

The injured brain and hemodynamics

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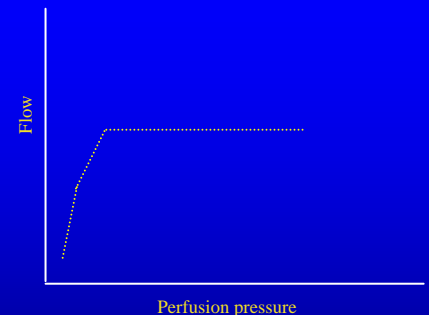
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The injured brain & Hemodynamics

- **Normal brain**
 - Well developed autoregulation
 - Maintenance of constant flow at different levels of perfusion pressure
- **Injured brain**
 - More or less disturbed autoregulation

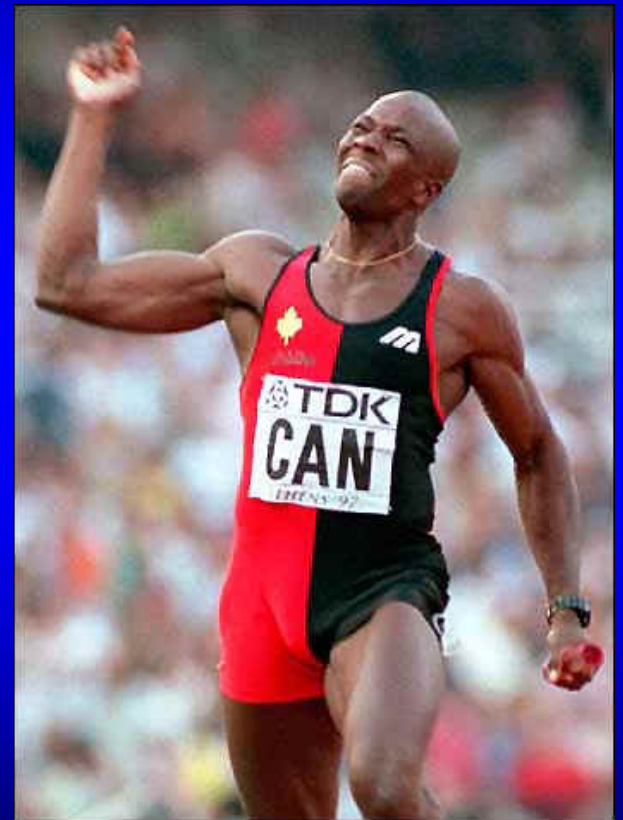


The injured brain & Hemodynamics

- **The brain**
 - Does not forgive !! (like other organs)
 - The mean or median does not count!!
 - If you do 10 weeks perfectly, but 5 minutes not, only the 5 minutes will count
 - Only a winner when you win all & always!!



Winners



The injured brain & Hemodynamics

- **Goals of hemodynamic therapy**
 - maintain sufficient **FLOW**
 - (oxygen rich blood)
 - maintain sufficient **PERFUSION PRESSURE**
- Continuous measurements
- Instantaneous action whenever necessary



The injured brain & Hemodynamics

- **What happens during (induced) hypothermia**
 - Shivering → higher energetic demands → HR ↑
 - to be prevented
 - HR ↓ SVR ↑ SV ~ MAP ~
 - Risk of arrhythmias
 - avoid PA catheter (opinion)



The injured brain & Hemodynamics

- Assessment of preload
- Target for “optimal preload”
 - Def.: further increase of preload will not increase SV
- Assess circulatory sufficiency
 - not “high”, not “low” but “sufficient”
- Use of vasoactive drugs



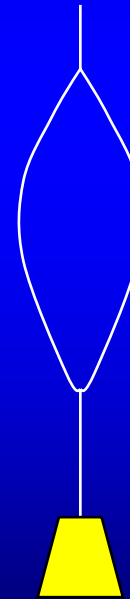
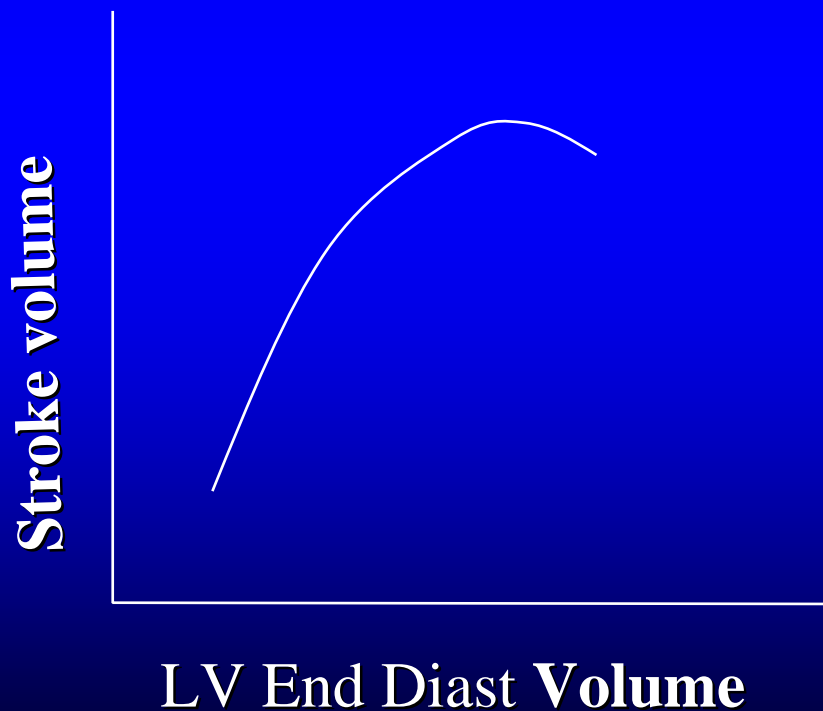
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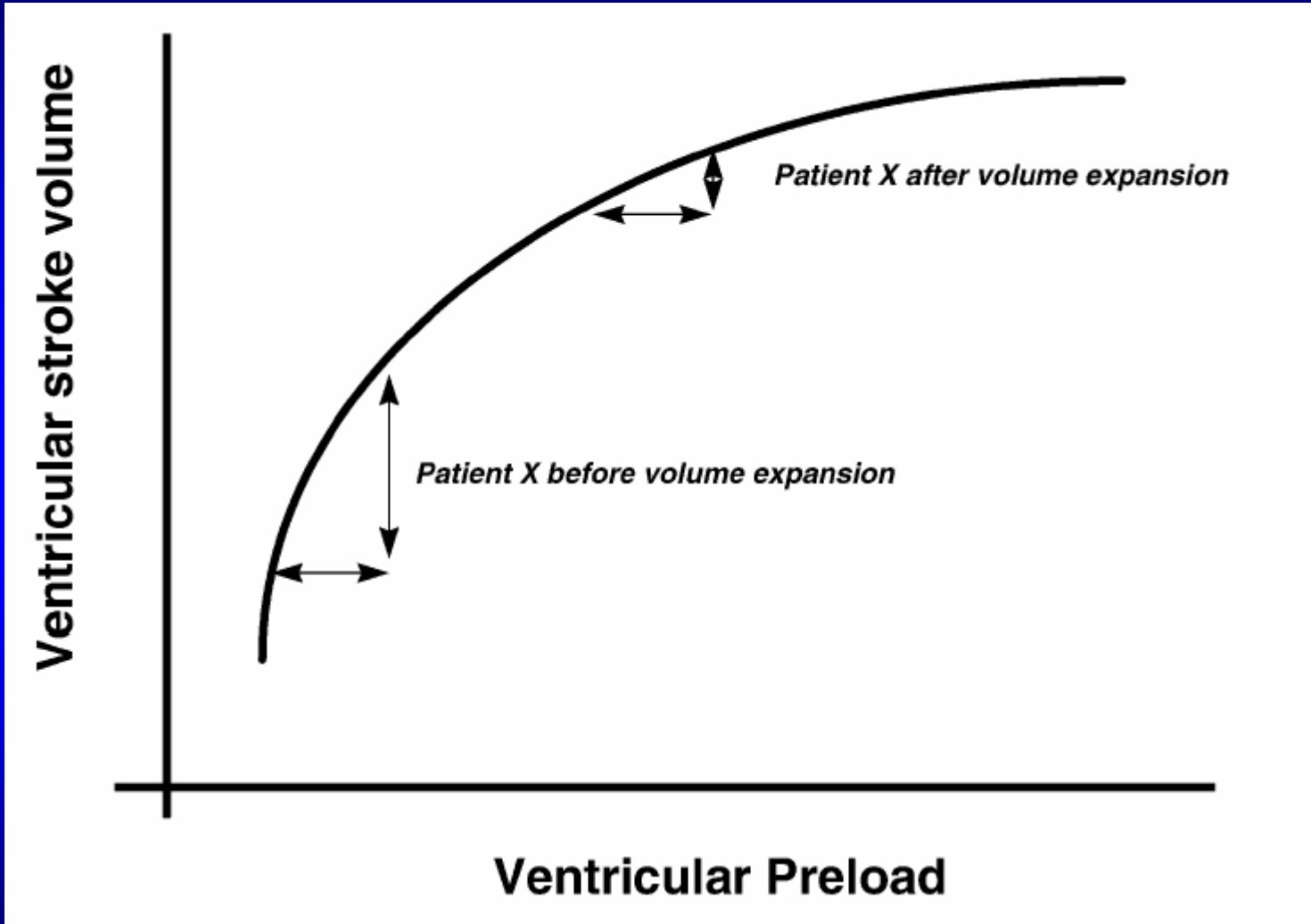
- Assessment of



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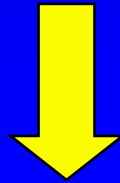
- Physiological cardiac reserve



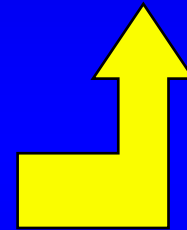


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Indication for fluid administration

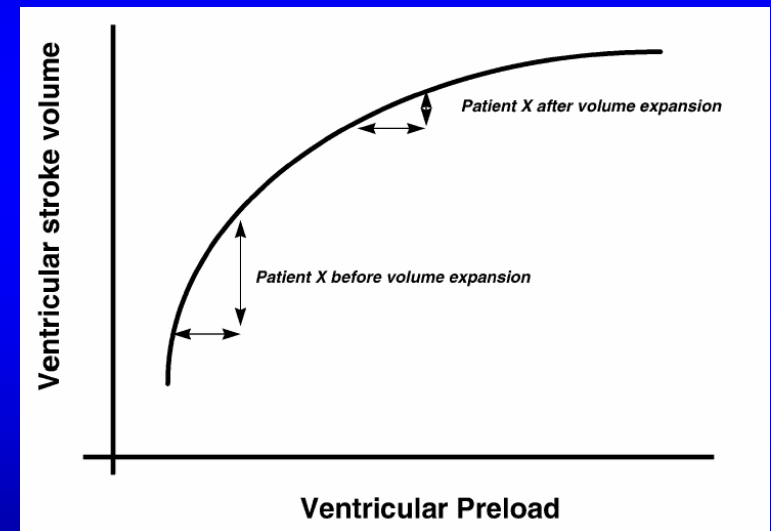


Effect fluid administration



Vochtbeleid

- **Indices of "fluid responsiveness"**
 - In mechanically ventilated patients
 - Fluidadministraion
 - Favorable in steep part
 - Unfavorable in flat part



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Hypovolemia

- **Suspicion of hypovolemia**
 - NOT one single parameter
 - BP, HR, circulatory indices – diuresis / physical exam
 - CVP (curve), [PAOP, CO / SV]
 - Arterial curve
 - Signs of poor peripheral perfusion: lactate, SvO₂
- **Effect of fluid administration**
 - BP, HR, etc
 - CVP (curve), [PAOP, CO / SV]
 - Arteriale curve
 - Signs of peripheral perfusion, lactate, SvO₂



The injured brain & Hemodynamics

Vigilance armée & permanente

- **Properties of heart change continuously**
 - Compliance (→ Starling curve)
 - Contractility
- **Changing vascular bed**
- **Effects of mechanical ventilation**
- **Effects of changing body temperature**
- **Fluid loss**
 - Diuresis – transpiration/ perspiration
 - Ascites – pleurafluid
 - Capillary leakage



The injured brain & Hemodynamics

- **Measure response on therapy**
(fluid challenge)
 - Bedside!!!!
 - Important role physician & ICU nurse



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Vigilance armée & permanente

- Target: CVP 18 mm Hg

WRONG



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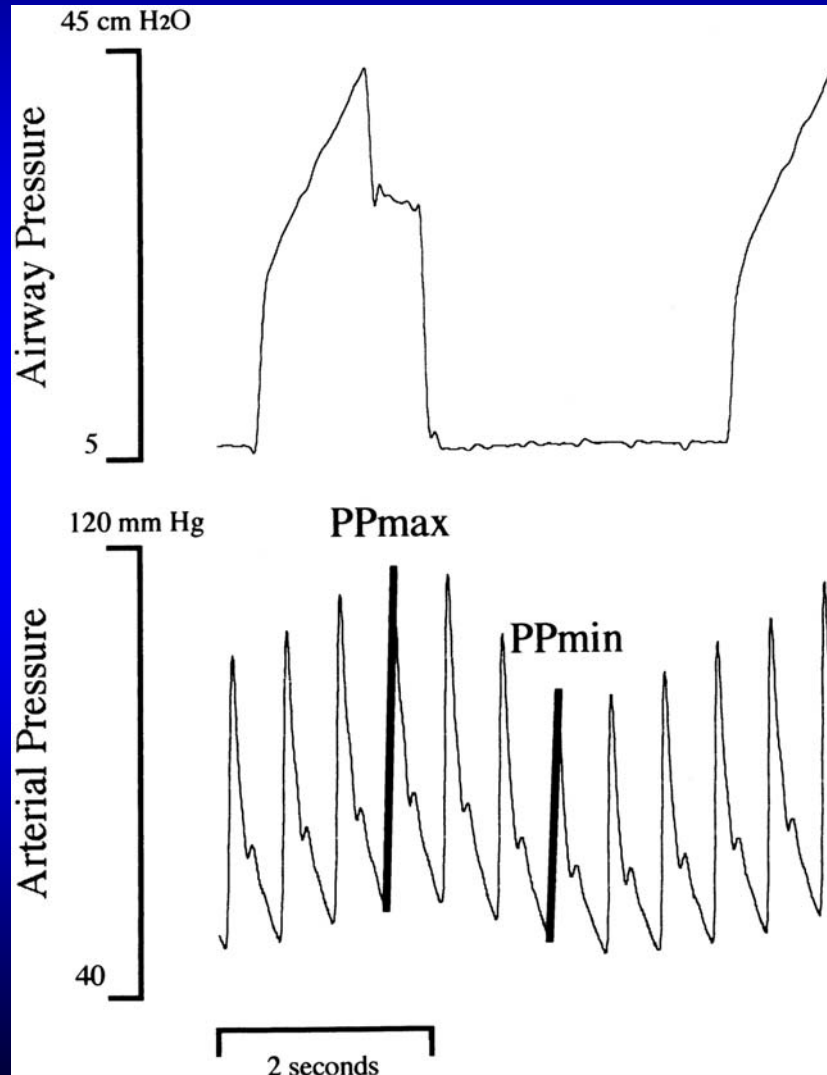
Simple predictors of fluid responsiveness bedside

- Leg tilt - effect on RR / HR / CVP / CO / SV
- Systolic pressure variation
- Pulse pressure variation



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Pulse Pressure variation



Vochtbeleid

- **Pulsepressure variation**
 - n=40 circulatory failure (in sepsis)
 - Response on 500 cc colloid
 - Distinguish
 - Responder = increase CI > 15%
 - Non-responder

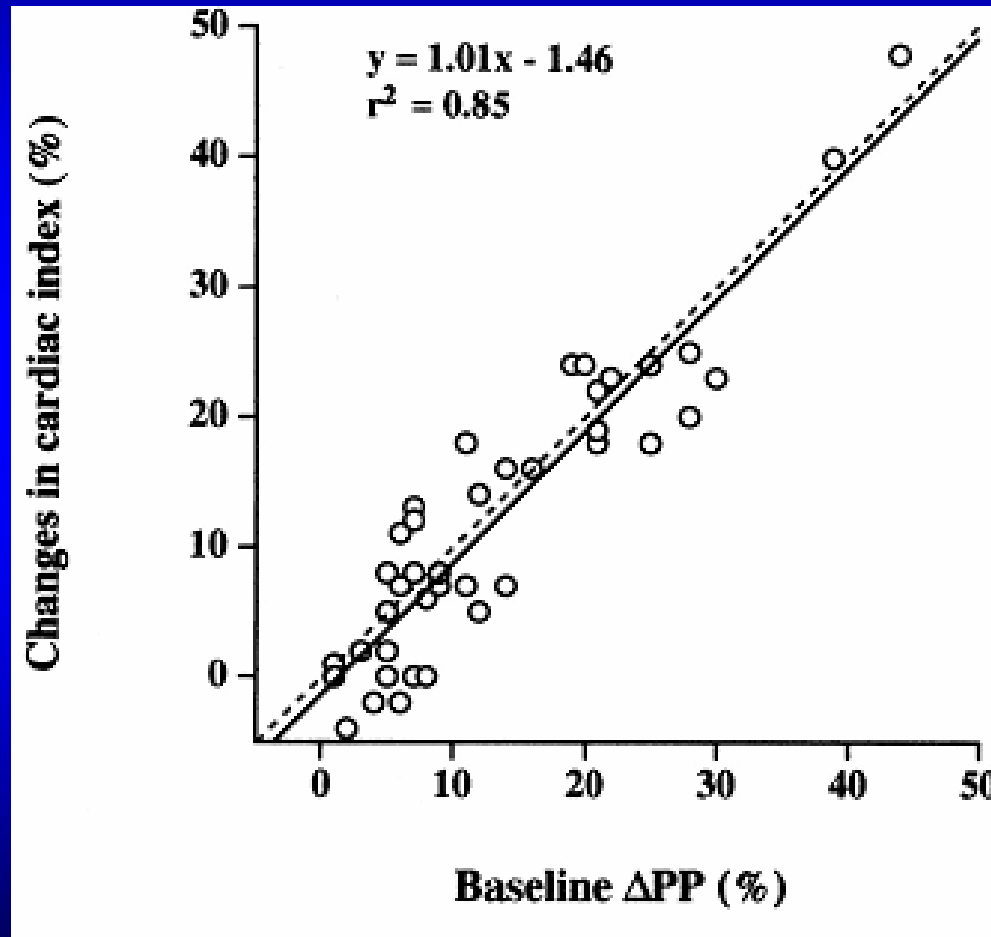


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- **Pulse-pressure variation (delta-PP)**
 - Delta-PP (PPV) = $PP \text{ max} - PP \text{ min} / PP \text{ mean}$
→ in %
 - PPV \geq 13% distinguishes (non-) responders
 - Sensitivity 94%
 - Specificity 96%



Correlation PPV & change in CI



The injured brain & Hemodynamics

- **What if fluids are not enough?**
 - problem brain
 - problem heart (post resuscitation, post coronary intervention)
 - other? e.g. vasoplegia / sepsis / SIRS/ etc.



The injured brain & Hemodynamics

- Use of inotropes

	<i>DA1</i>	<i>DA2</i>	<i>alpha1</i>	<i>alpha2</i>	<i>bèta1</i>	<i>bèta2</i>
Dobutamine	0	0	0-1*	0	2	1
Dopamine	2	1	1-2*	0-1	1-2*	0-1*
Dopexamine	1	0-1	0	0	0-1	2
Noradrenaline	0	0	2	1-2	1-2	1
Adrenaline	0	0	2	1-2	1-2	2
Isoprenaline	0	0	0-1*	0-1*	2	1
Fenoldopam	2	0	0 [#]	0	0	0



The injured brain & Hemodynamics

- **The brain needs**
 - flow
 - perfusion pressure



The injured brain & Hemodynamics

Vaso-active drugs

- **My experience:**
Norepinephrine allergic syndrome
 - specific effects of norepinephrine in the ICU
 - substantial increase in heart rate + BP
 - rise in temperature
 - aggressive behavior
 - rare cases: fighting behavior
 - strangely: not in patients



Metabolic effects

Vaso-active drugs

- **Norepinephrine allergic syndrome**
 - epidemiology
 - mainly in (cardiothoracic-) surgeons
 - cardiologists
 - case of norepinephrino-phobia



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Norepinephrine

- **Norepinephrine is bad for the heart**
 - Deleterious effects on aerobic metabolism
 - Increases BP
 - Increases Systemic Vascular Resistance
 - Induces vasoconstriction
 - Induces coronary vasoconstriction
 - Induces ischemia
 - Is it this simple?



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norepinephrine

- **Norepinephrine**
 - potent peripheral vasoconstrictor
 - widely used in the ICU
 - vasoplegic shock
 - during cardiac shock ?!@
 - restores perfusion pressure
 - e.g. can improve brain perfusion, renal function



The injured brain & Hemodynamics

Norepinephrine and the Heart

- **Norepinephrine – cardiac effects**
 - induces coronary vasodilation
 - improves coronary circulation
 - improves oxygen delivery
 - improves endocardial oxygen delivery
 - reduces infarct size

Sun et al. July 2002, Circulation

Hoffman & Spaan, 1990



The injured brain & Hemodynamics

- **Conclusions**
 - Maintain perfusion pressure AND flow
 - Sufficient is enough. “Better is the enemy of good”
 - Very very close observation of hemodynamics
 - Optimal preload
 - PPV and other indices
 - Vaso-actives based on hemodynamic profile
 - norepinephrine is not bad for the heart

