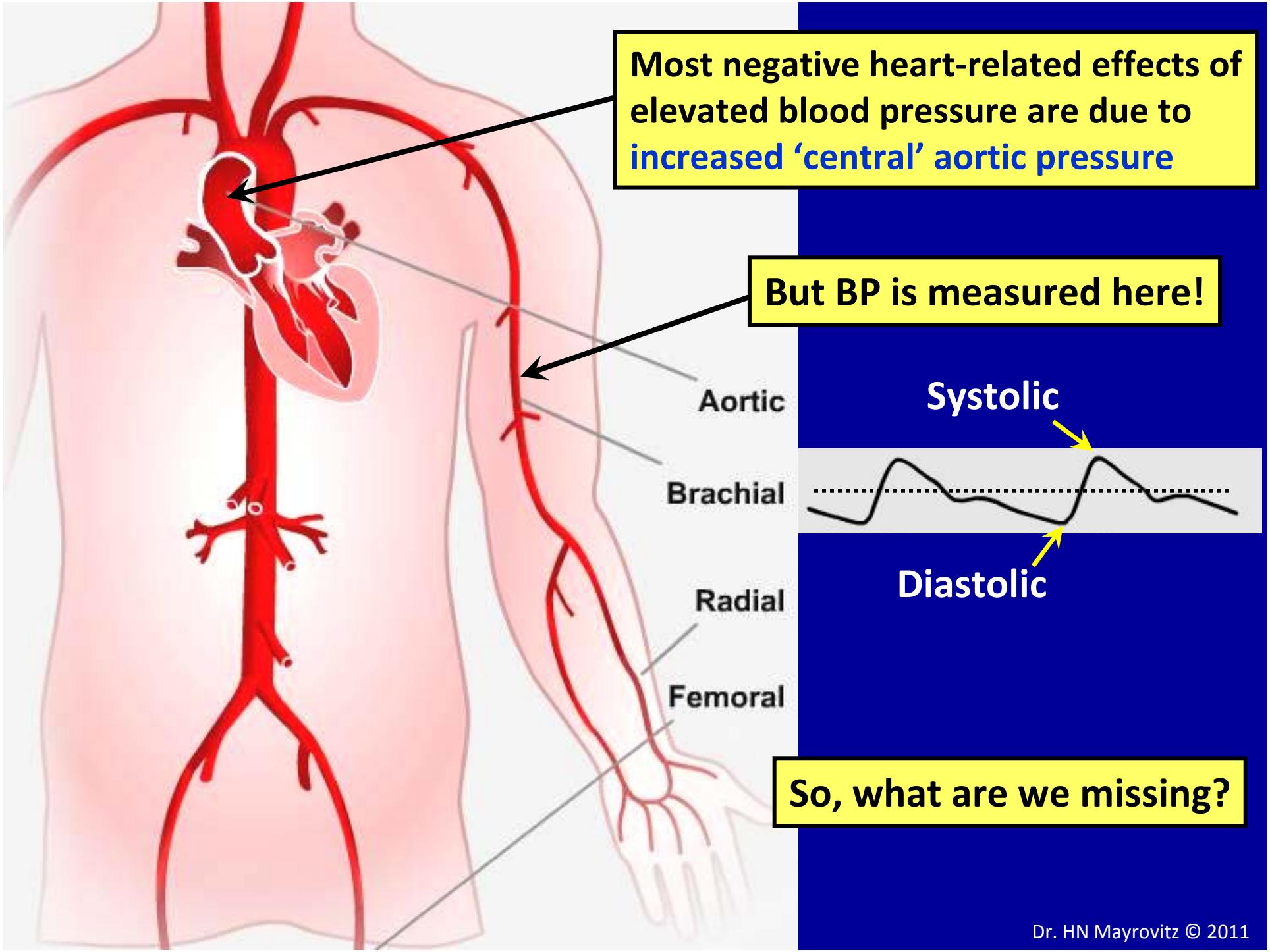
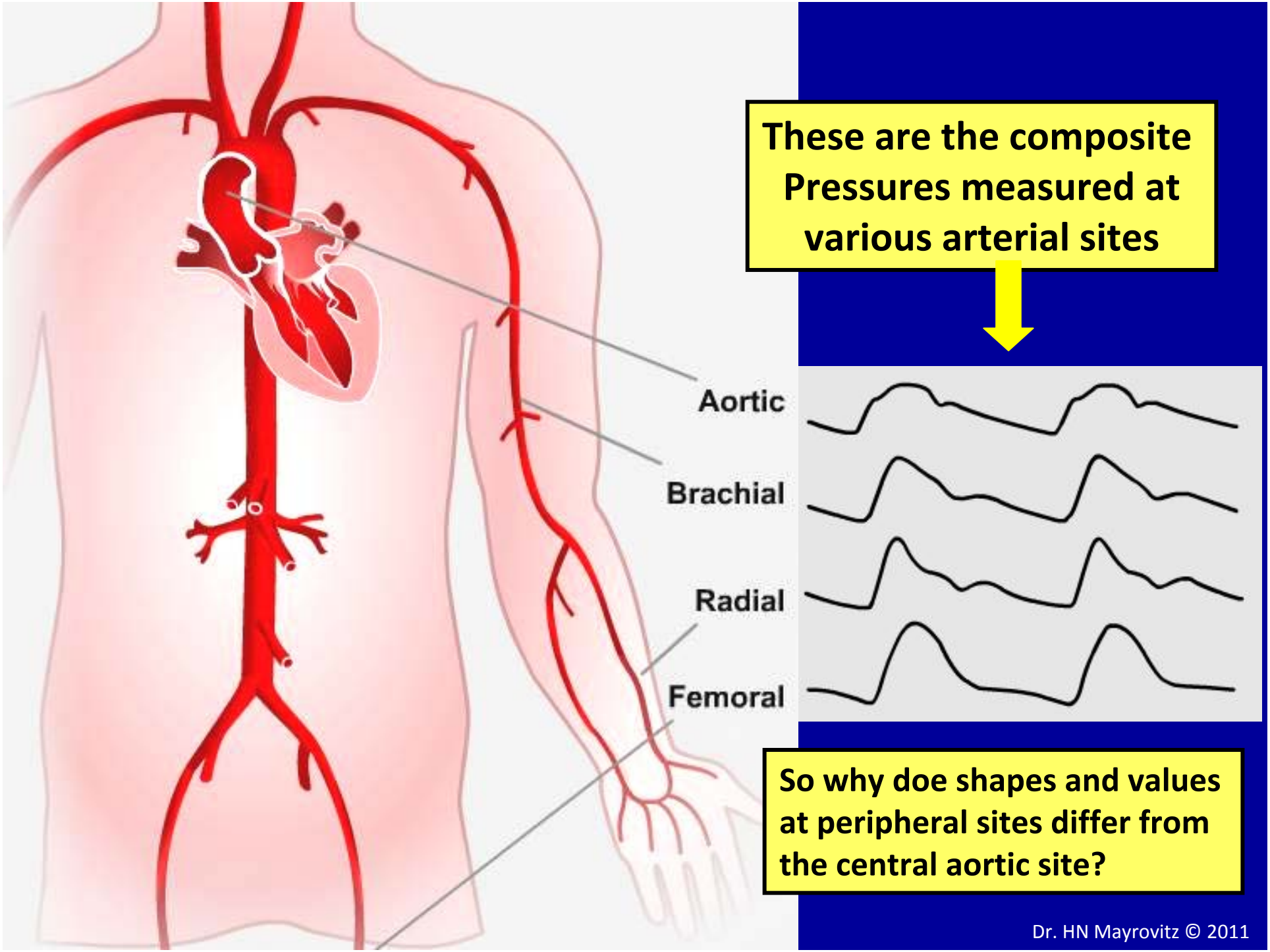
What is not revealed by a simple arm blood pressure measurement?

Affects of Pressure Pulse Reflections on Central (Aortic) Pressure

Dr. HN Mayrovitz


Most negative heart-related effects of elevated blood pressure are due to increased 'central' aortic pressure
But BP is measured here!
Aortic
Brachial
Radial
Femoral
Systolic
Diastolic
So, what are we missing?
Dr. HN Mayrovitz © 2011


These are the composite Pressures measured at various arterial sites
Aortic
Brachial
Radial
Femoral
So why doe shapes and values at peripheral sites differ from the central aortic site?
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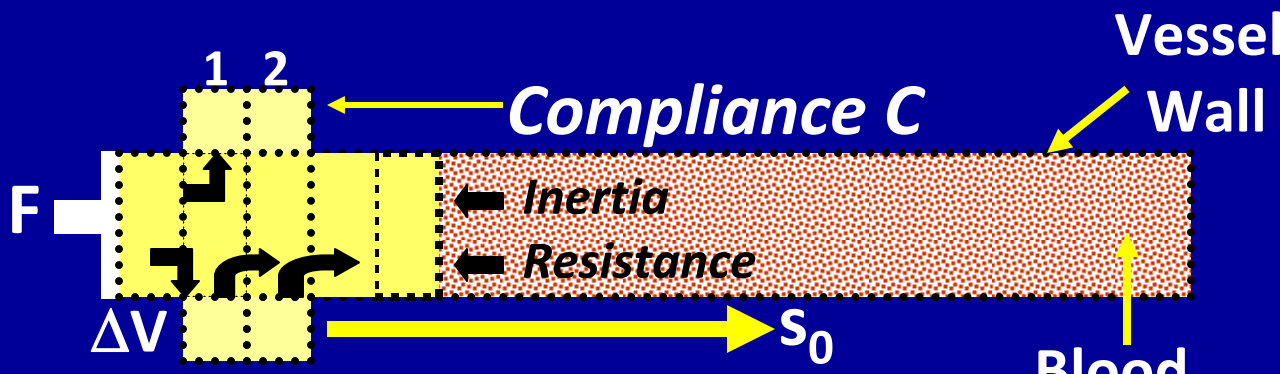
Pulse Wave Generation and Propagation

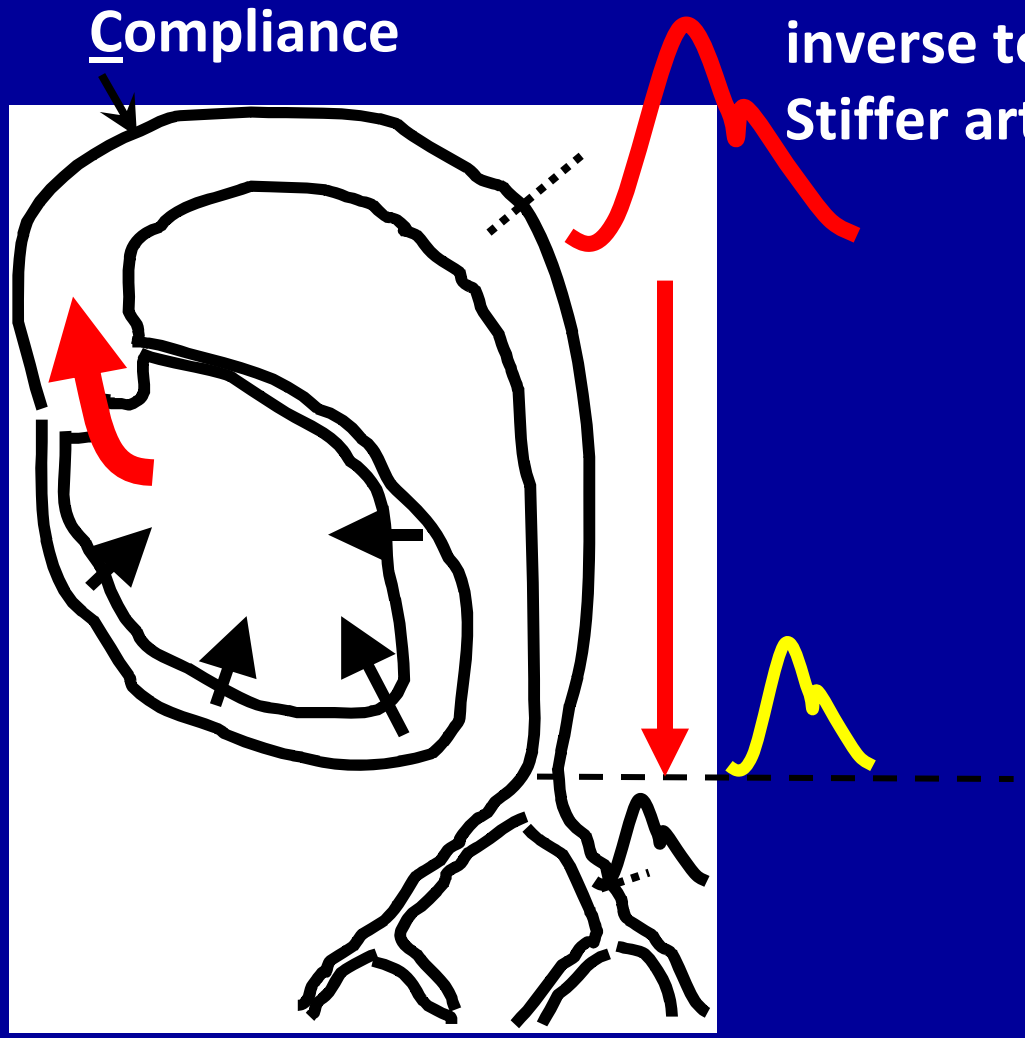


$$S_0^2 \sim \frac{1}{\rho C}$$

Pulse "wave-speed" inverse to Compliance

Stiffer arteries ~ higher speed

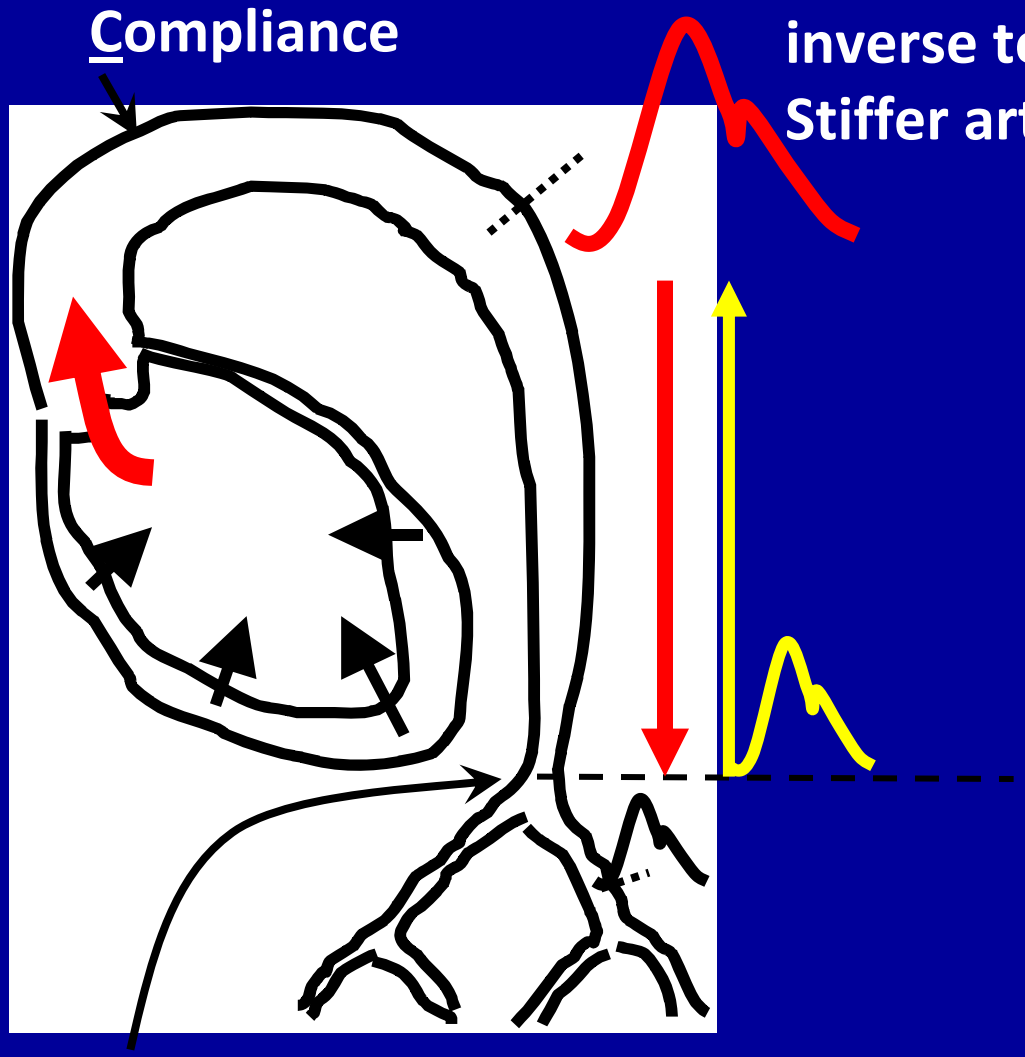
Reflection of Pulses



1. Pulse "wave-speed" (S_0) is inverse to Compliance (C)
Stiffer arteries ~ higher speed

$$S_0^2 \sim \frac{1}{C}$$

Reflection of Pulses



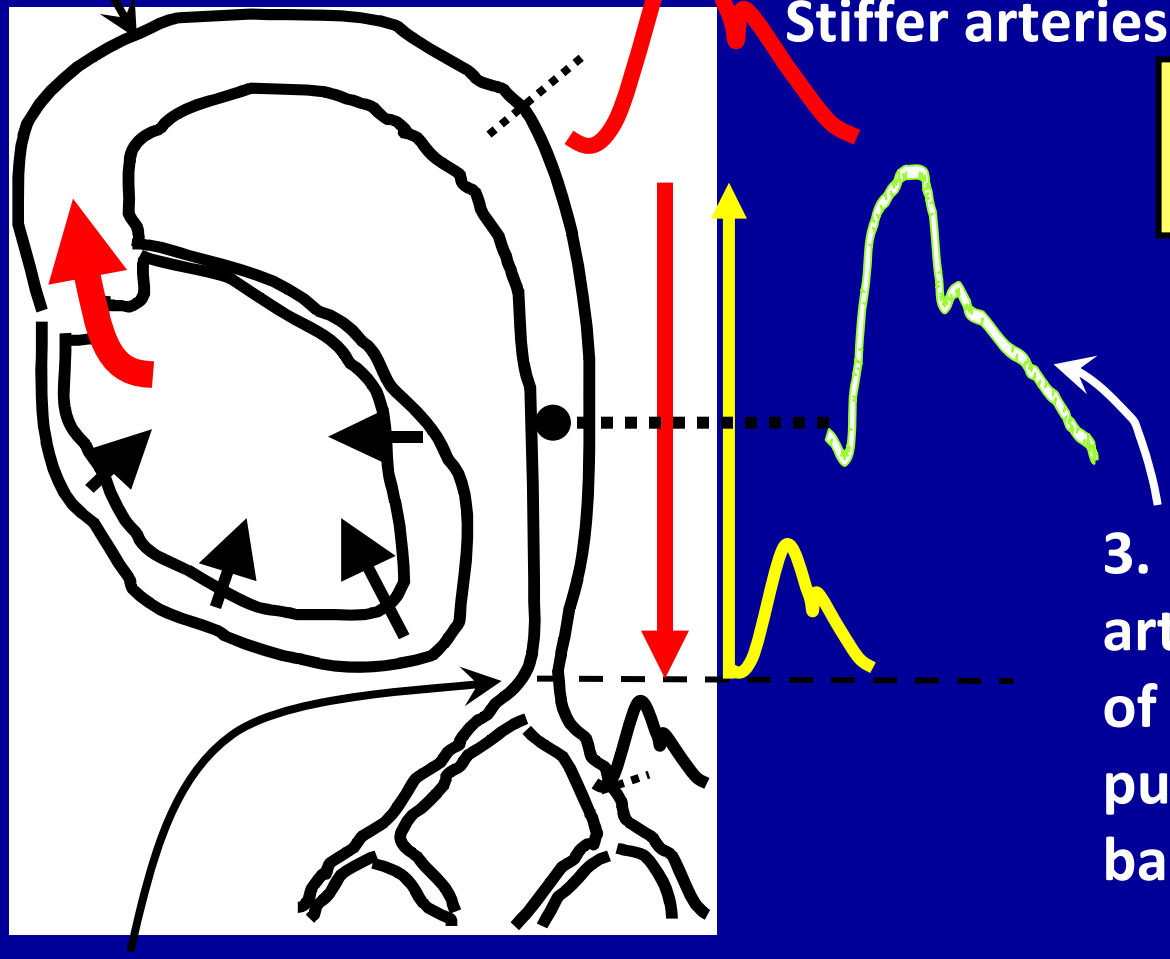
1. Pulse "wave-speed" (S_0) is inverse to Compliance (C)
Stiffer arteries ~ higher speed

$$S_0^2 \sim \frac{1}{C}$$

2. Reflection sites mainly at arterial branches

Reflection of Pulses

Compliance



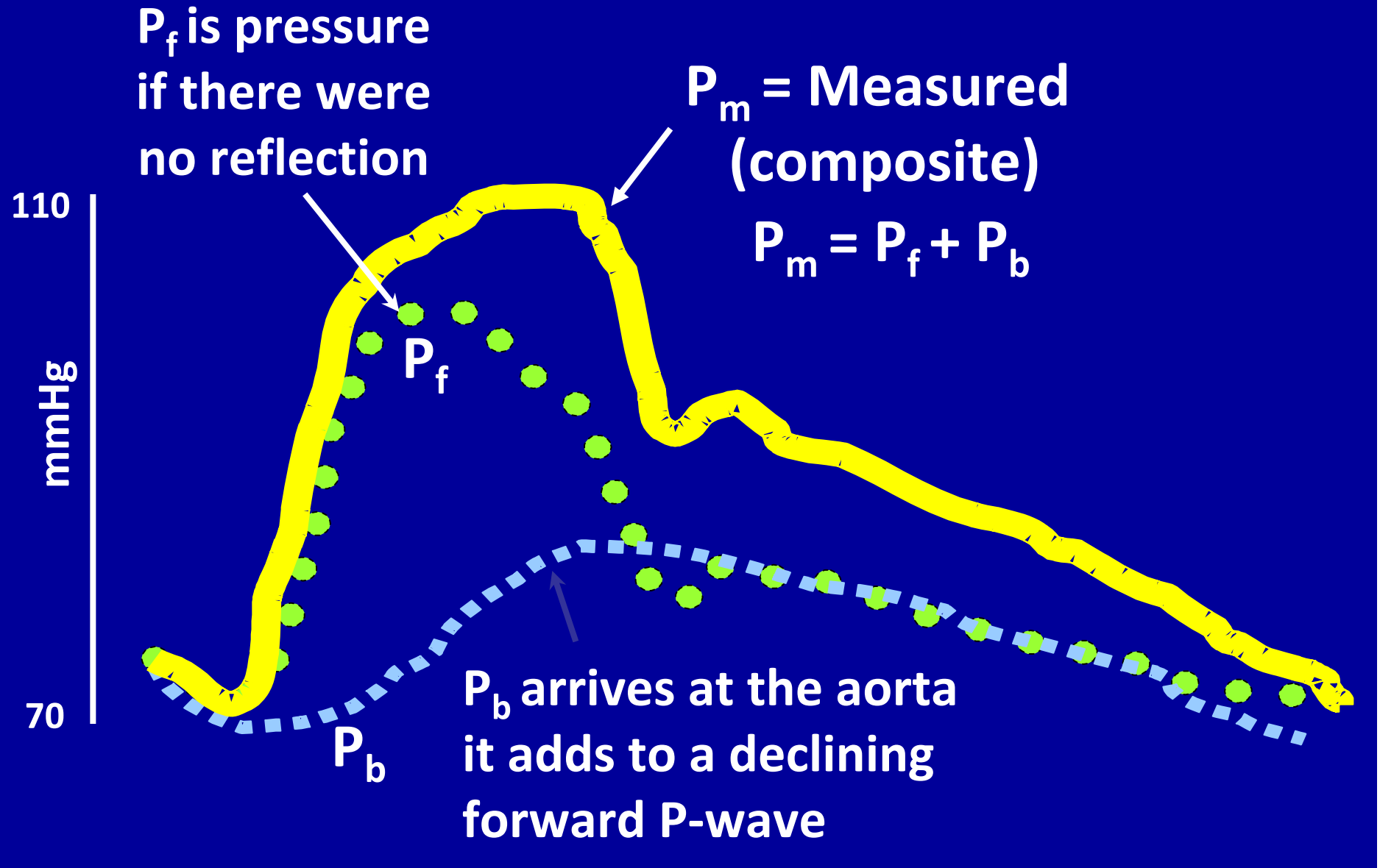
1. Pulse "wave-speed" (S_0) is inverse to Compliance (C)
Stiffer arteries ~ higher speed

$$S_0^2 \sim \frac{1}{C}$$

3. Pulse at any point in artery is algebraic sum of forward transmitted pulses and reflected backward pulses

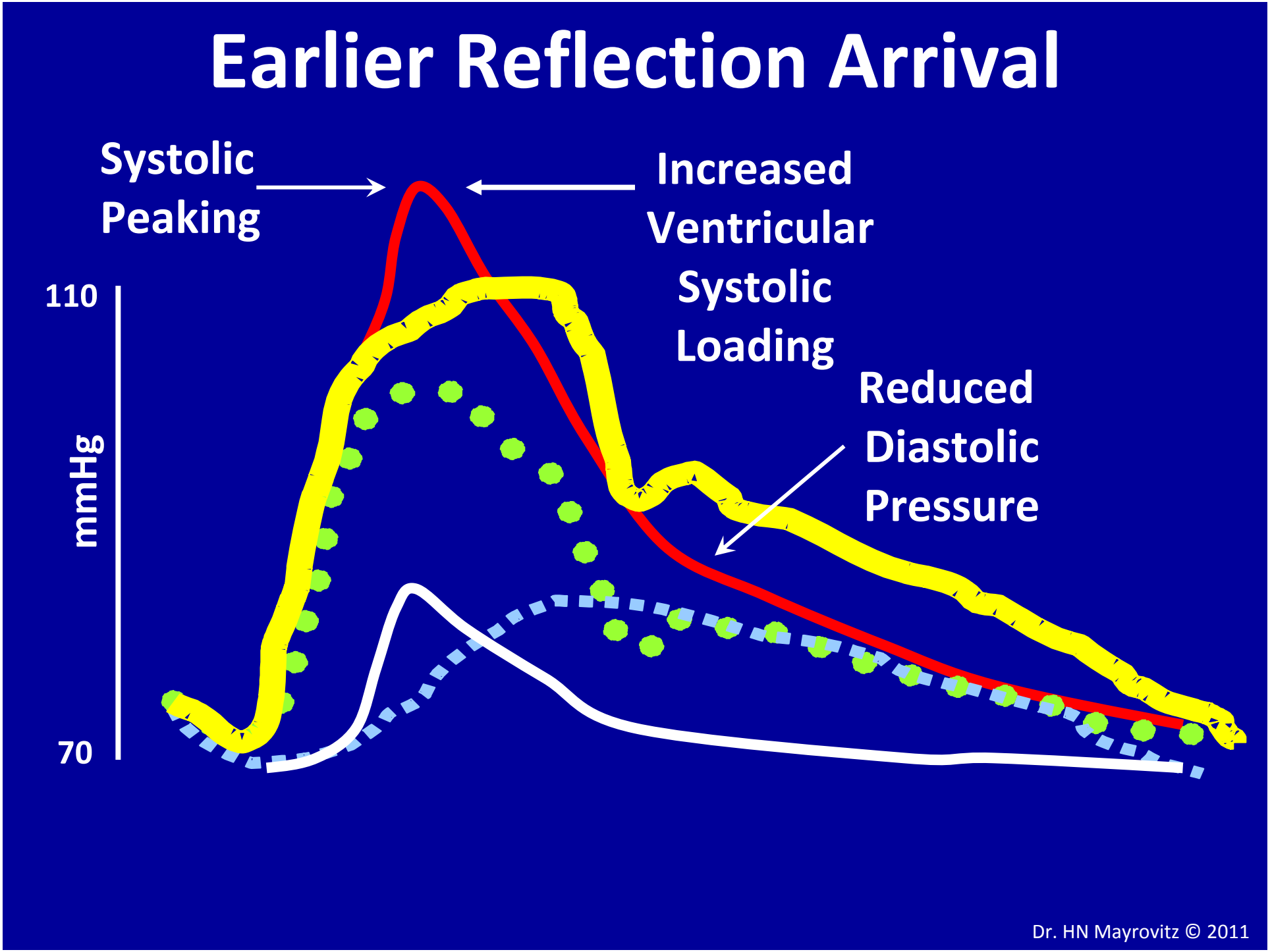
2. Reflection sites mainly at arterial branches

Normal Ascending Aortic Pressure

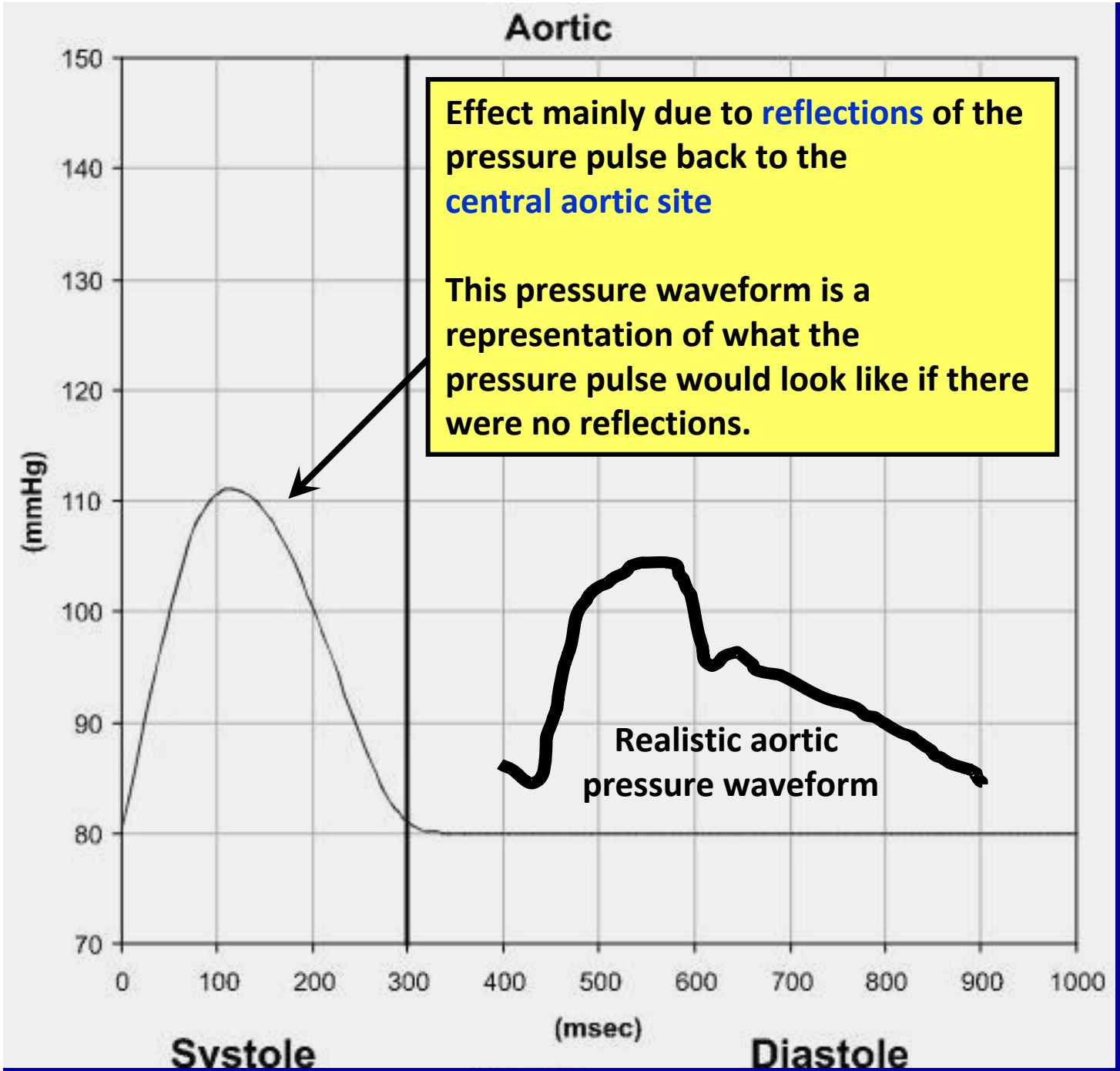


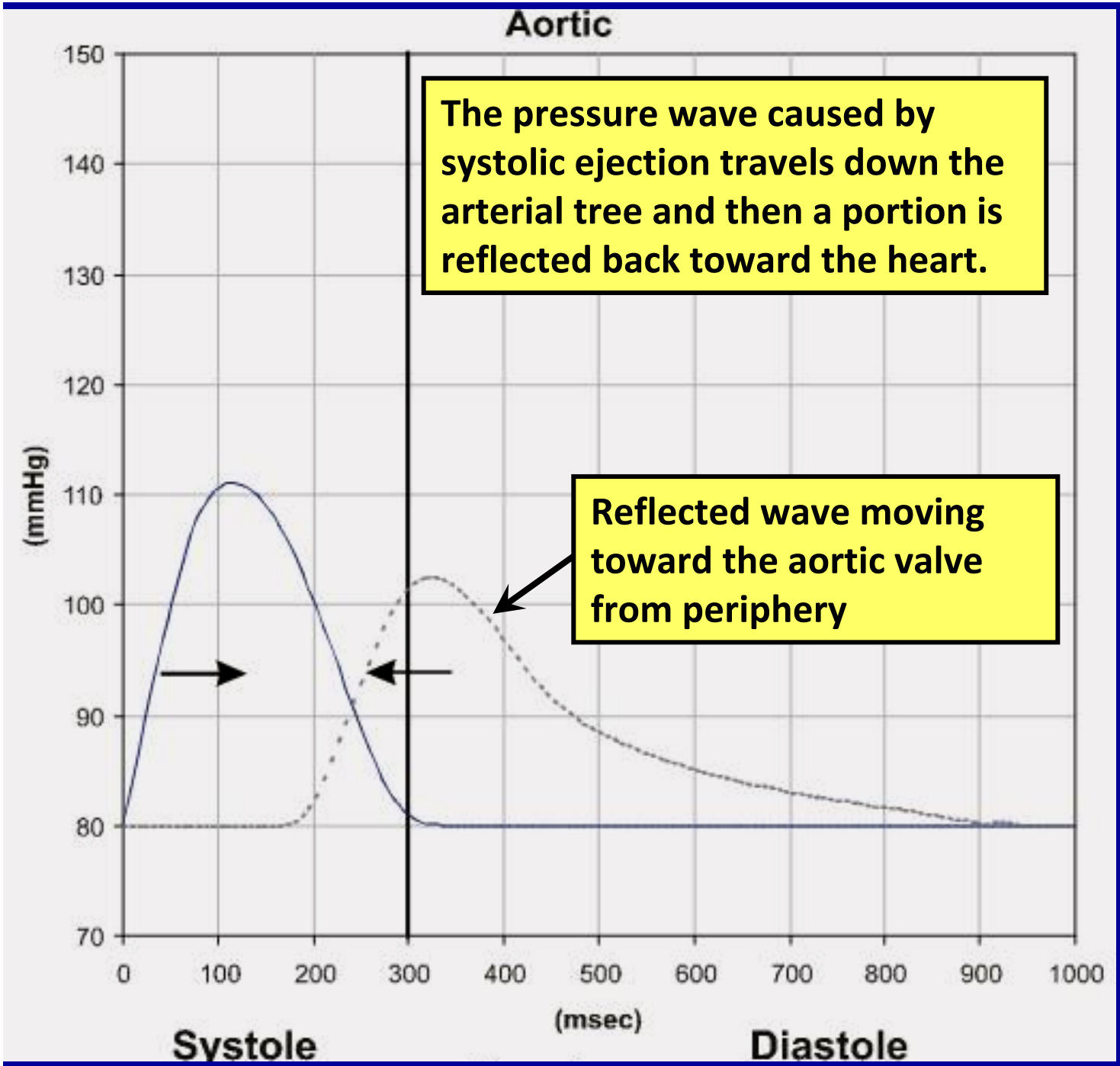
So What?

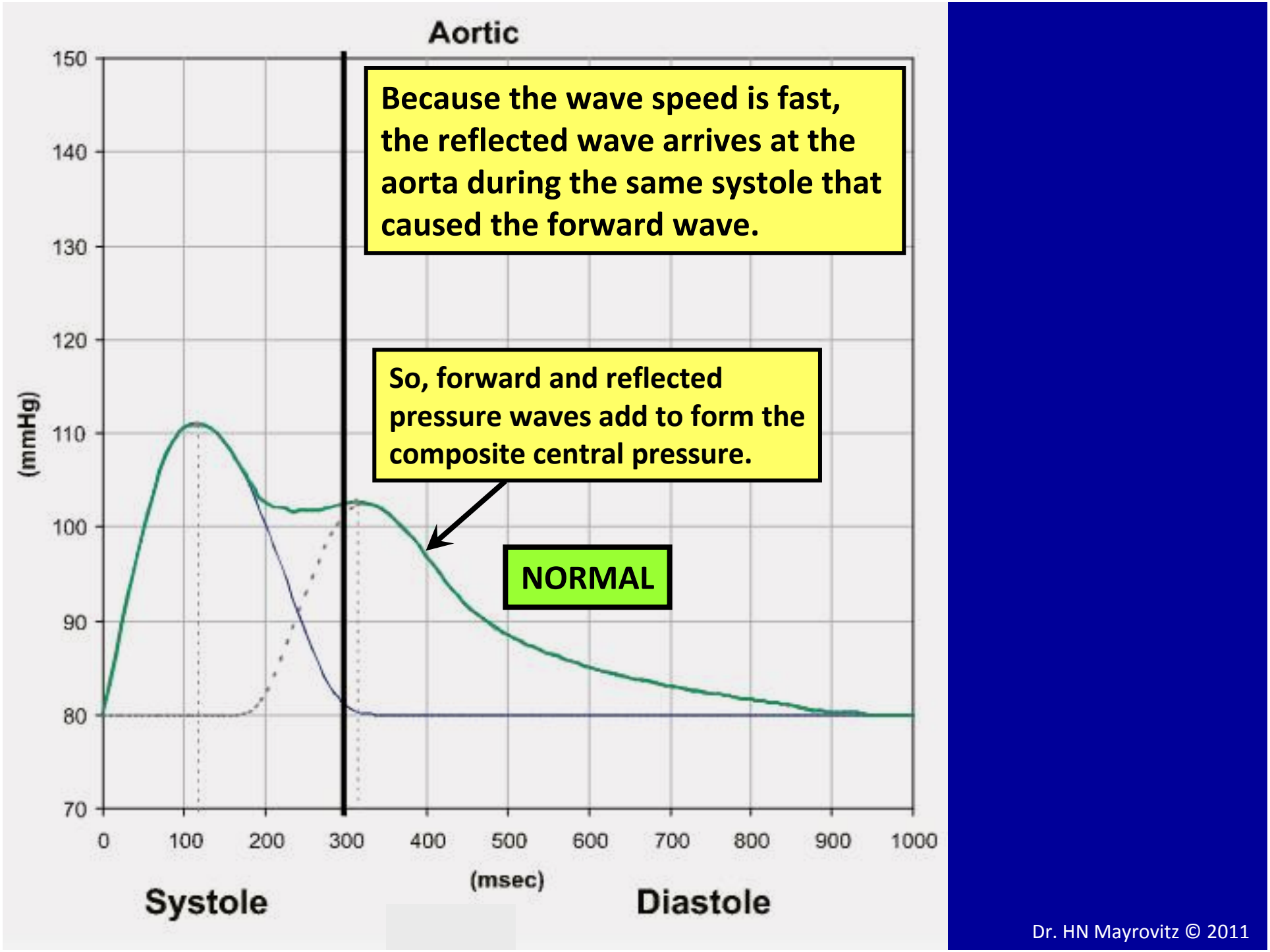
Earlier Reflection Arrival

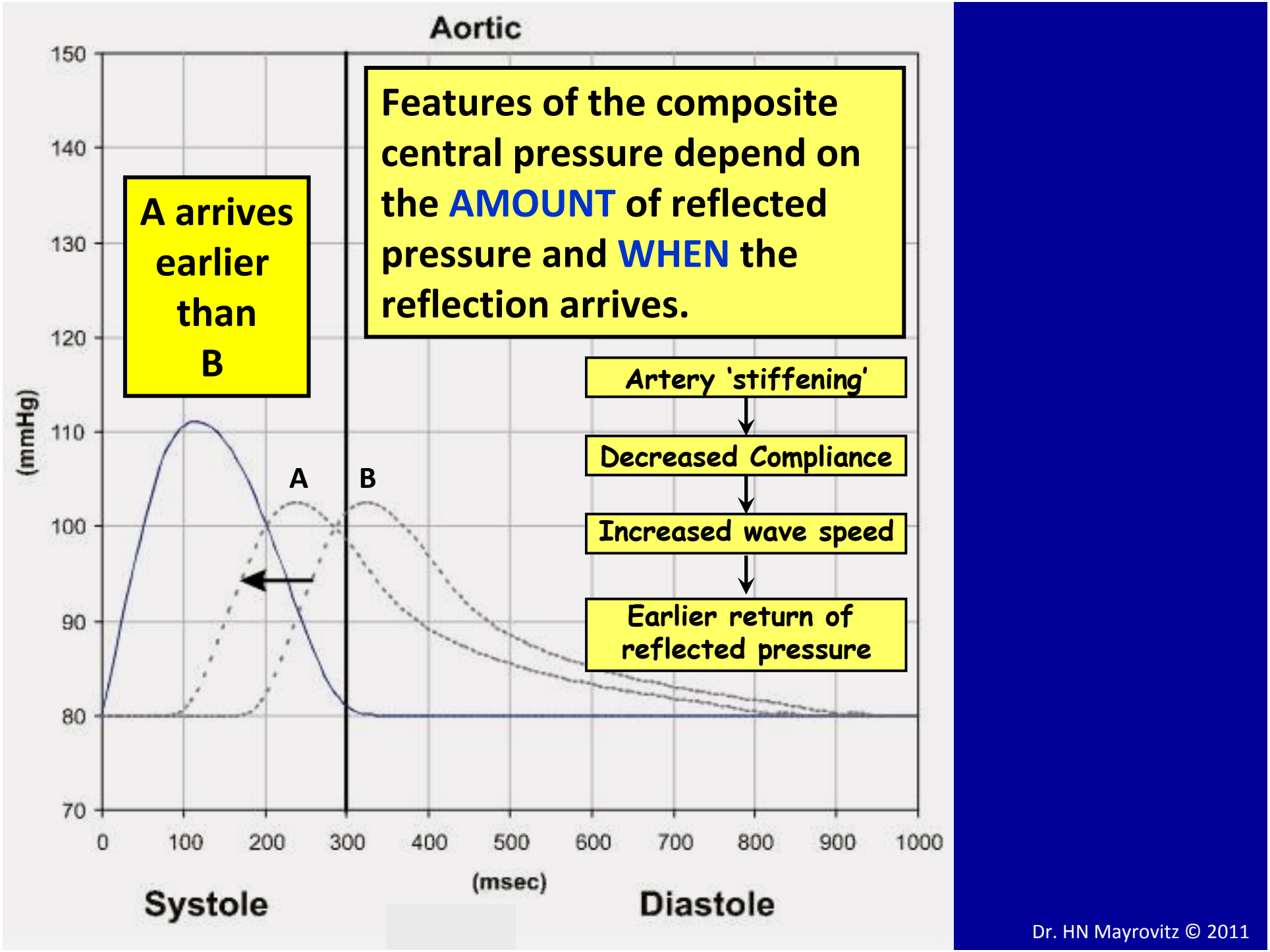


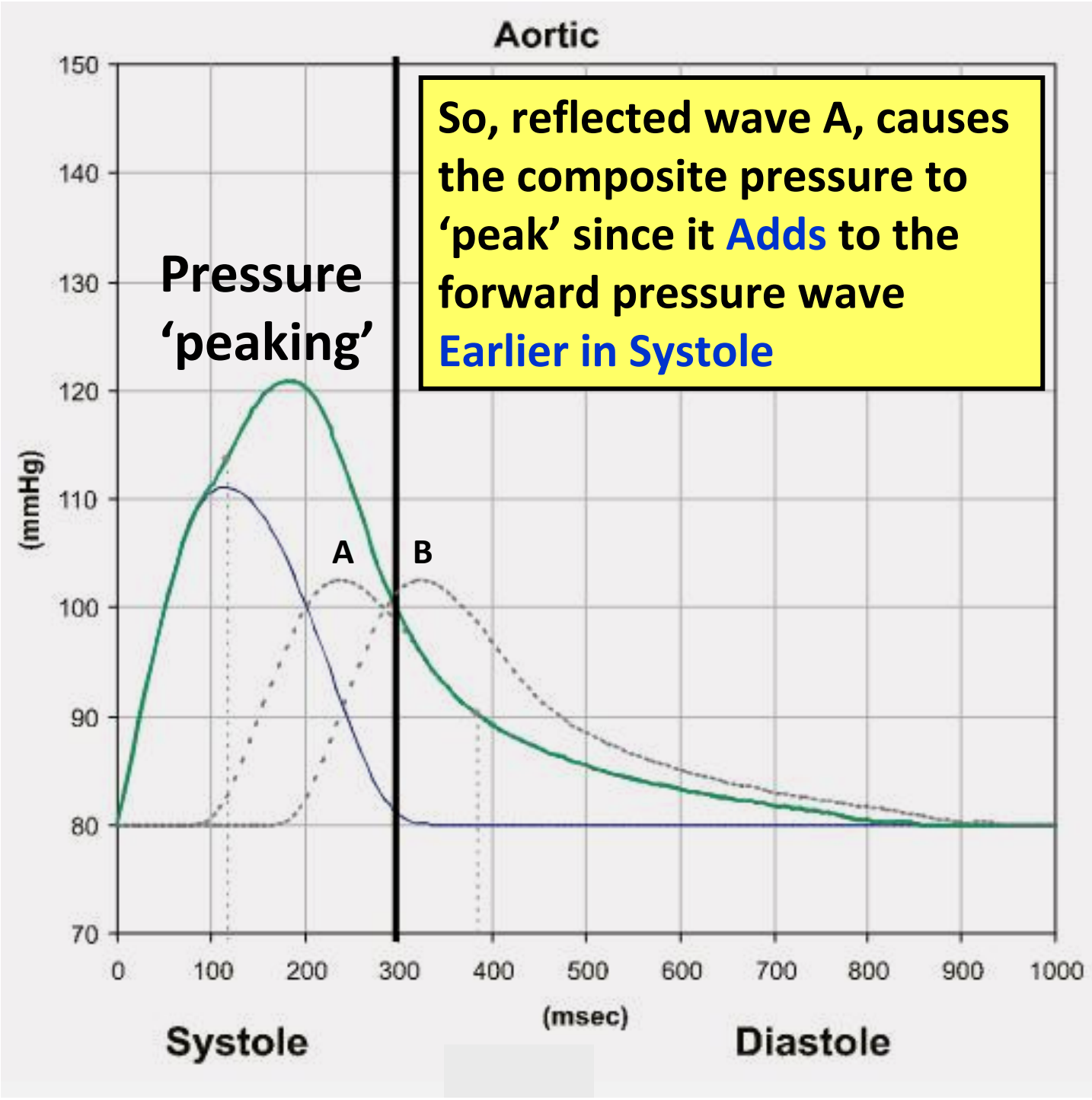
Review Fundamental Process



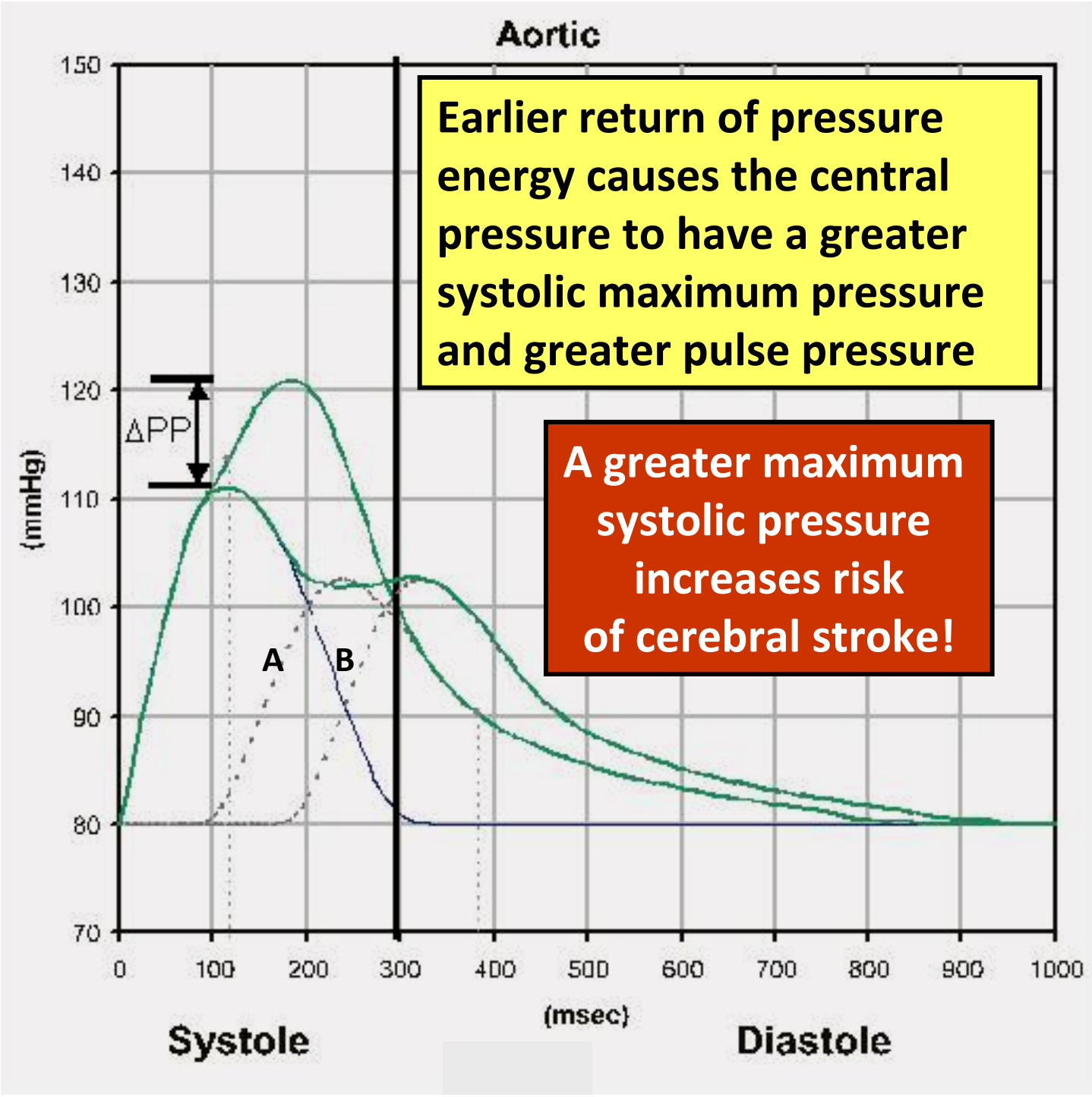








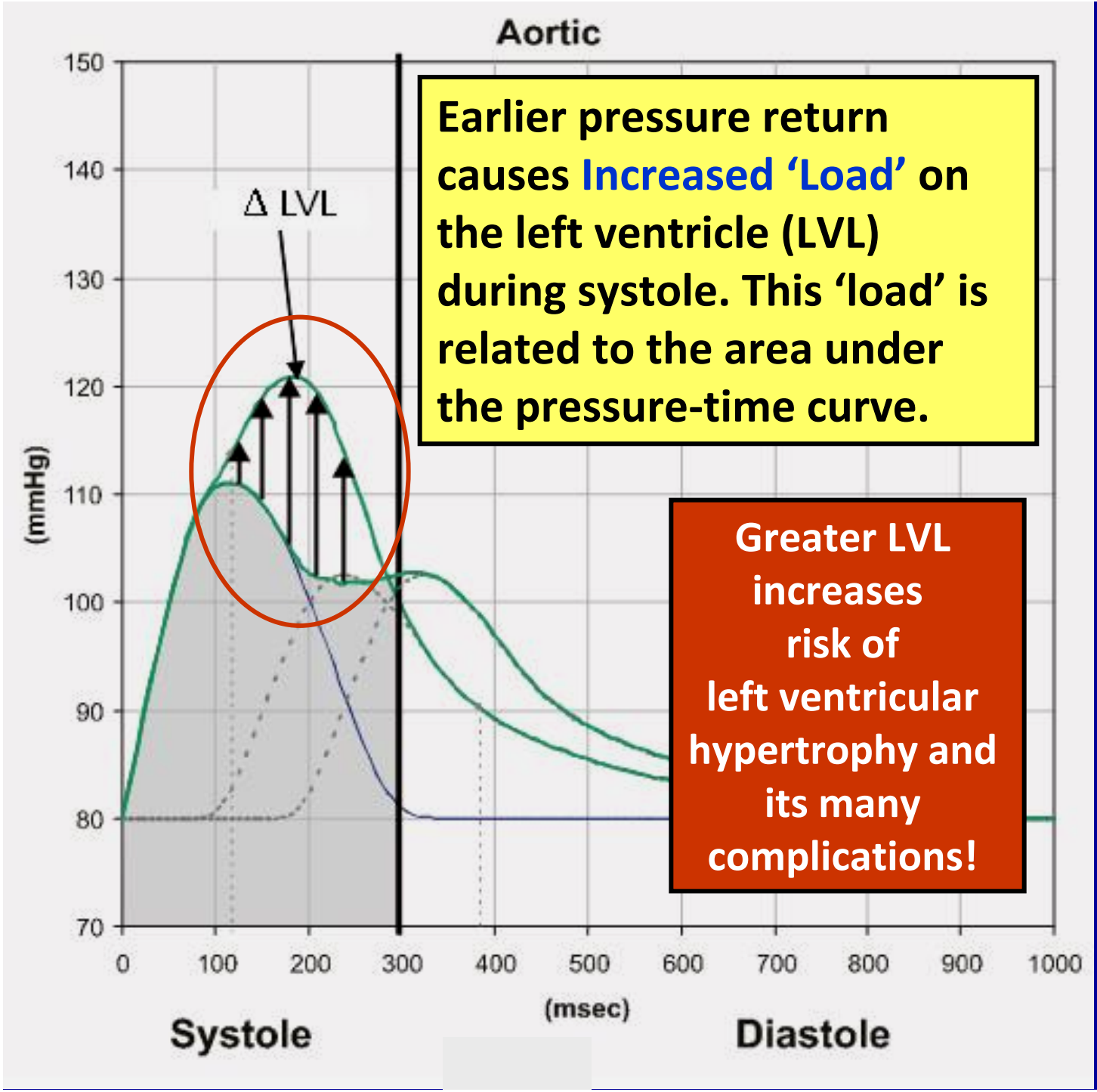
"So What"



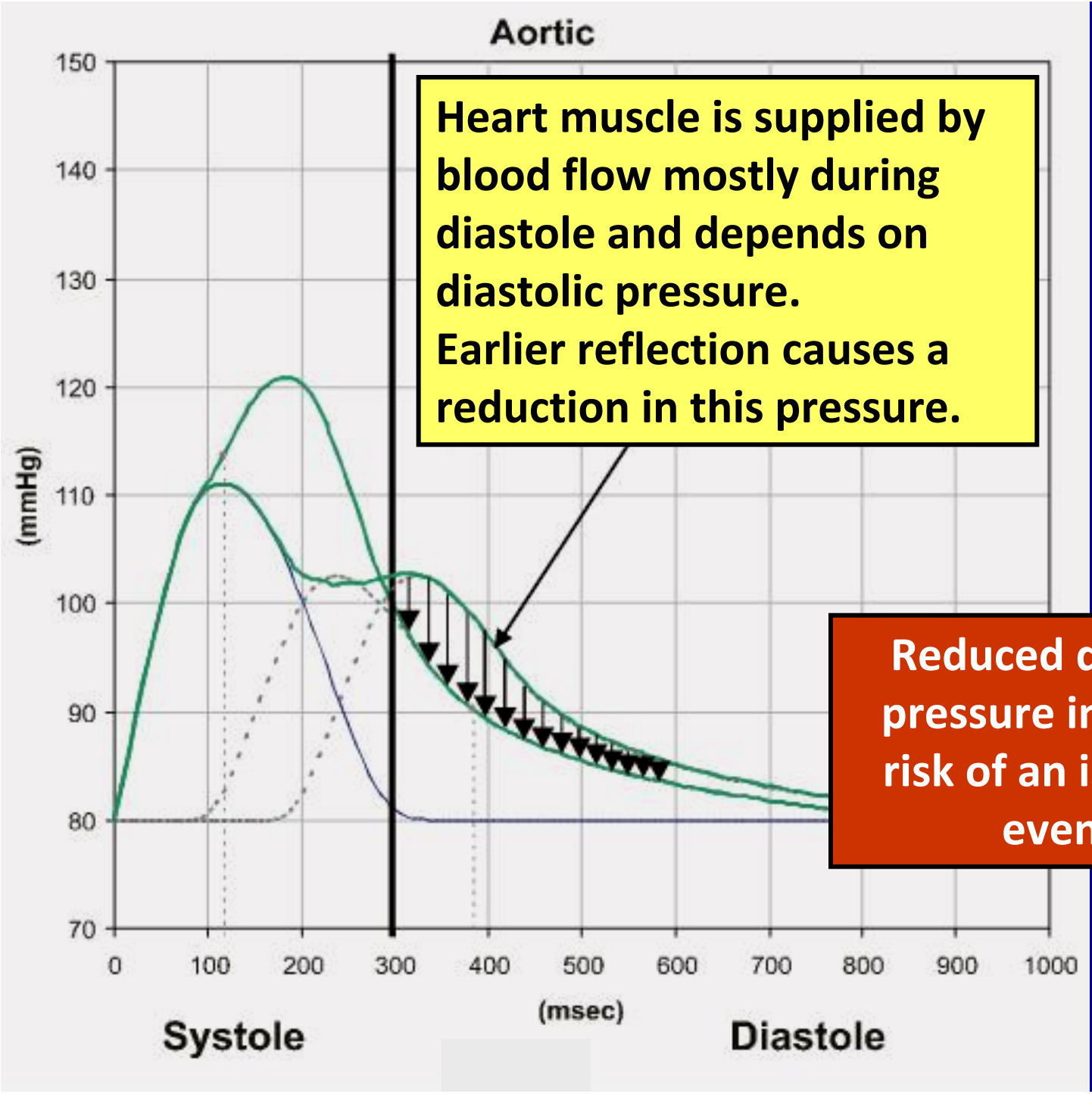
Earlier return of pressure energy causes the central pressure to have a greater systolic maximum pressure and greater pulse pressure

A greater maximum systolic pressure increases risk of cerebral stroke!

A "So What" Emerges!



A 2nd "So What" Emerges!

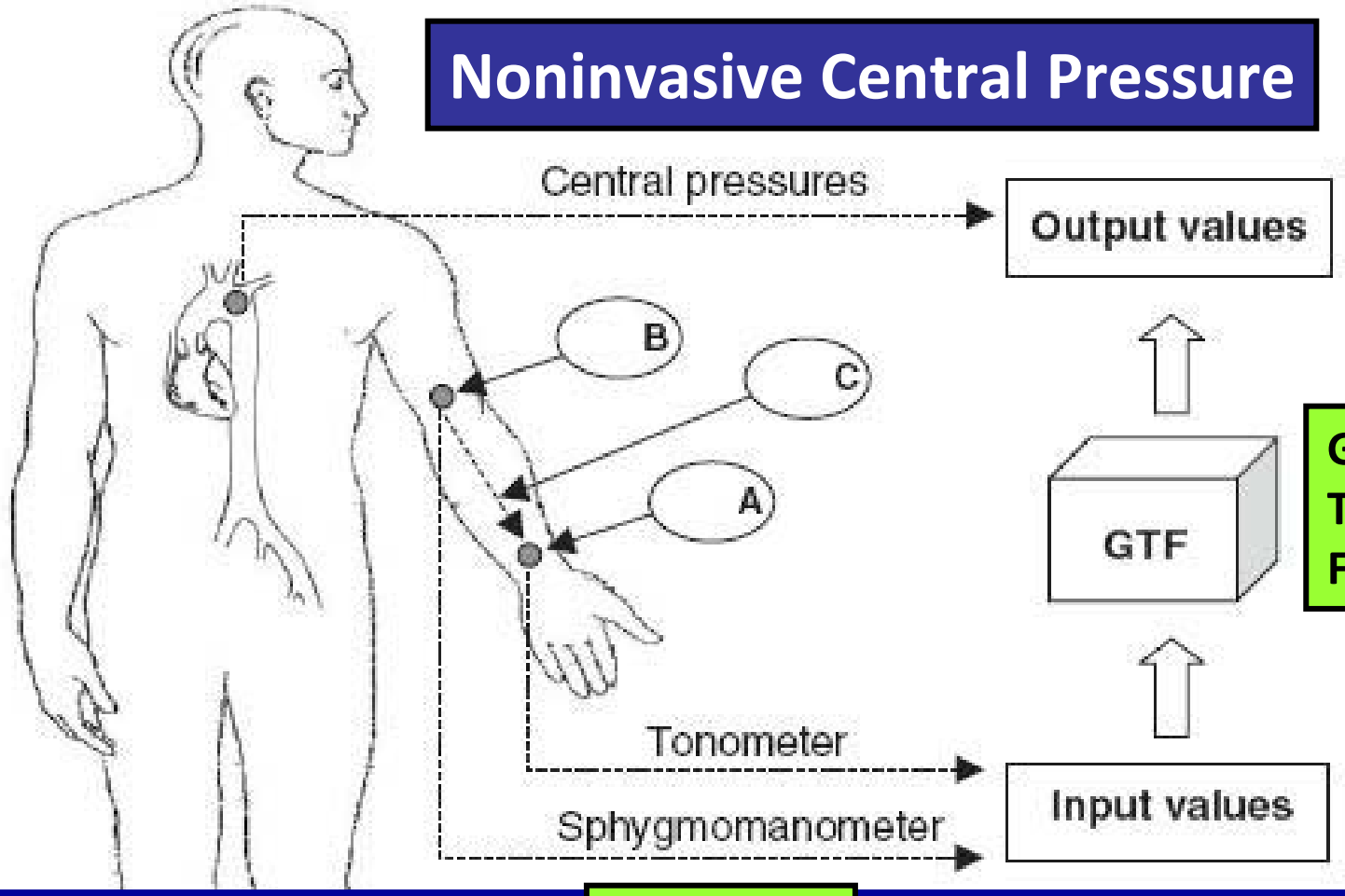


A 3rd "So What" Emerges!

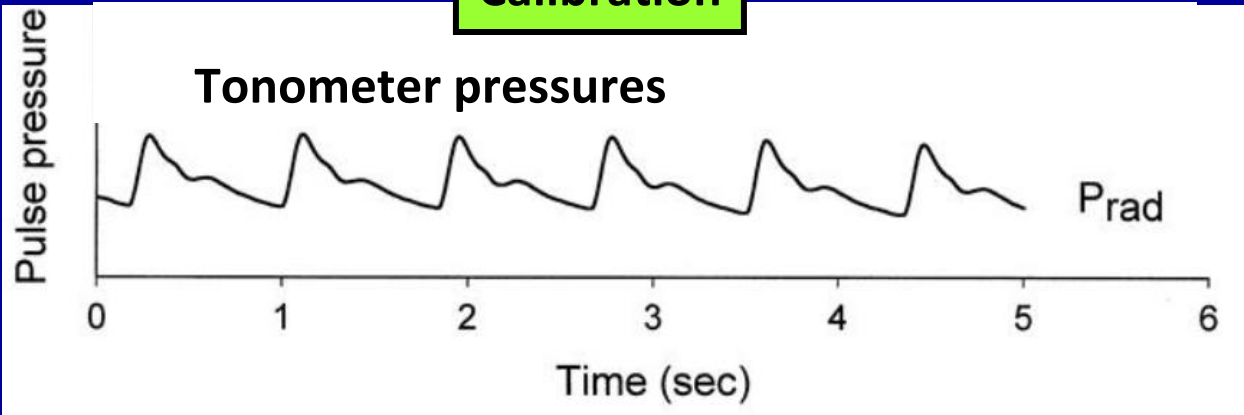
So – Standard BP by sphygmomanometry, though important and clinically useful only tells PART of the story

- Stiffening of arteries is a more-or-less general feature of the aging process
- There is a major push to be able to reliably and noninvasively assess *Aortic Central Pressure*
- More accurate risk assessment?

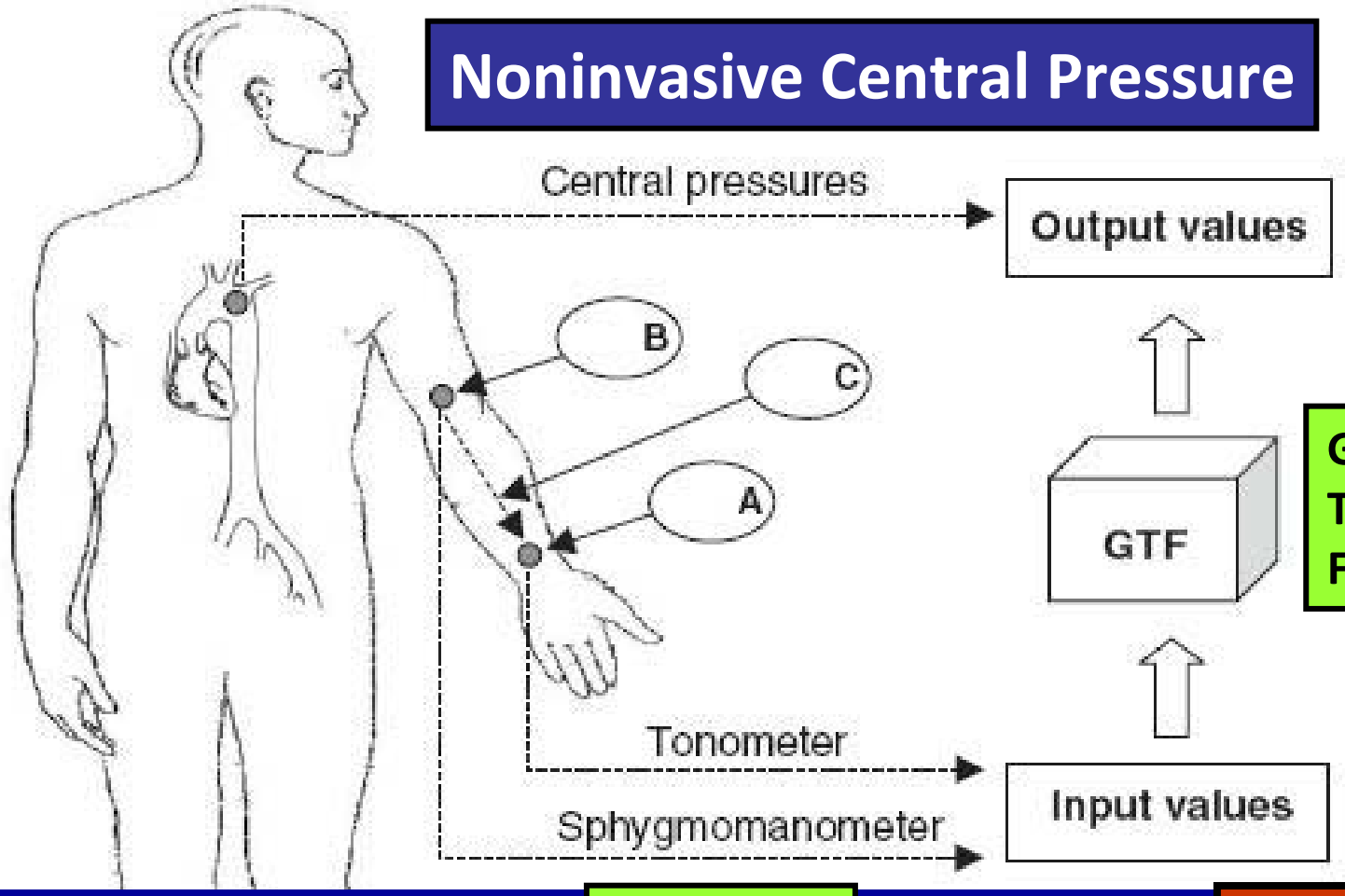
Noninvasive Central Pressure



Calibration

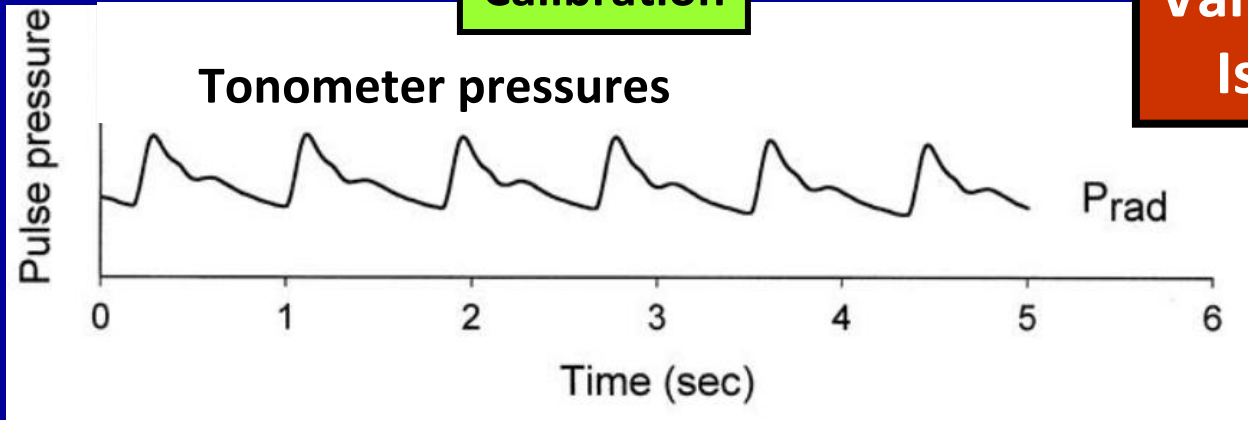


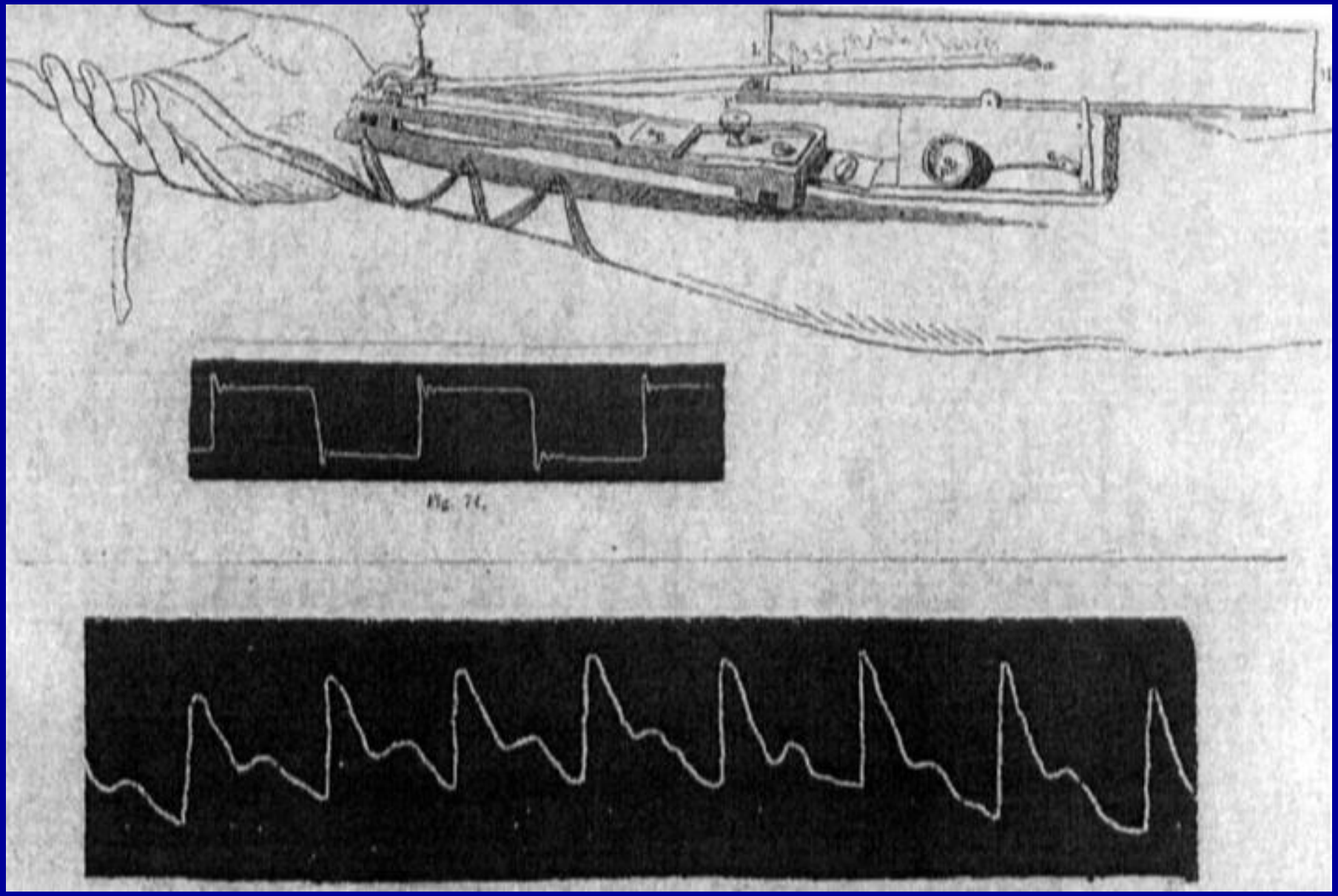
Noninvasive Central Pressure



Calibration

Validation Issues

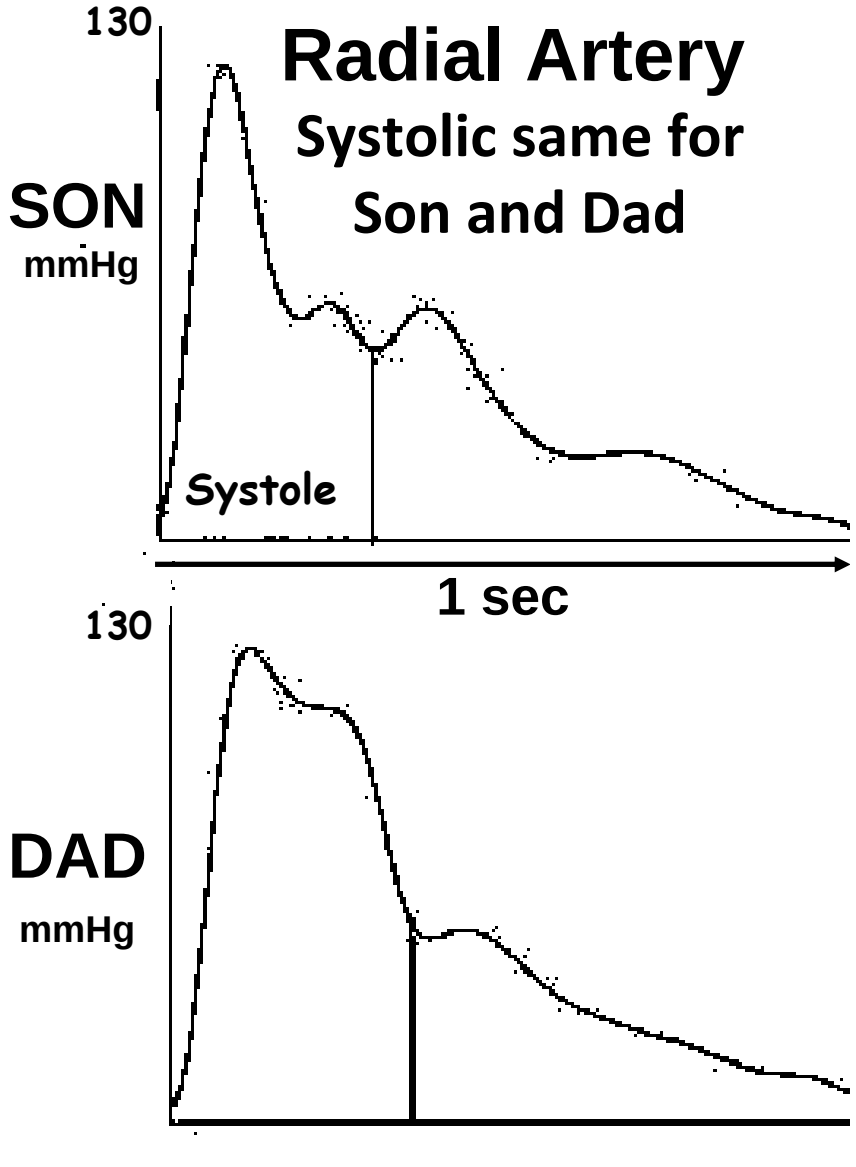




Marey EJ. Physiologie Medicale de la Circulation du Sang. Paris, France: Adrien Delahaye; 1863

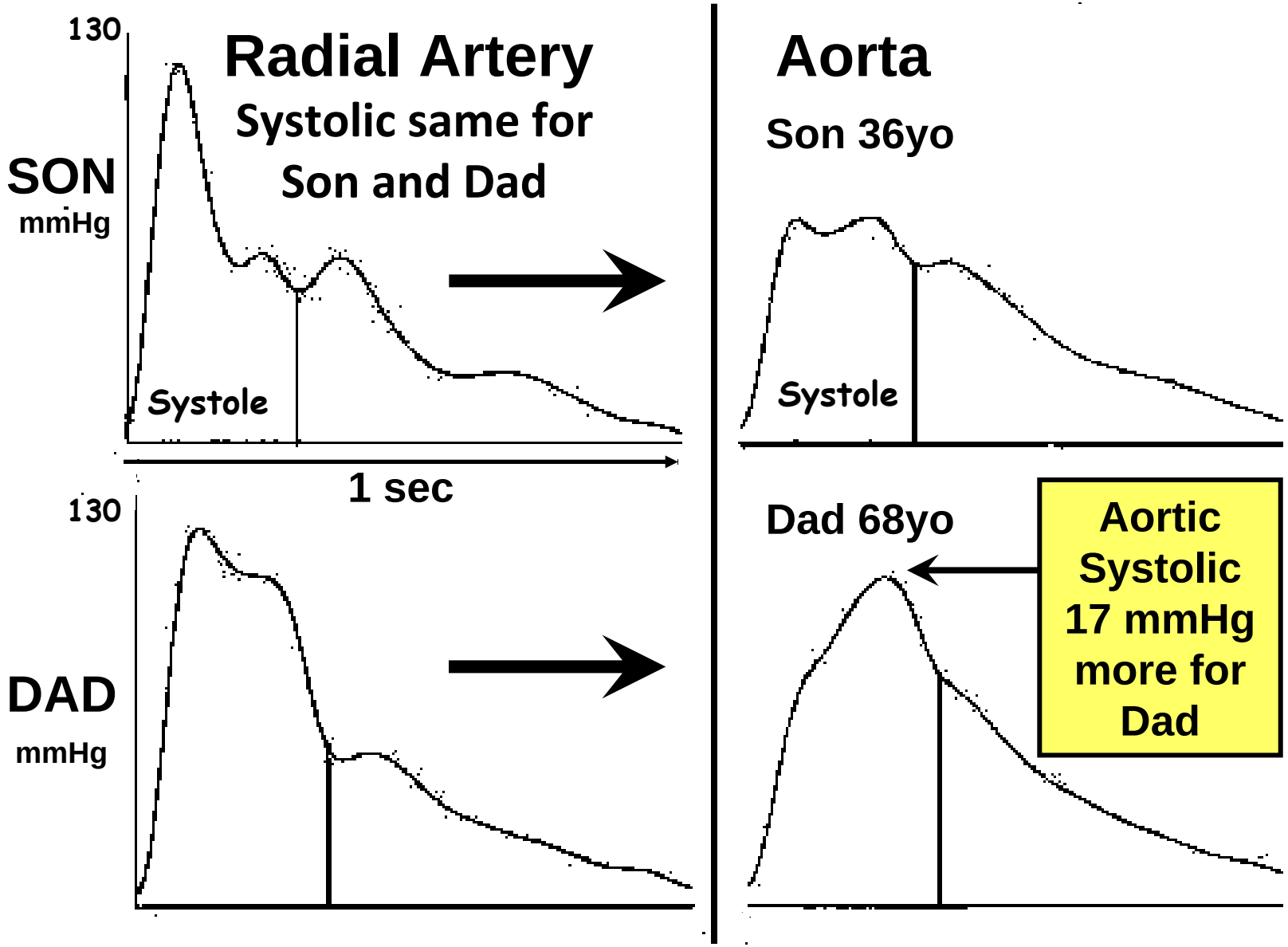
Actual Example of Principle

Son and Dad: Same Brachial Systolic Pressure



Modified from: O'Rourke, M. F. et al. J Am Coll Cardiol 2007;50:1-13

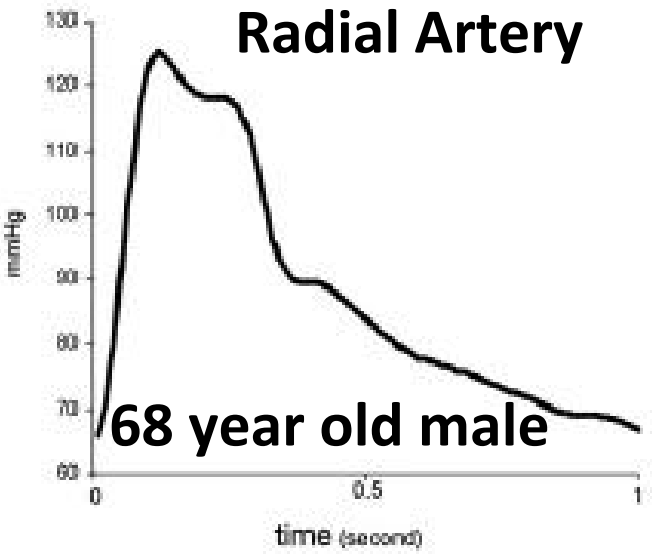
Son and Dad: Same Brachial Systolic Pressure



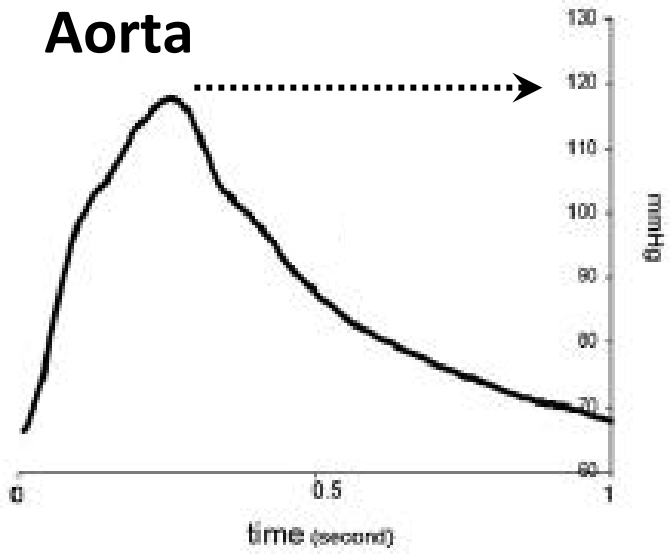
Modified from: O'Rourke, M. F. et al. J Am Coll Cardiol 2007;50:1-13

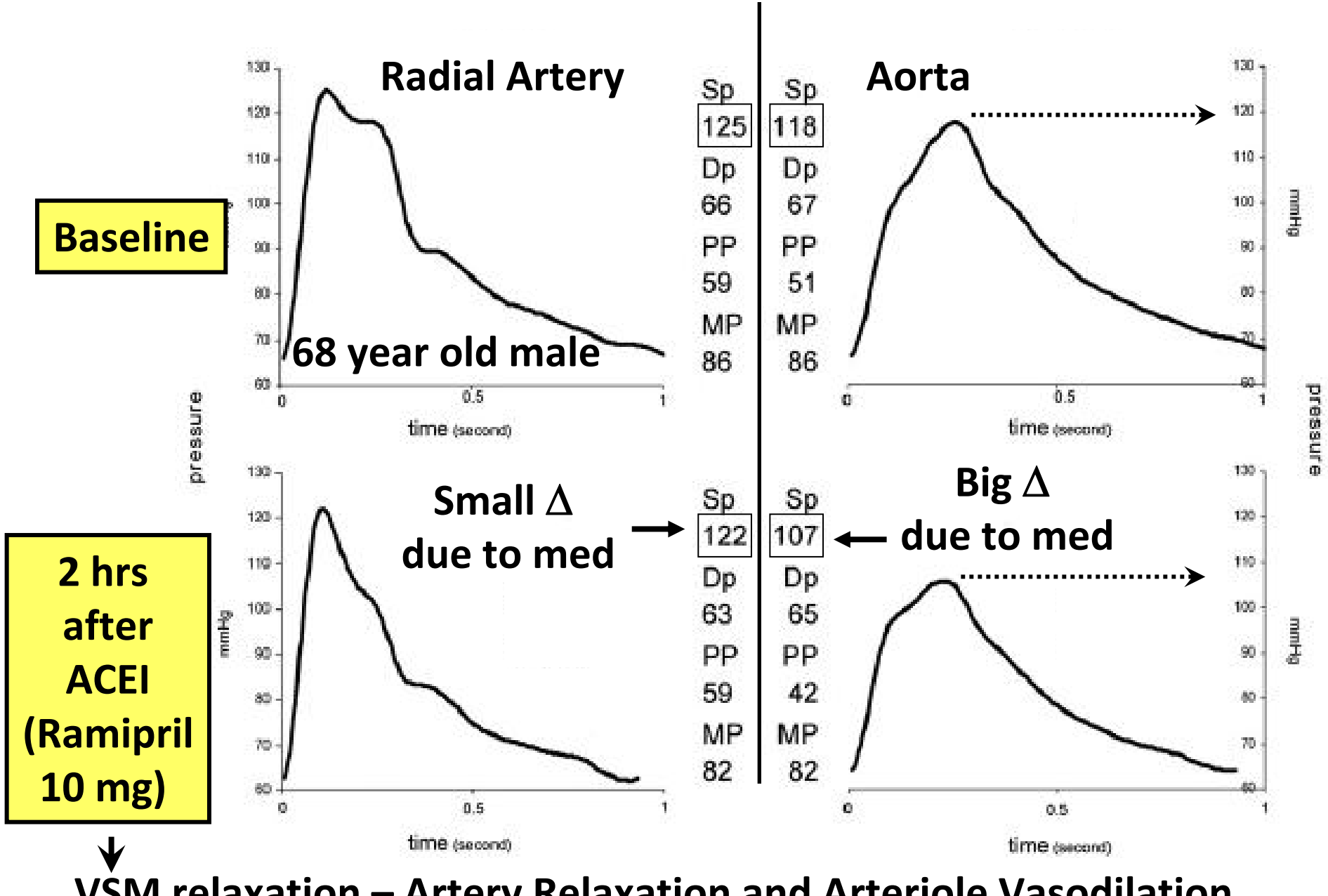
Actual Example of "Treatment" Effect

Baseline



Sp	Sp
125	118
Dp	Dp
66	67
PP	PP
59	51
MP	MP
86	86



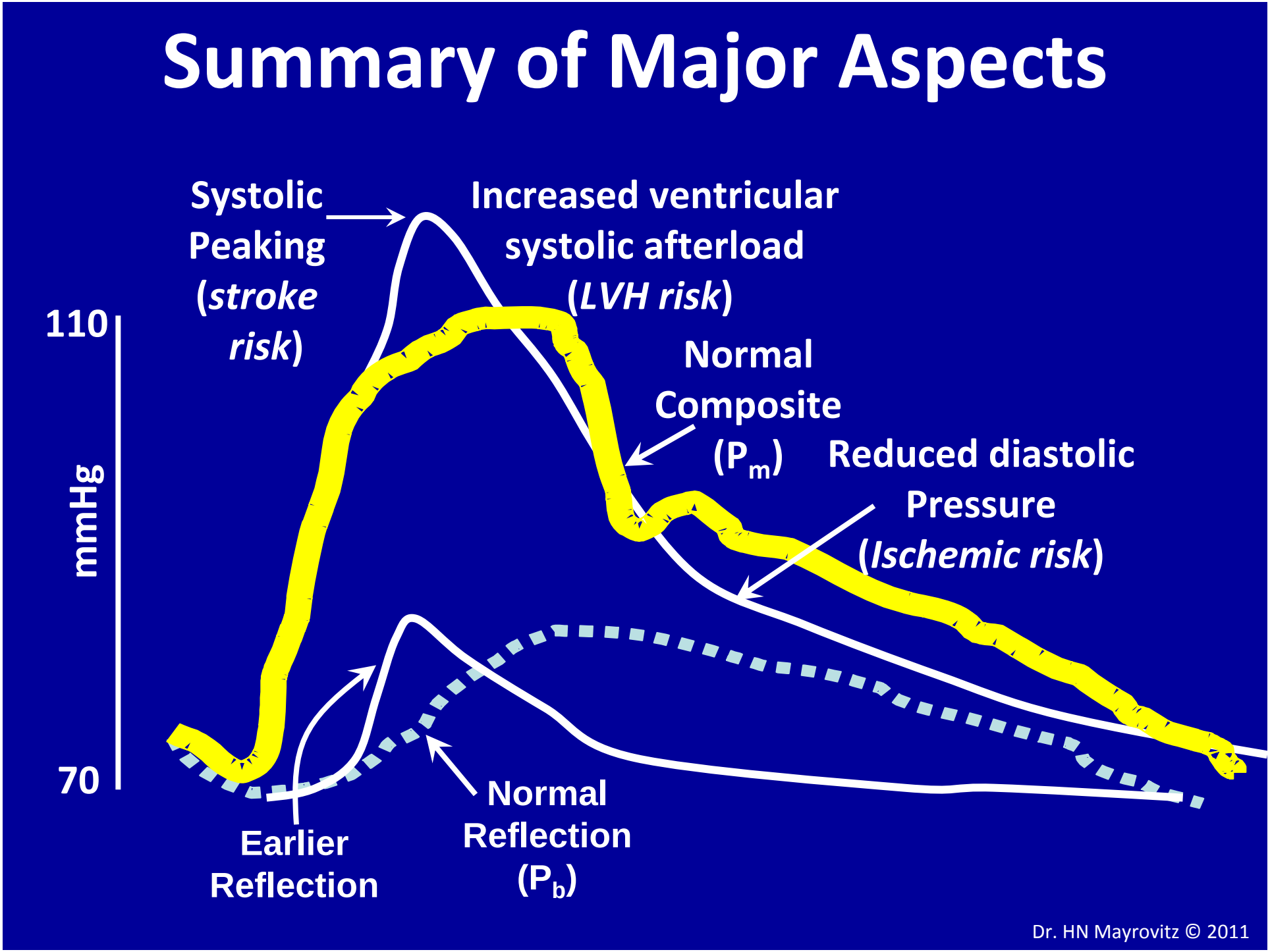


VSM relaxation – Artery Relaxation and Arteriole Vasodilation

Increases C
Reduces S_0

Reduces Reflection

Summary of Major Aspects



Conclusions

- Standard BP good but misses stuff that effects heart

- Reasons have to do with pressure wave interactions that are most directly influenced by:

  A. Pulse wave speed (Artery compliance)
  B. Reflection amplitudes (Vasoconstriction state)

  Both tend to increase with hypertension and aging

- Prediction:
  New office BP assessment devices within 4 years??


"That's
all
folks!"