

# Brain Protection and neuromonitoring in neonatal aortic arch surgery

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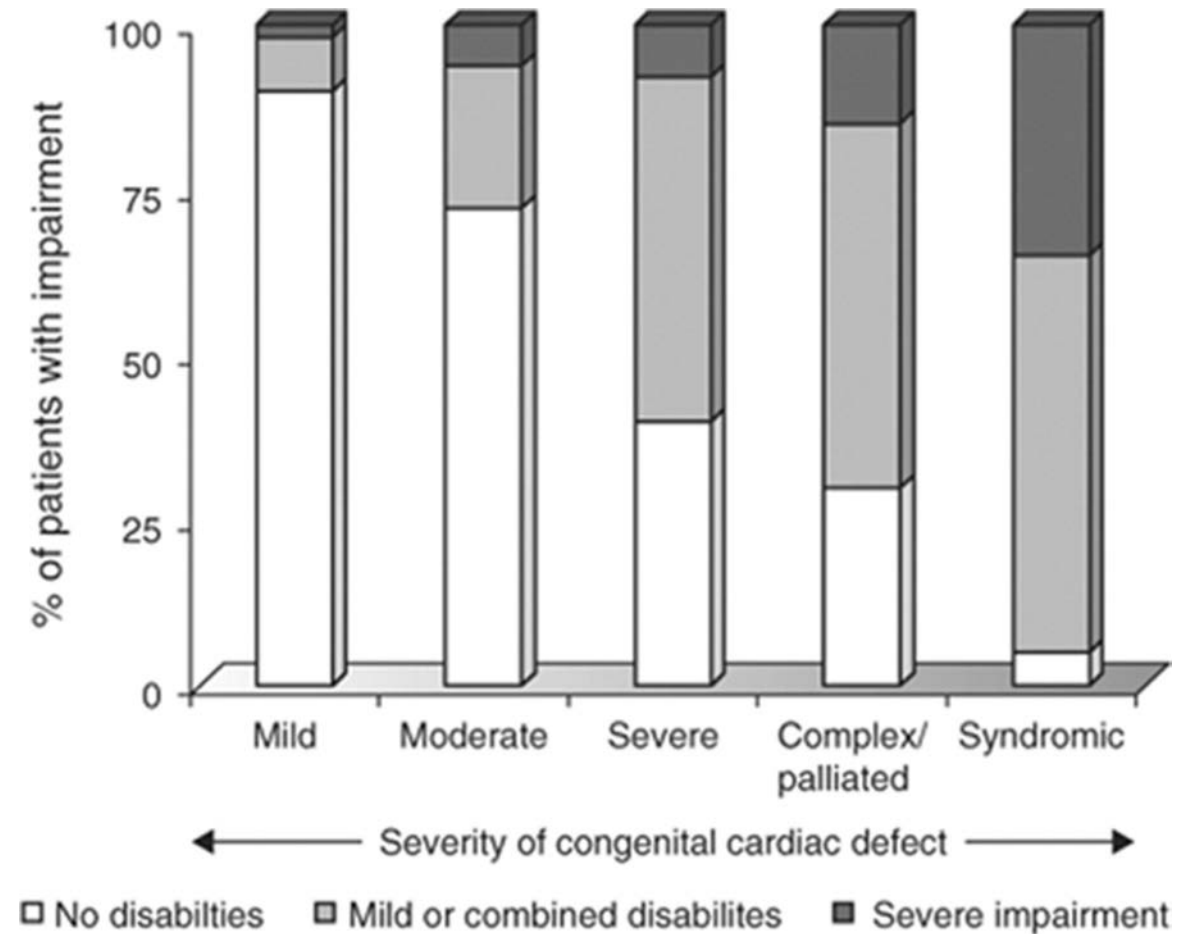
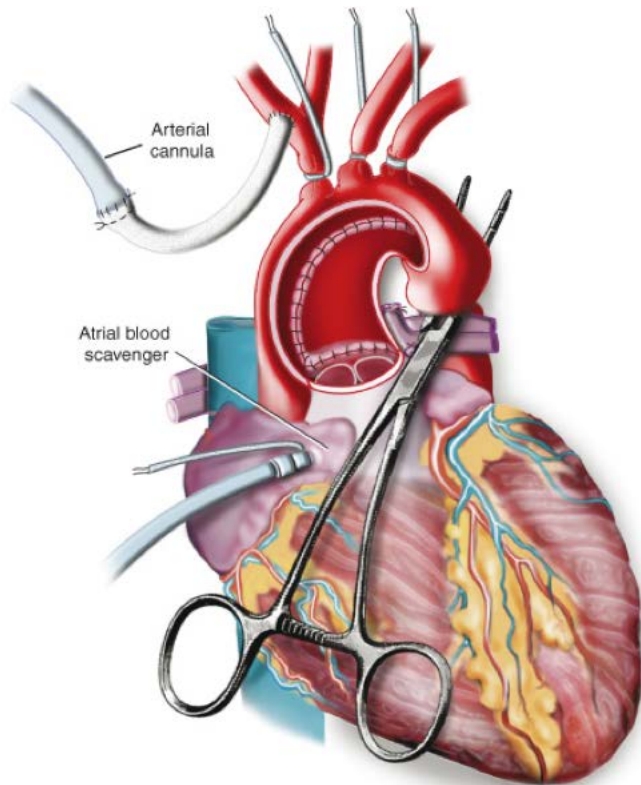
February 8, 2020



No disclosures

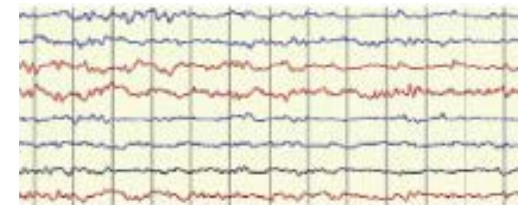
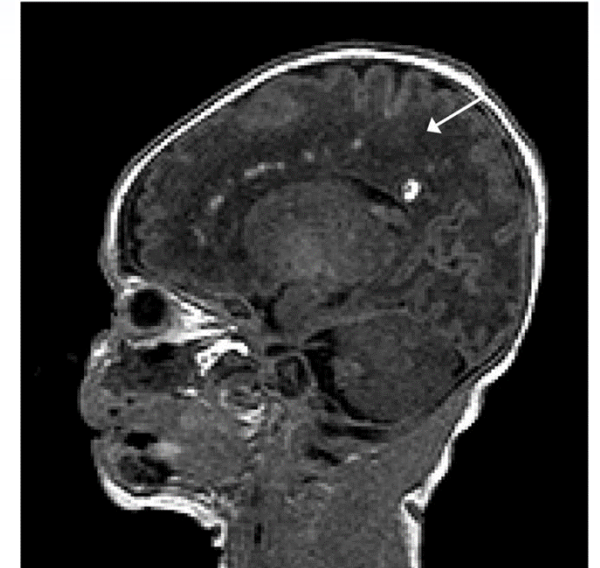


# Increased surgical complexity = decreased I.Q.

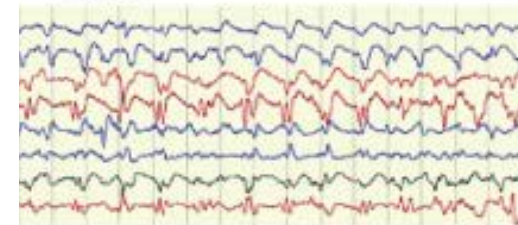


# Latest Seizure data from CHOP

- 8% of 739 neonates had seizure after CPB
- Full montage recording
- 85% clinically silent
- Associated with death
  - 27% with seizure died vs. 5% without seizure died

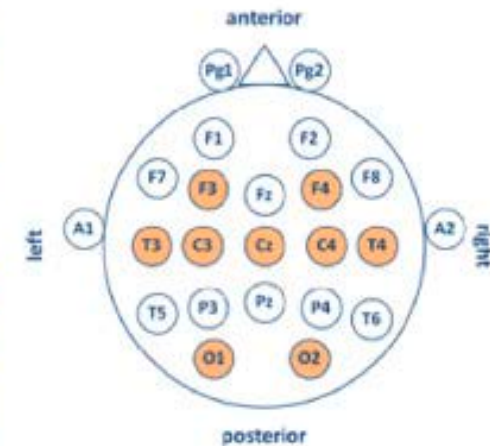


normal



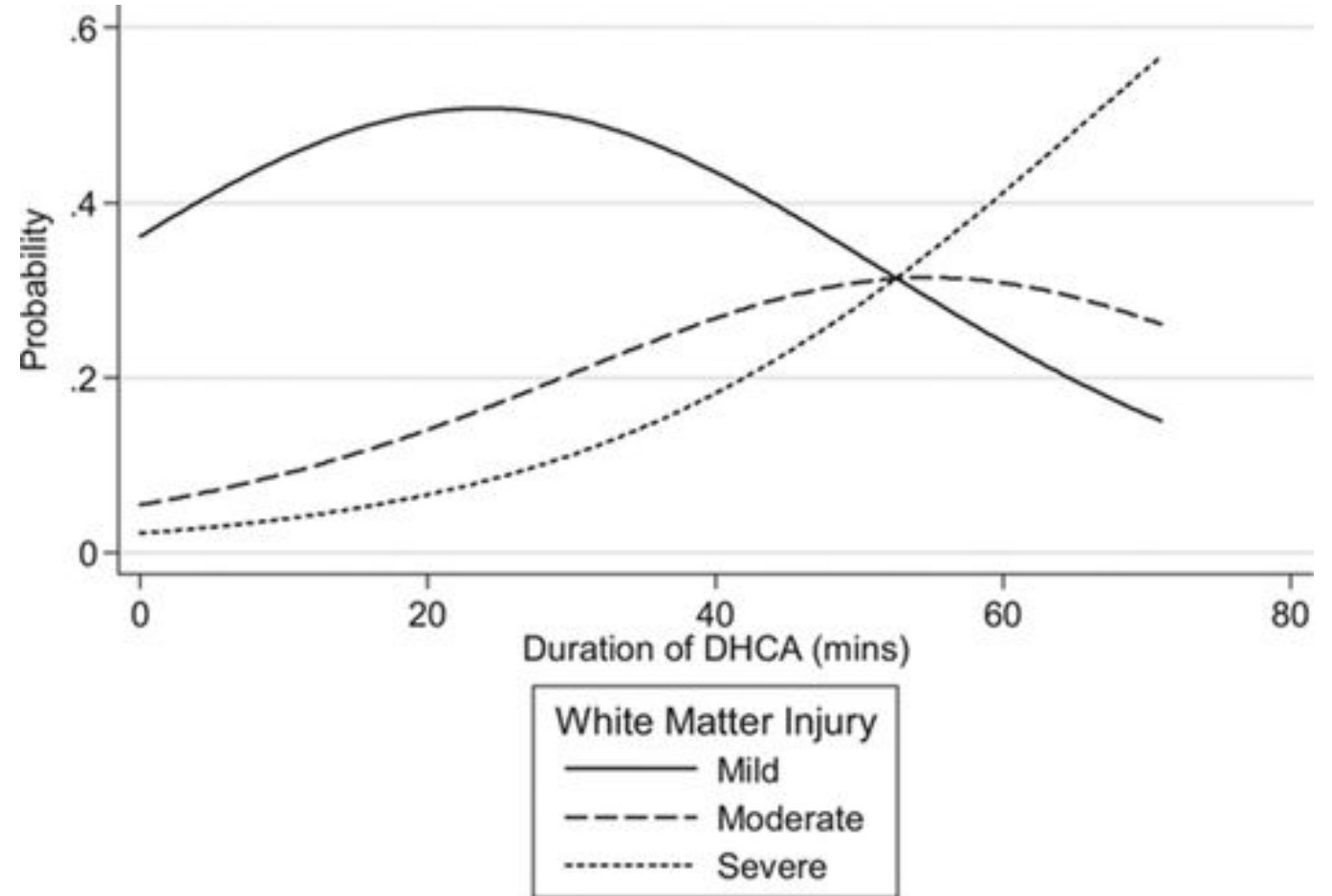
seizure

(a)



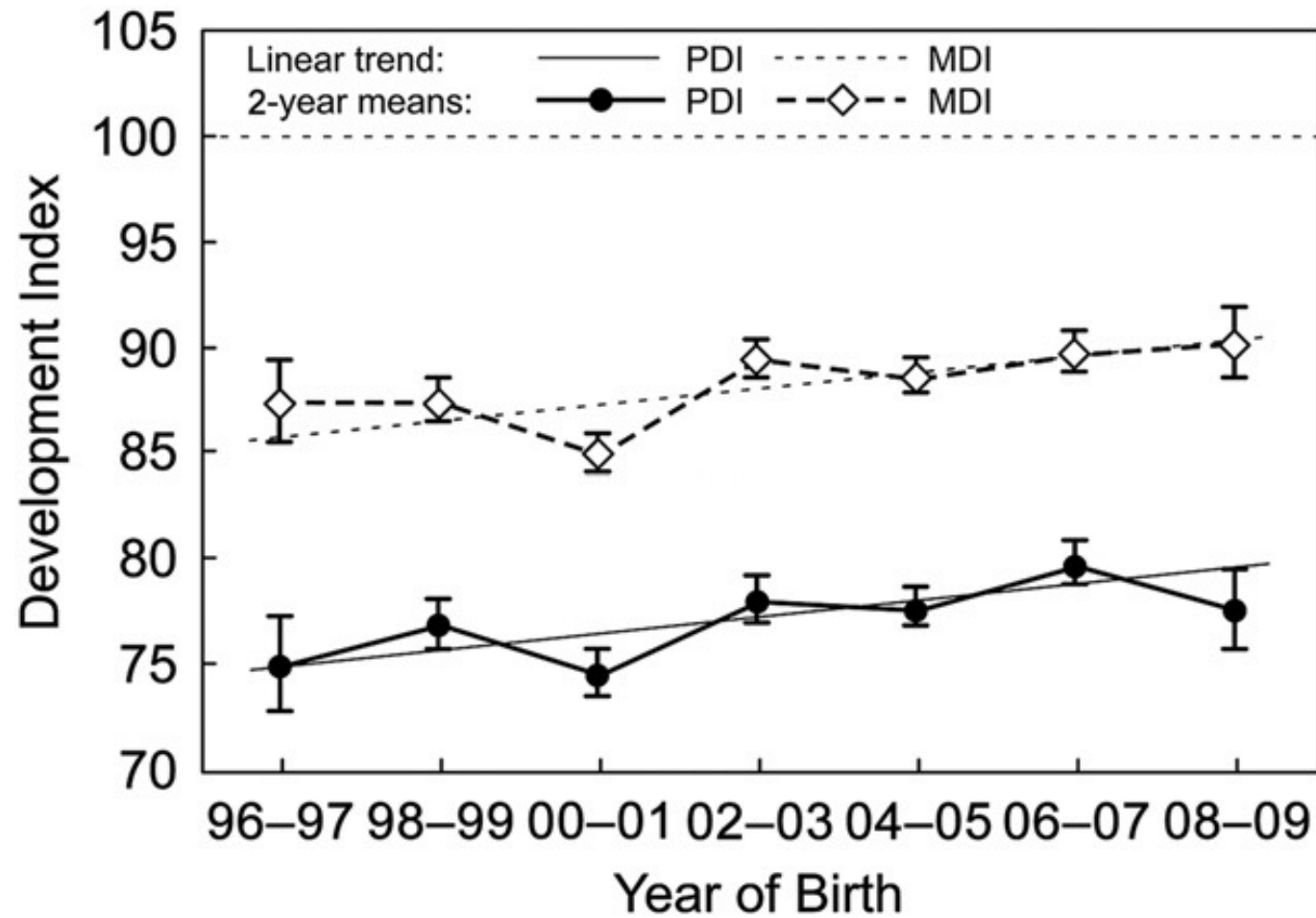
(b)

# Modifiable?

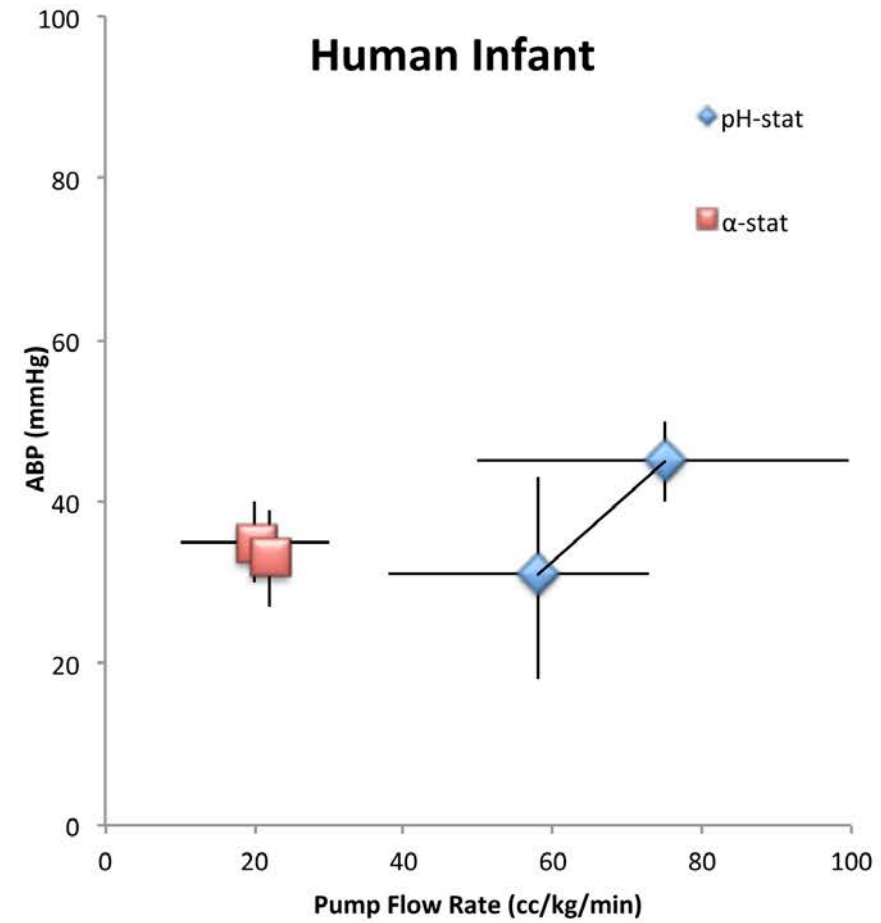
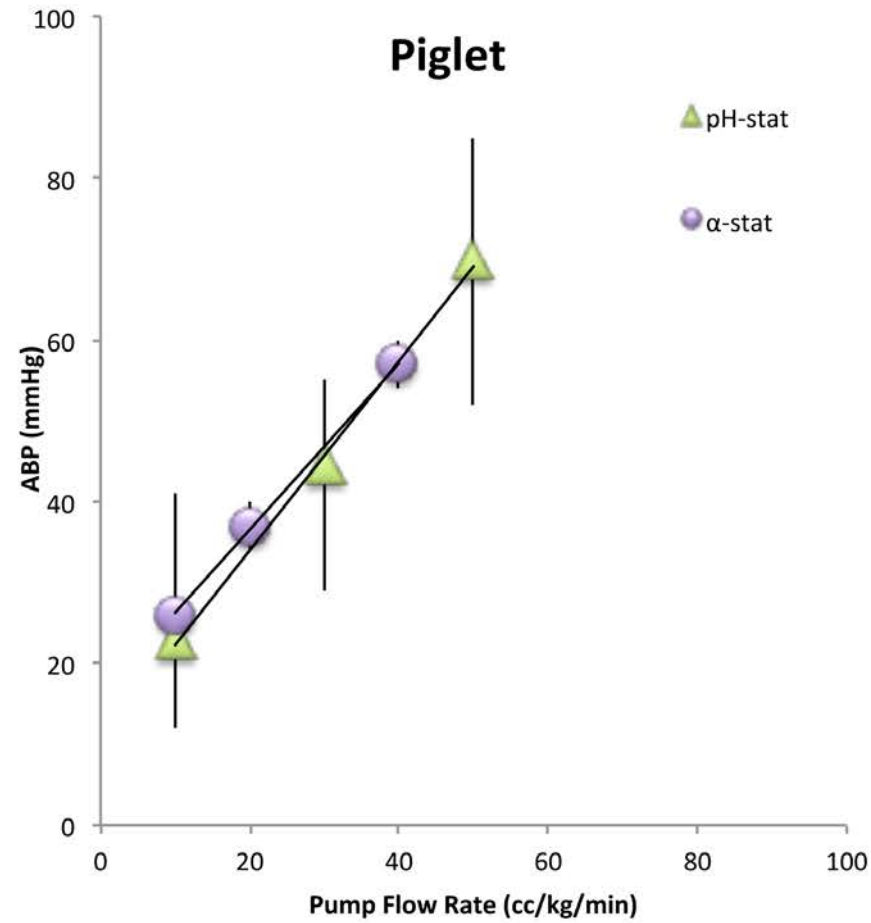


Assuming median values (CPB time of 191 mins, brain maturation score 11 & no WMI before surgery)

# Not Modifiable?

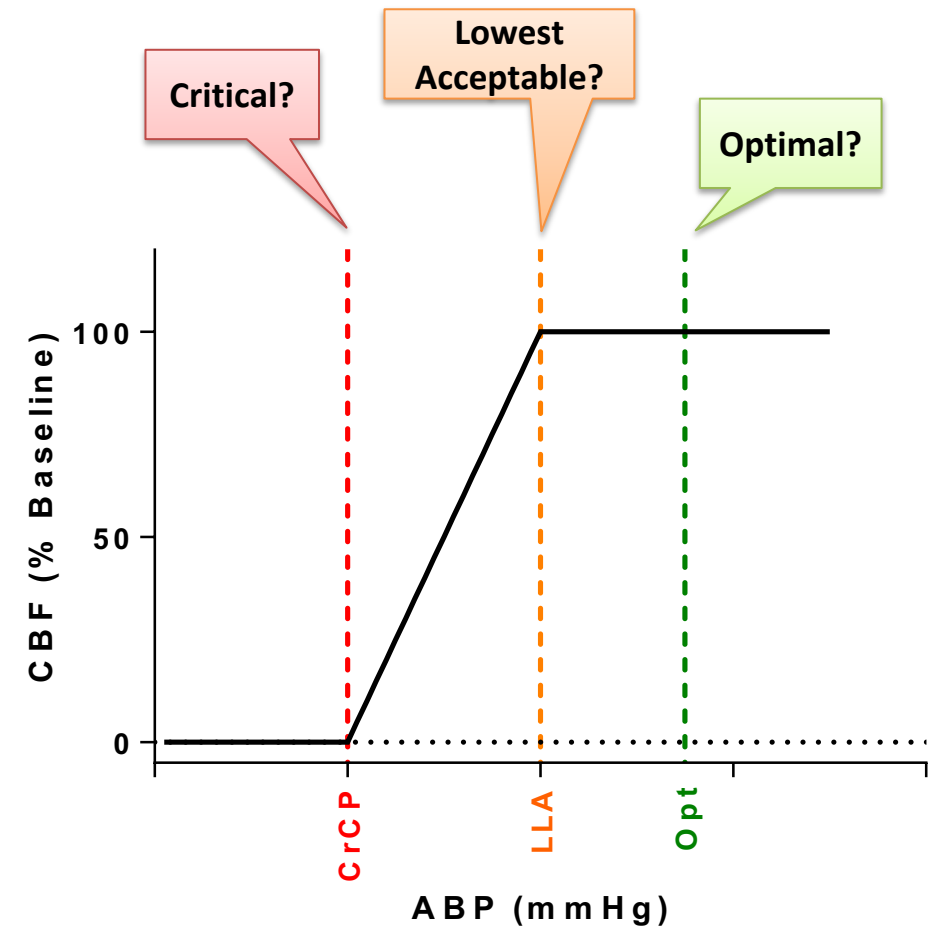


# SACP: How much flow?



# Objectives

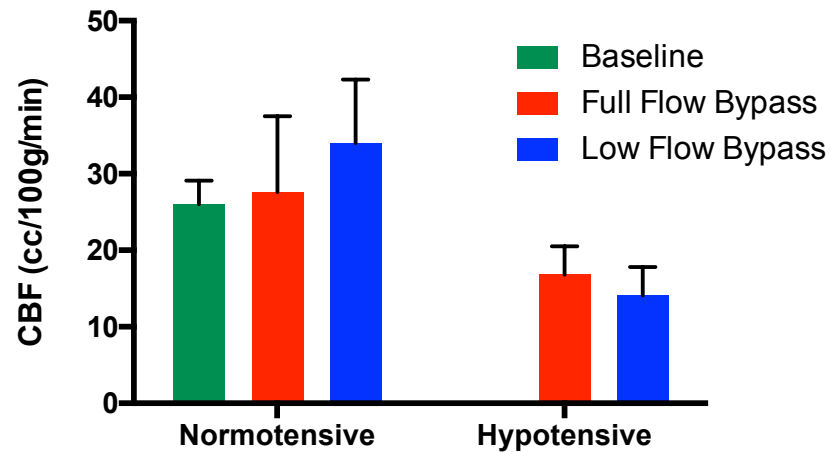
1. Delineate differences in organ perfusion between the brain and viscera
2. Critically compare methods to quantify cerebrovascular autoregulation
3. Formulate a reasonable evidence burden for the use of autoregulation monitoring in clinical practice



# I. The difference between cerebral and renal perfusion



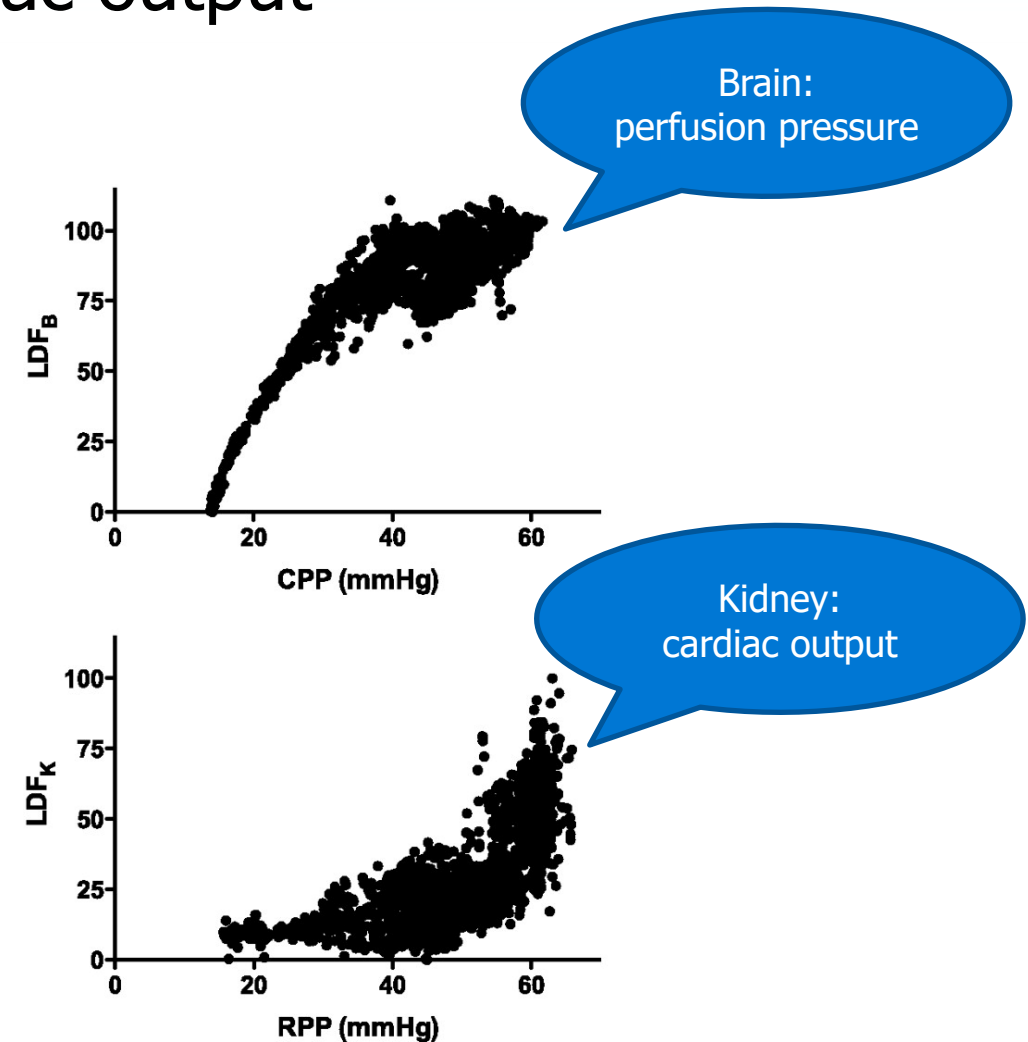
# The basics: Cerebral Blood Flow is dependent on ABP, not cardiac output



- Basic neurosurgical doctrine
- Not part of the cardiac lexicon
- Data shown are baboons on CPB

# Renal blood flow is dependent on cardiac output

- Hemorrhagic shock in neonatal piglets
- CBF does not fall *until* ABP falls
- RBF falls *before* ABP falls



## II. What is autoregulation monitoring?

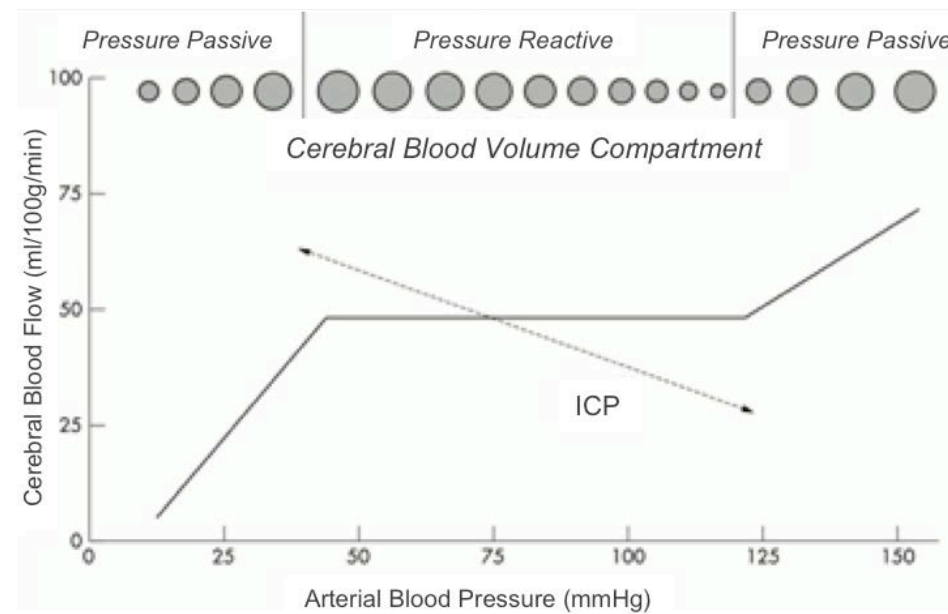


# The Cambridge Hypothesis: finding LLA



## Feature Articles

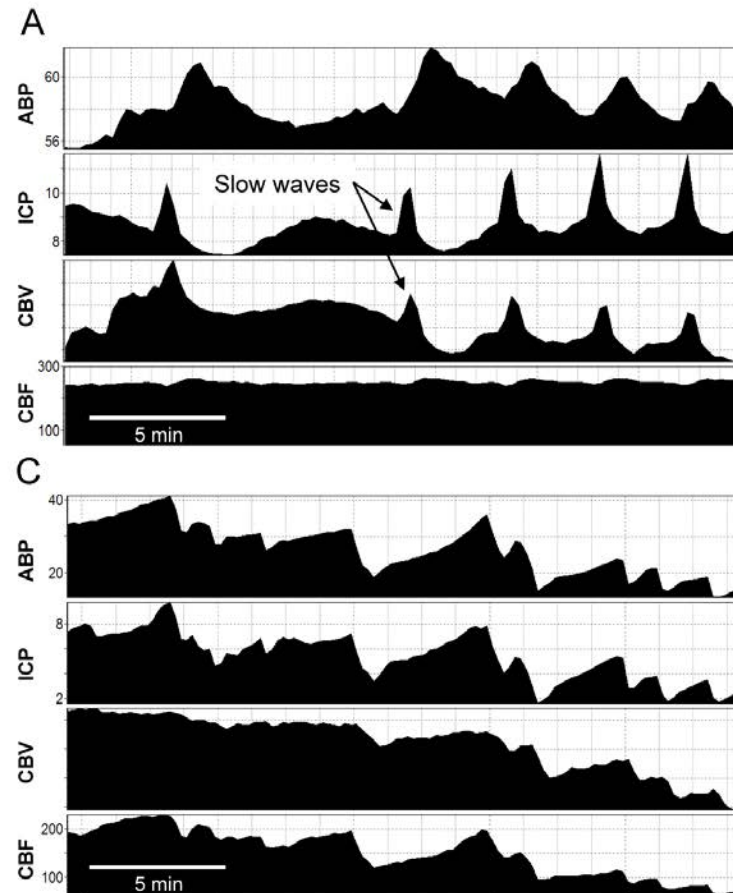
Continuous monitoring of cerebrovascular pressure reactivity allows determination of optimal cerebral perfusion pressure in patients with traumatic brain injury



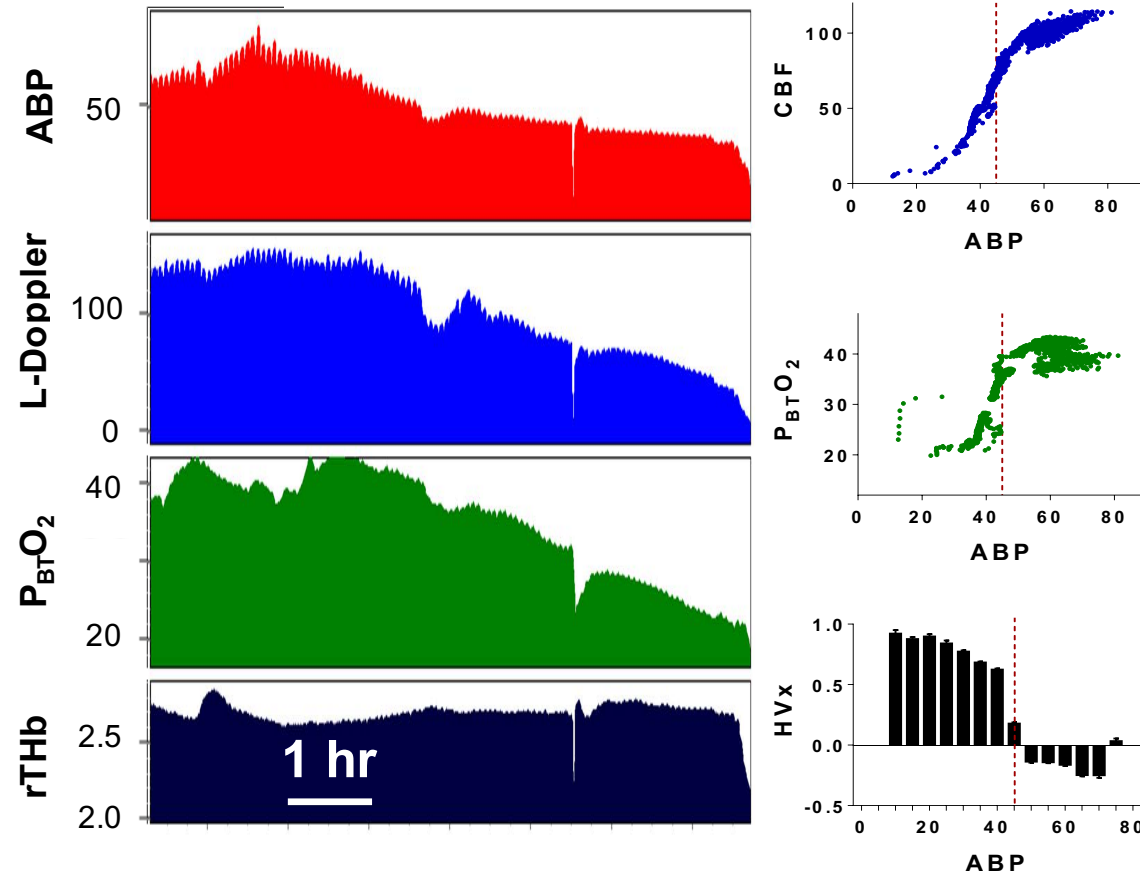
•Czosnyka M, *Stroke*, 1996

•Steiner LA, *Crit Care Med*, 2002

# The Cambridge Method



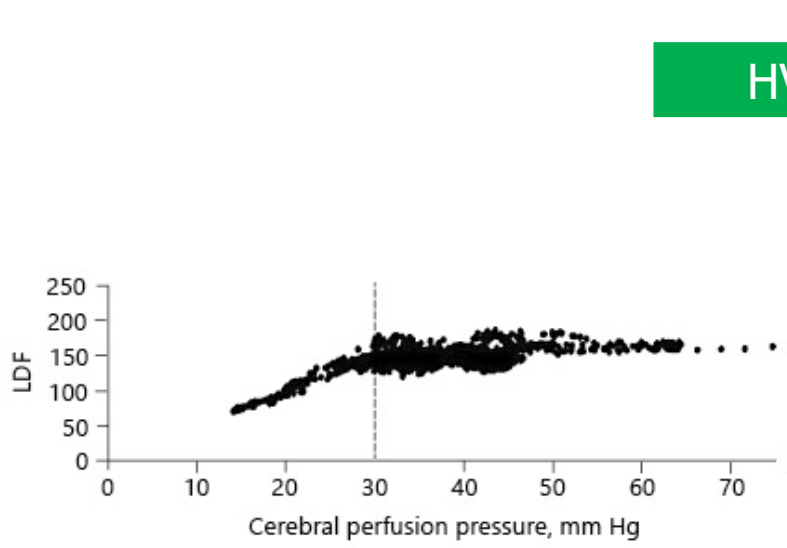
# Autoregulation monitoring during piglet bypass



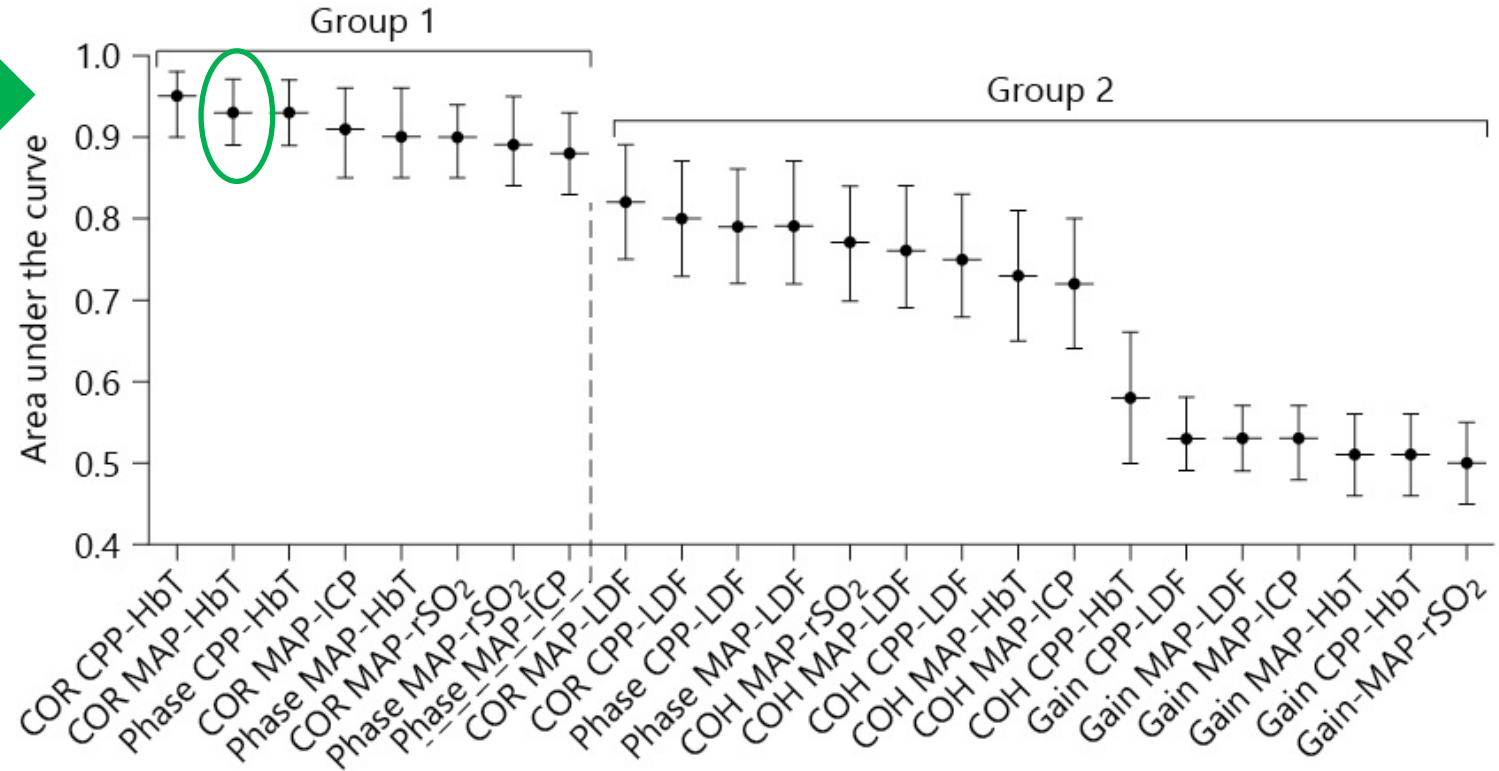
# III. Validation



# Validation of autoregulation monitoring techniques



HVx



Gold Standard

Study Technique

From: **Effect of Targeting Mean Arterial Pressure During Cardiopulmonary Bypass by Monitoring Cerebral Autoregulation on Postsurgical Delirium Among Older Patients: A Nested Randomized Clinical Trial**

JAMA Surg. 2019;154(9):819-826. doi:10.1001/jamasurg.2019.1163



**Table 2. Characteristics of Management During Cardiopulmonary Bypass for Patients Randomized to Standard Care vs Autoregulation-Targeted Management of Mean Arterial Pressure**

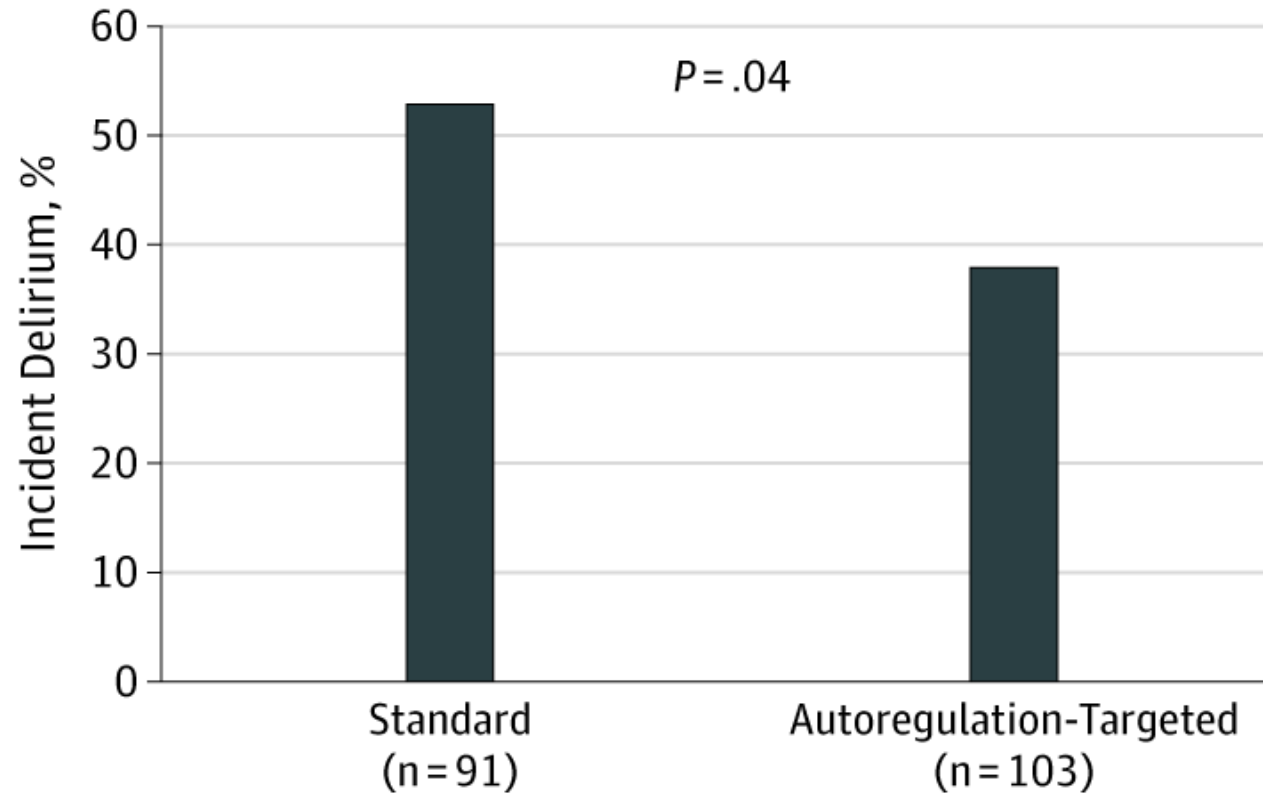
Characteristic of Management	Standard Care (n = 94)	Autoregulation-Targeted (n = 105)	P Value
Phenylephrine, median (IQR), mg	1.2 (0.3-2.3)	1.8 (0.5-3.6)	.02
Vasopressin administration, No. (%)	6 (6.4)	9 (8.6)	.56
Cardiopulmonary bypass flow, mean (SD), L/min	4.4 (0.6)	4.4 (0.6)	.92
Isoflurane, mean (SD), %	0.76 (0.27)	0.77 (0.31)	.71
Arterial pressure during cardiopulmonary bypass, mean (SD), mm Hg	71.3 (7.6)	73.9 (6.7)	.01
Arterial pressure at the lower limit of autoregulation, mean (SD), mm Hg	68.7 (11.3)	66.0 (10.9)	.10
Product of the duration of time and mean arterial pressure below the lower limit of autoregulation, median (IQR), mm Hg × h <sup>a</sup>	9.5 (3.7-19.5)	5.3 (2.0-13.4)	.002

Abbreviation: IQR, interquartile range.

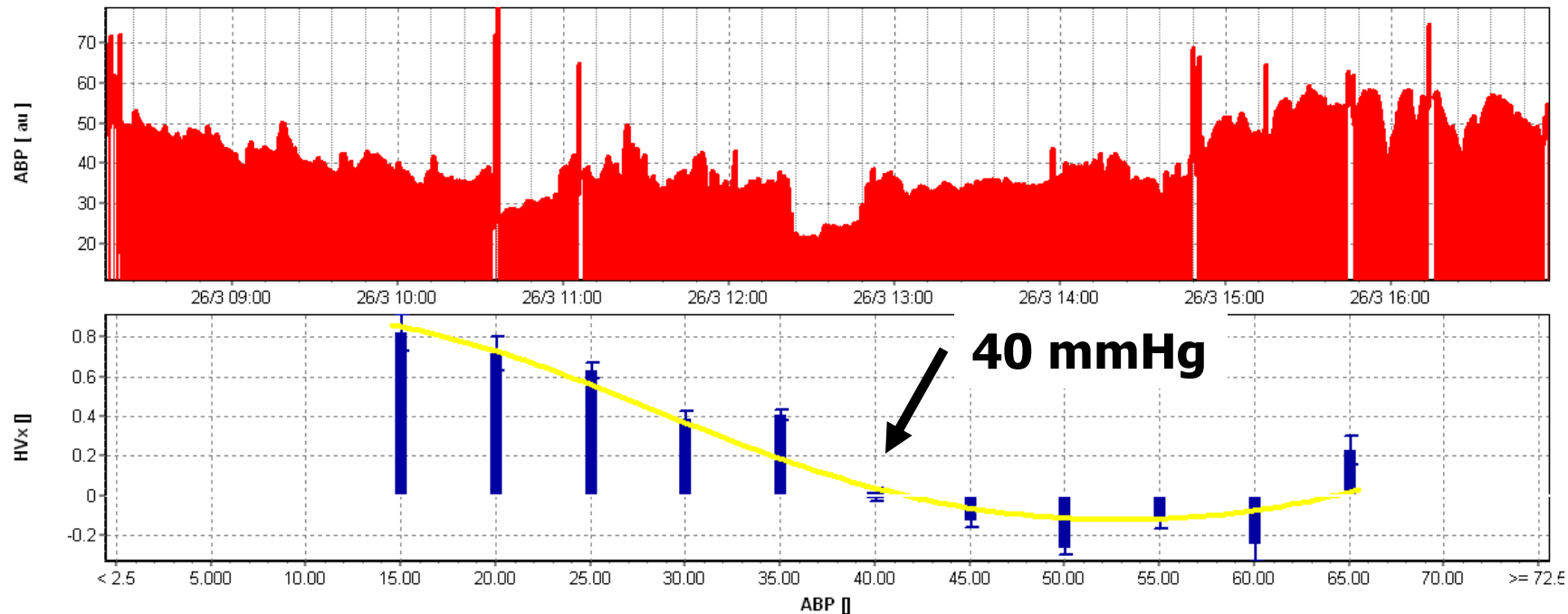
<sup>a</sup> Calculated as the product of duration of time and magnitude of blood pressure that mean arterial pressure was below the lower limit of autoregulation.

From: **Effect of Targeting Mean Arterial Pressure During Cardiopulmonary Bypass by Monitoring Cerebral Autoregulation on Postsurgical Delirium Among Older Patients: A Nested Randomized Clinical Trial**

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# What it looks like in a neonate on bypass



- ABP > 40 mmHg is associated with intact autoregulation in this neonate
- ABP < 40 mmHg is associated with impaired autoregulation in this neonate

What did we learn?



# Conclusions

- The brain requires arterial blood pressure to autoregulate, regardless of the adequacy of cardiac output.
- Autoregulation can be monitored using NIRS and ABP
- The neonatal lower limit of autoregulation is usually between 35 and 45 mmHg.

# Thank You



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