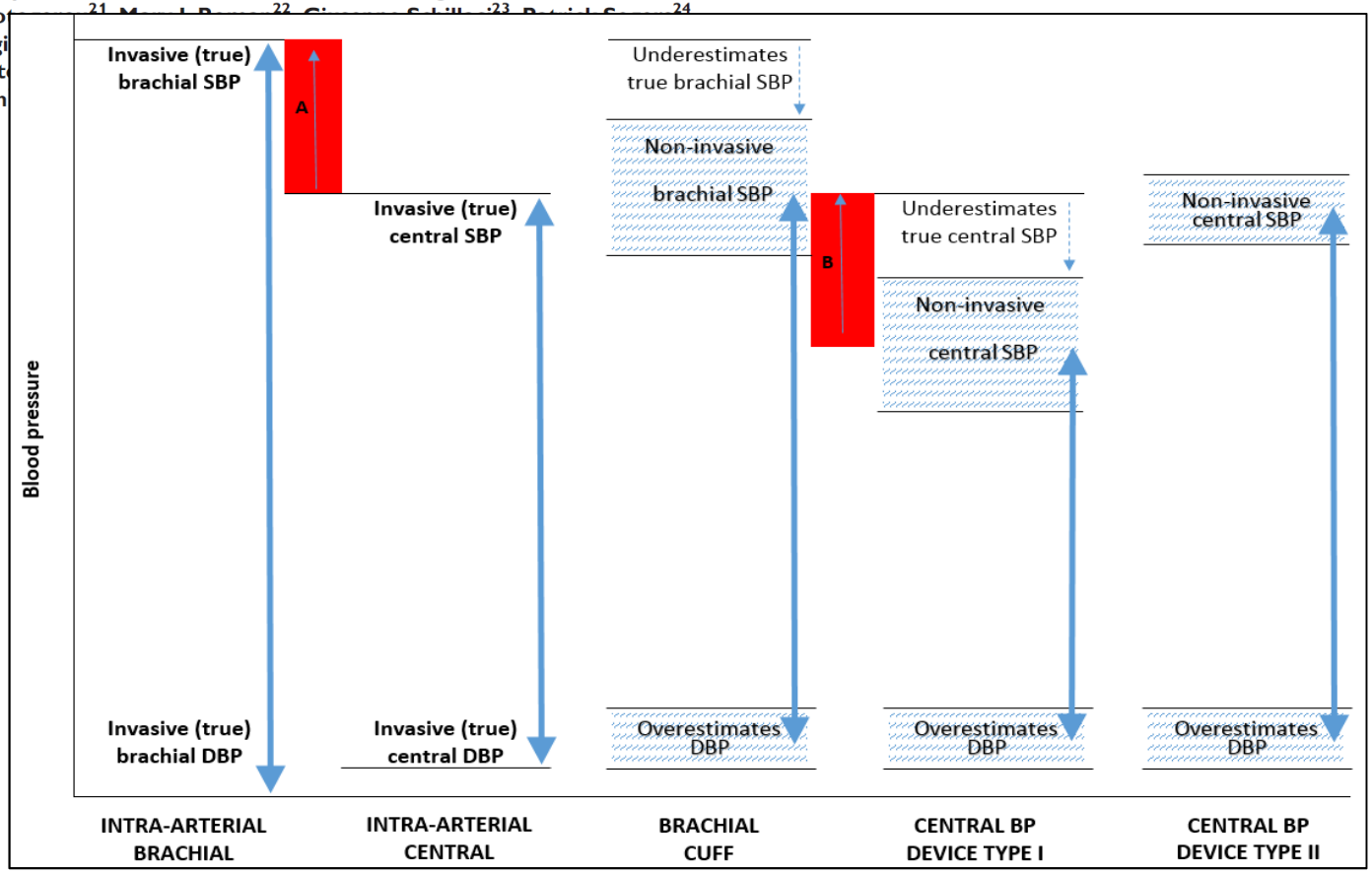
non



Validation of non-invasive central blood pressure devices: ARTERY Society task force consensus statement on protocol standardization

James E. Sharman[1]*, Alberto P. Avolio[2], Johannes Baulmann[3], Athanase Benetos[4], Jacques Blacher[5], C. Leigh Blizzard[1], Pierre Boutouyrie[6], Chen-Huan Chen[7], Phil Chowienczyk[8], John R. Cockcroft[9], J. Kennedy Cruickshank[10], Isabel Ferreira[11], Lorenzo Ghiadoni[12], Alun Hughes[13], Piotr Jankowski[14], Stephane Laurent[6], Barry J. McDonnell[9], Carmel McEniery[15], Sandrine C. Millasseau[16], Theodoros G. Papaioannou[17], Gianfranco Parati[18,19], Jeong Bae Park[20], Athanase D. Pro[21], [22], [23], [24], George S. Stergi, Luc M. Van Bort, Ian B. Wilkinson

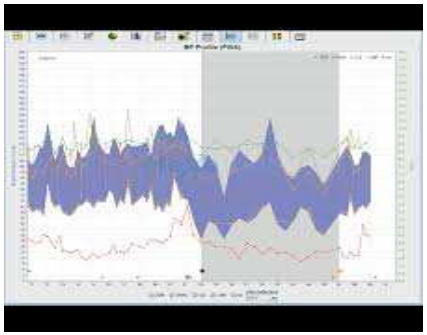
Sharman J et al. Eur Heart J 2017;38:2805-2812.



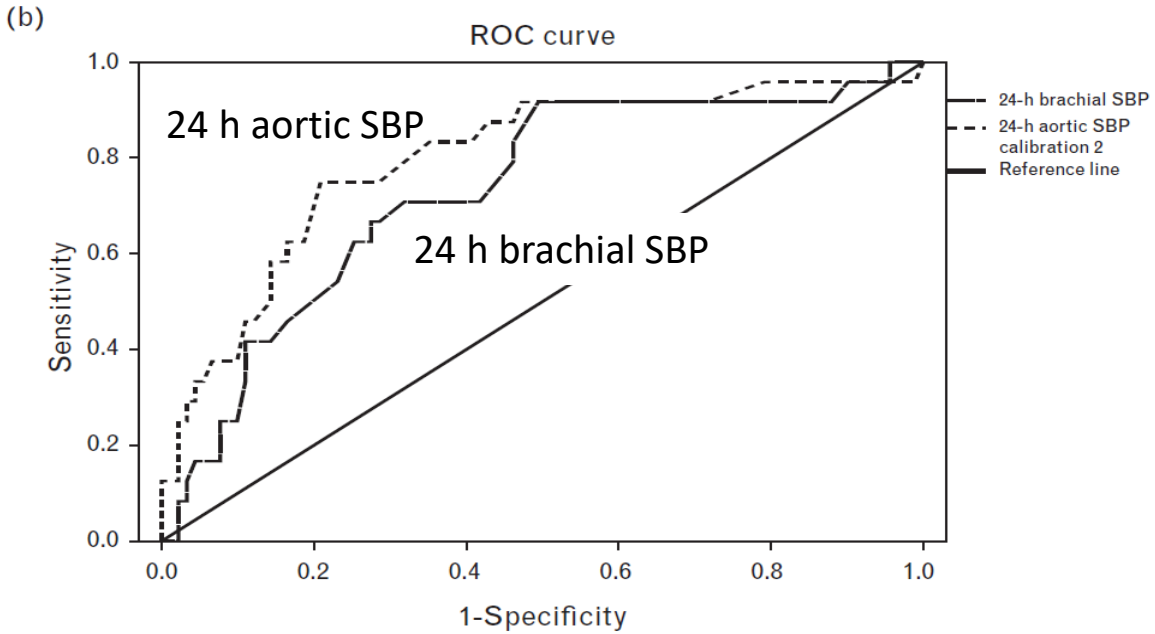
Left-ventricular hypertrophy is associated better with 24-h aortic pressure than 24-h brachial pressure in hypertensive patients: the SAFAR study

Protogerou A et al. J Hypertens 2014

Athanase D. Protogerou[a], Antonis A. Argyris[a], Theodoros G. Papaioannou[b], Georgios E. Kollias[a], Giorgos D. Konstantonis[a], Efthimia Nasothimiou[a], Apostolos Achimastos[c], Jacques Blacher[d], Michel E. Safar[d], and Petros P. Sfikakis[a]



Mobil-O-graph



n=229 individuals, age 54 yrs

AUC=0.73 vs AUC=0.69, p=0.007

Relationship Between 24-Hour Ambulatory Central Systolic Blood Pressure and Left Ventricular Mass

A Prospective Multicenter Study

Thomas Weber, Siegfried Wassertheurer, Arno Schmidt-Trucksäss, Enrique Rodilla, Cornelia Ablasser, Piotr Jankowski, Maria Lorenza Muiesan, Cristina Giannattasio, Claudia Mang, Ian Wilkinson, Jörg Kellermair, Bernhard Hametner, Jose Maria Pascual, Robert Zweiker, Danuta Czarnecka, Anna Paini, Massimo Salvetti, Alessandro Maloberti, Carmel McEniery

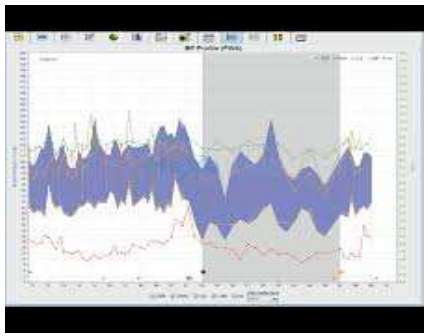
Weber T et al. Hypertension 2017

Blood Pressure Component	AUC	*P* for AUC	*P* vs bOSBP
bOSBP	0.719 (0.662–0.771)	0.004	…
24-h bASBP	0.786 (0.734–0.832)	0.0006	0.13
24-h cASBP (MBP/DBP cal)	0.800 (0.749–0.845)	<0.0001	0.05

office

24h brach-SBP

24h aortic-SBP



Mobil-O-graph

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P=0.43

Is 24-Hour Central Blood Pressure Superior to 24-Hour Brachial Blood Pressure for Predicting Organ Damage?

Aletta Elisabeth Schutte, Stephane Laurent

Schutte A et al. Hypertension 2017

The road may be long because it has not yet been demonstrated that a therapeutic strategy based on brachial ambulatory BP monitoring is superior to one based on brachial office BP.

European Heart Journal
doi:10.1093/eurheartj/eht151

2013 ESH/ESC Guidelines for the management of arterial hypertension

The Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC)

Thus the current guidelines, like previous ones,[2,141] consider that, although the measurement of central BP and augmentation index is of great interest for mechanistic analyses in pathophysiology, pharmacology and therapeutics, more investigation is needed before recommending their routine clinical use. The only exception may be ISH in the young: in some of these individuals increased SBP at the brachial level may be due to high amplification of the central pressure wave, while central BP is normal.[142]

Merci !