

# Advances in the evaluation and management of neonatal cardiac function

Neil Patel MD

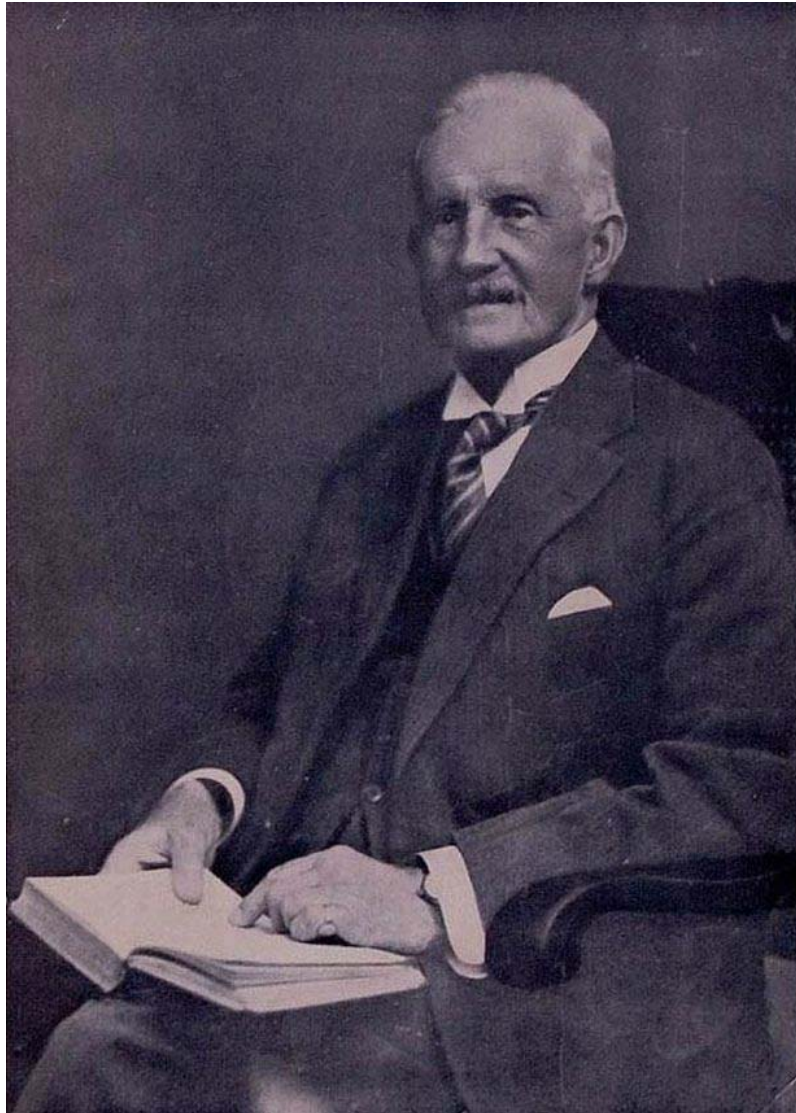
Neonatologist

Senior NHS Scotland Research Fellow

Royal Hospital for Children,

Glasgow, Scotland, UK





Alexander Watson Hutton



## Research Briefings

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### Neonatology

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Neonatology 2014;105:275–281

DOI: [10.1159/000357553](https://doi.org/10.1159/000357553)

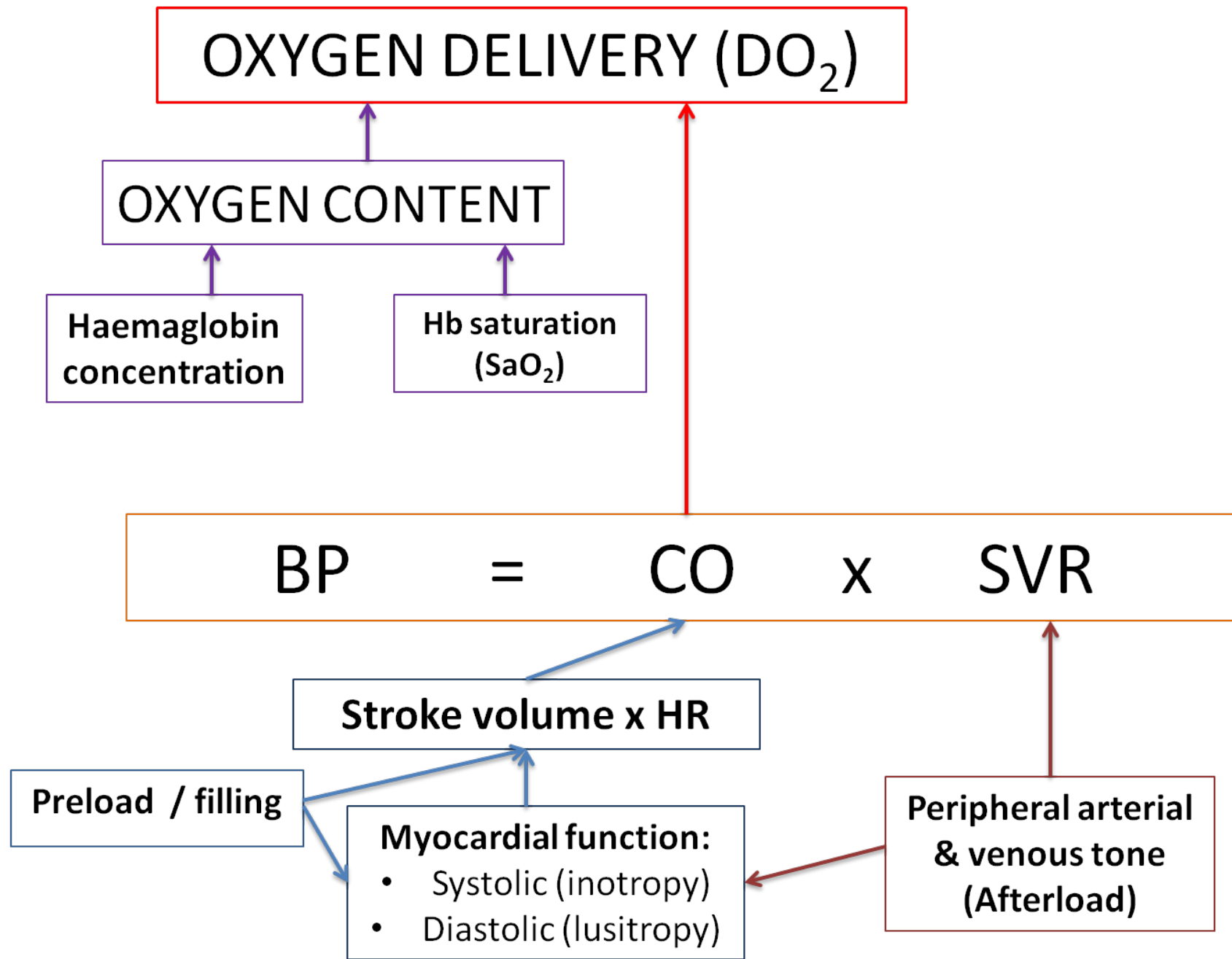
Received: August 15, 2013

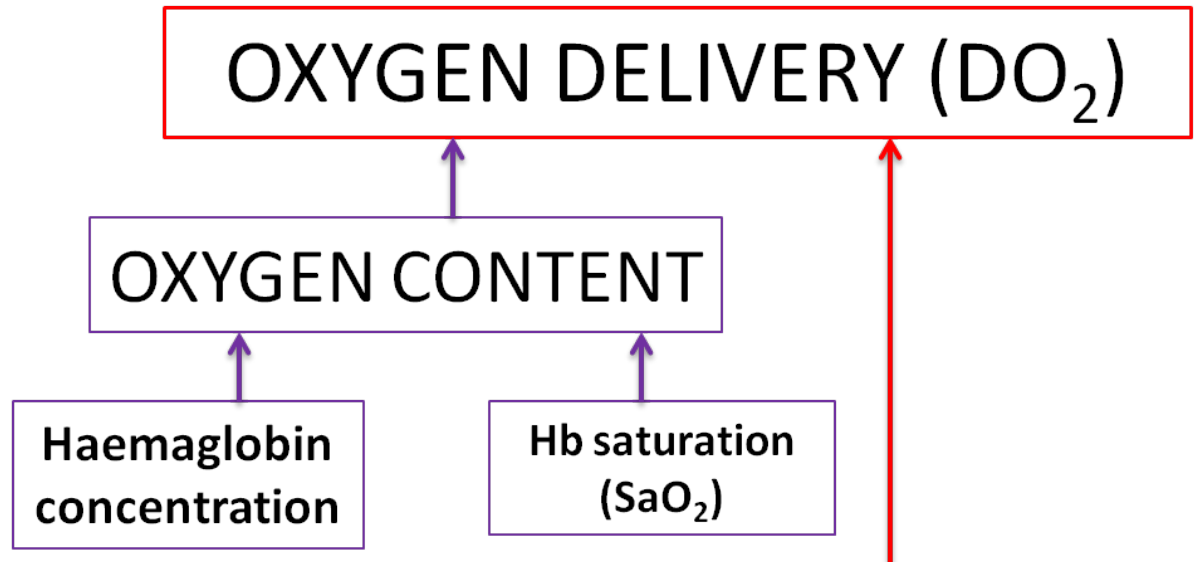
Accepted after revision: November 24, 2013

Published online: February 27, 2014

# Management of Hypotension in Preterm Infants (The HIP Trial): A Randomised Controlled Trial of Hypotension Management in Extremely Low Gestational Age Newborns

E.M. Dempsey<sup>a</sup> K.J. Barrington<sup>e</sup> N. Marlow<sup>g</sup> C.P. O'Donnell<sup>b</sup> J. Miletin<sup>c</sup>  
G. Naulaers<sup>h</sup> P.-Y. Cheung<sup>f</sup> D. Corcoran<sup>d</sup> G. Pons<sup>j</sup> Z. Stranak<sup>k</sup> D. Van Laere<sup>i</sup>  
on behalf of the HIP Consortium

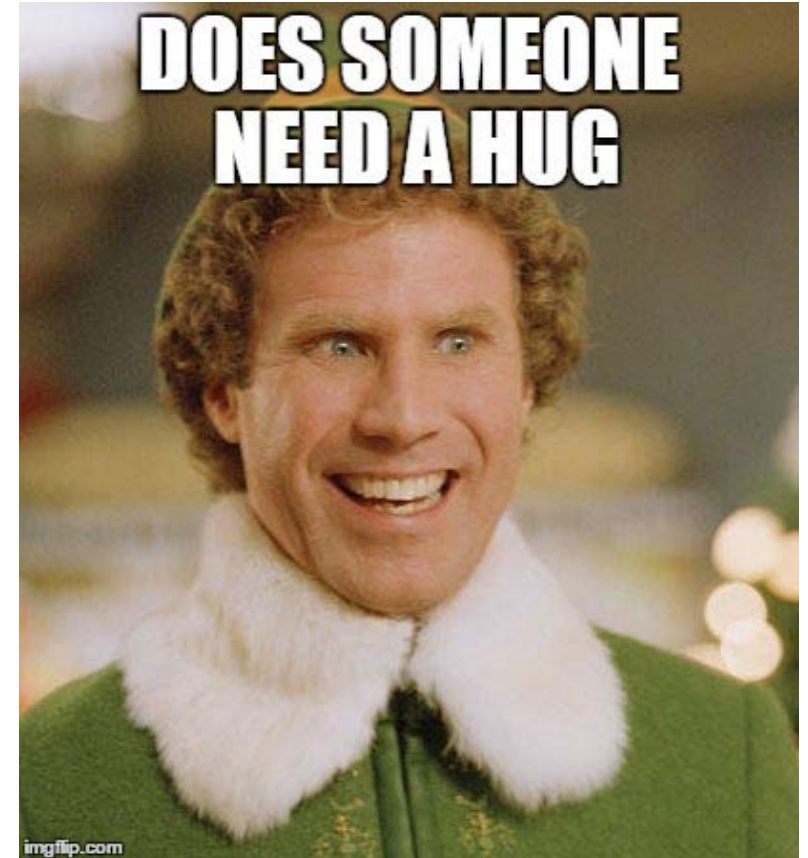
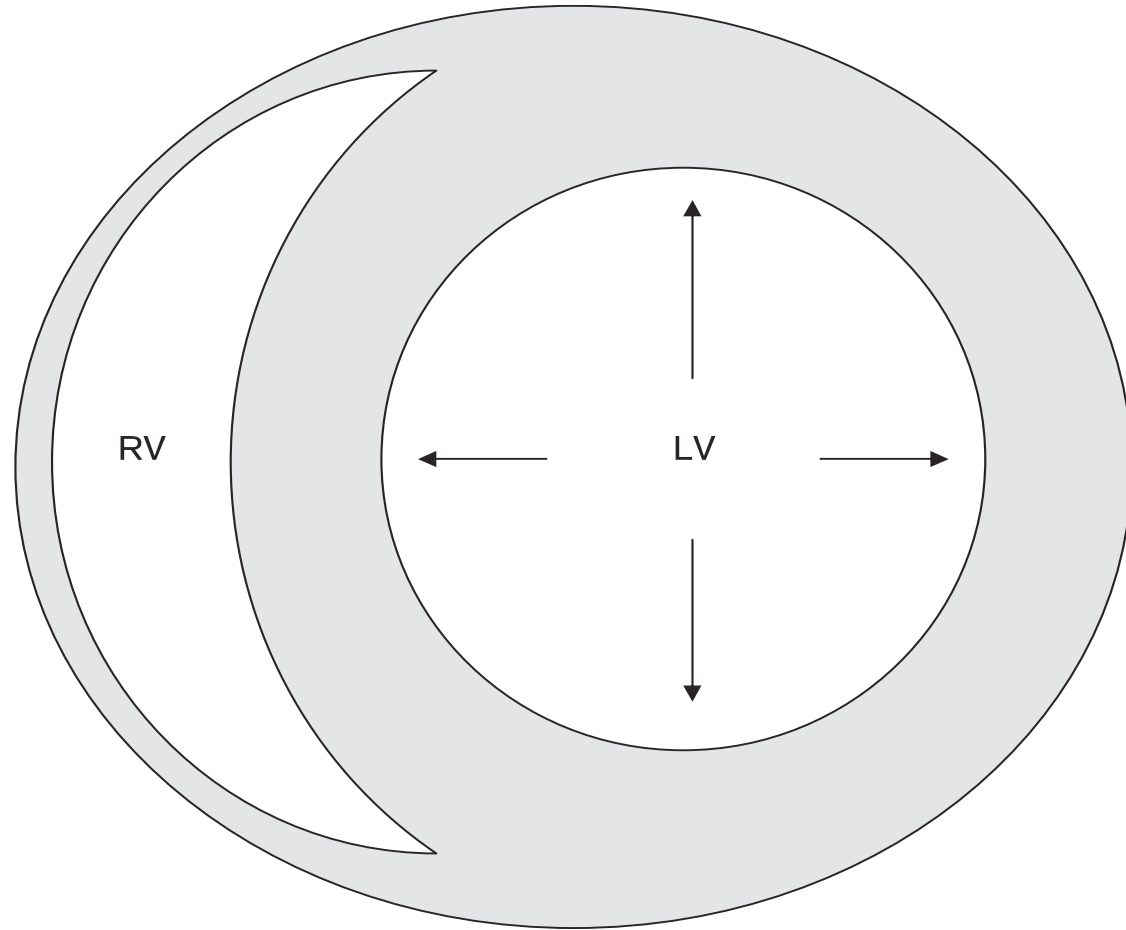




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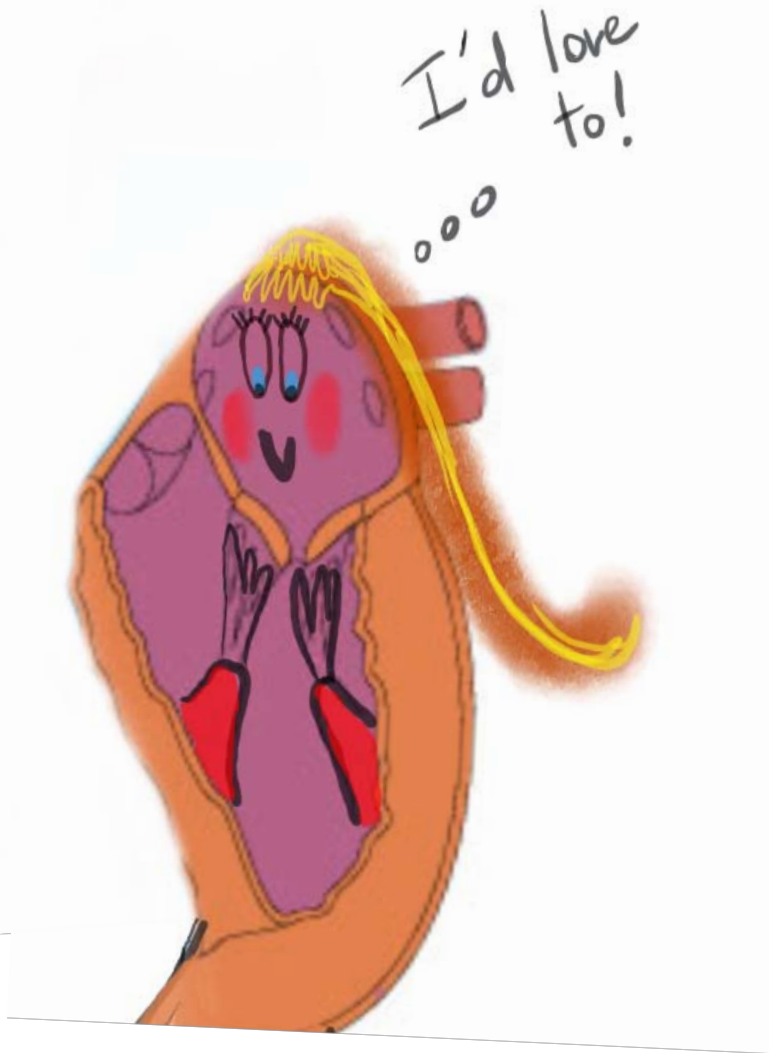


# Ventricular morphology and function





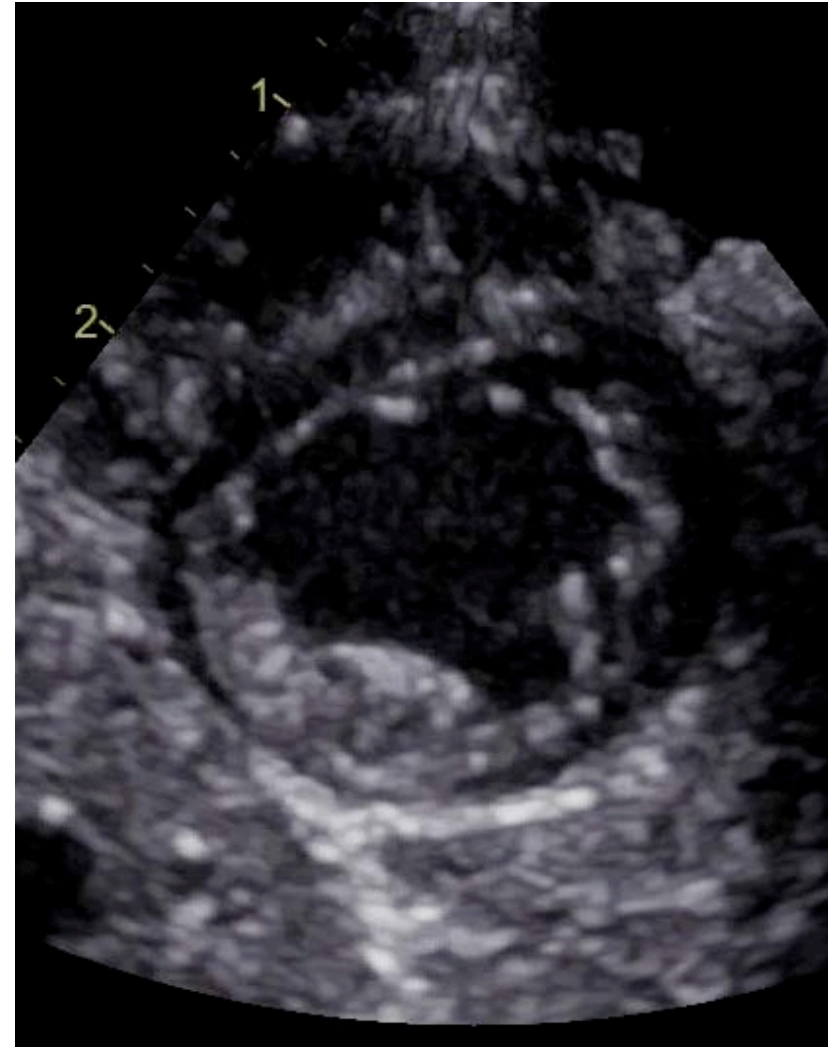
# Ventricular function



Claudia Massolo



# “Eyeballing of cardiac function”



# Quantitative assessment of cardiac function

Measurement type	Parameter	Function assessment	Limitations
<b>Geometric</b>	Fractional shortening	LV systole	Angle and load dependent
	Fractional area change	RV global function	Interobserver variability. Global function
<b>Time interval based</b>	Myocardial performance index (MPI)	Global function	Does not distinguish systolic and diastolic function
<b>Blood flow velocities</b>	Atrio-ventricular (AV) valve Doppler velocities	Diastolic filling	Load and angle dependent
<b>Displacements / distances</b>	TAPSE / MAPSE (tricuspid / mitral annular plane systolic excursion)	Longitudinal systolic function	Angle and load dependent. Systolic function only

# The Blind Men of Indostan and the Elephant in the Echo Lab

Lawrence G. Rudski, MDCM, FACC, FASE, and Jonathan Afilalo, MD, MSc, FRCPC, *Montreal, Quebec, Canada*

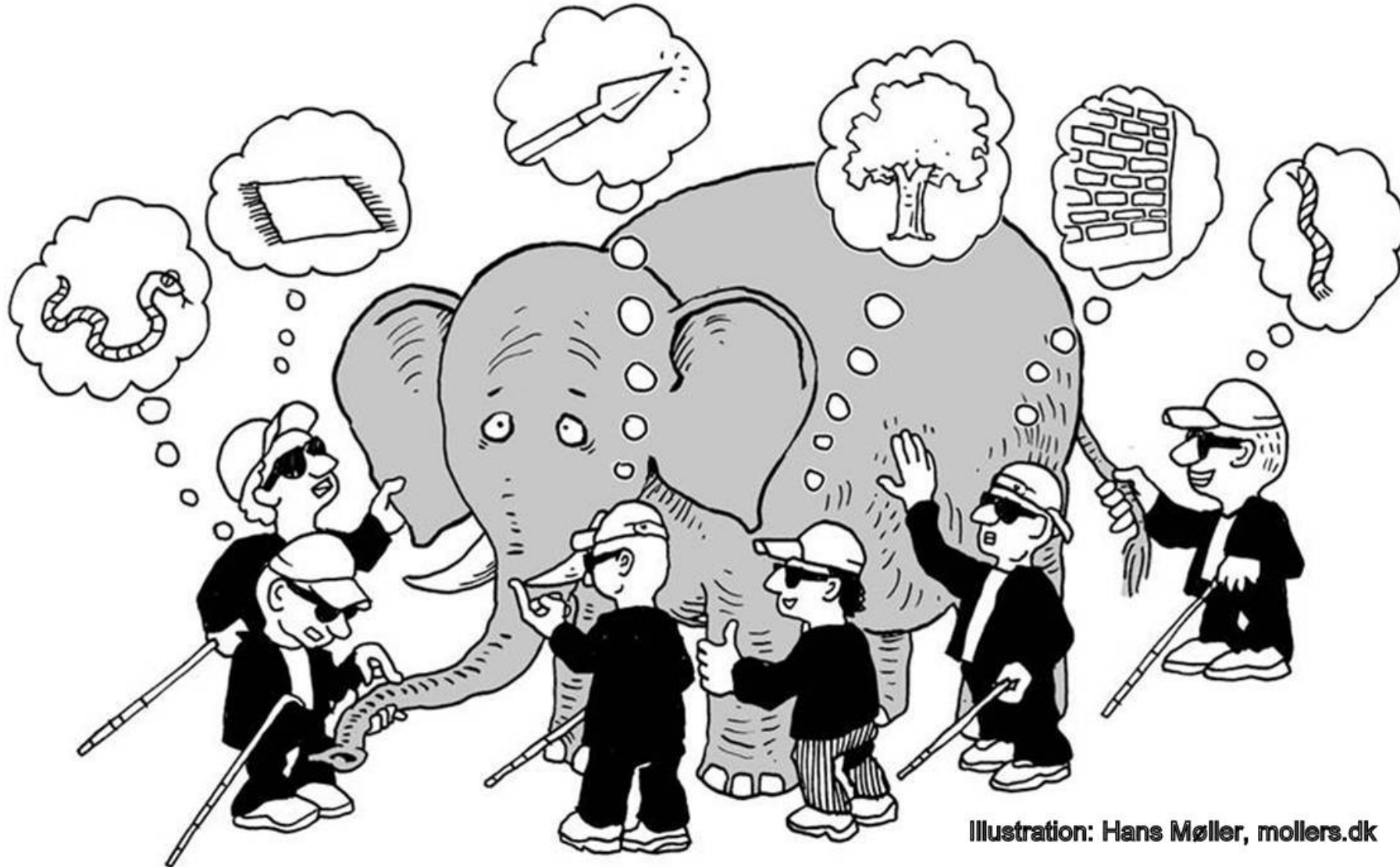
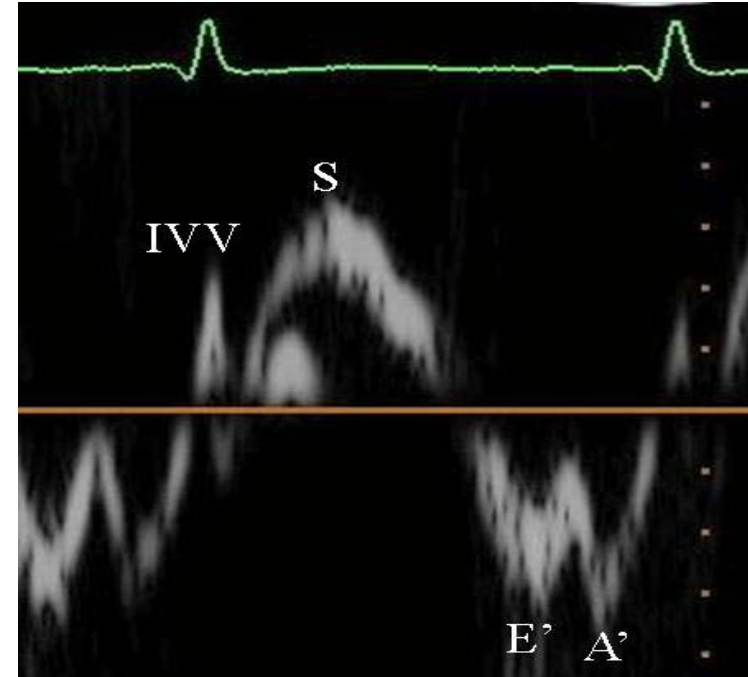
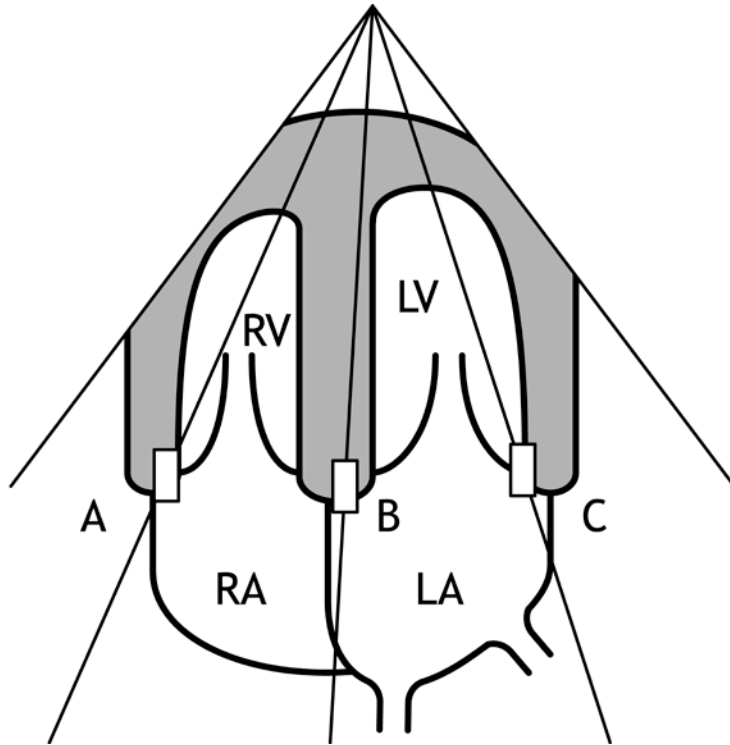


Illustration: Hans Møller, [mollers.dk](http://mollers.dk)

# Pulsed wave Tissue Doppler Imaging (PWTDI)

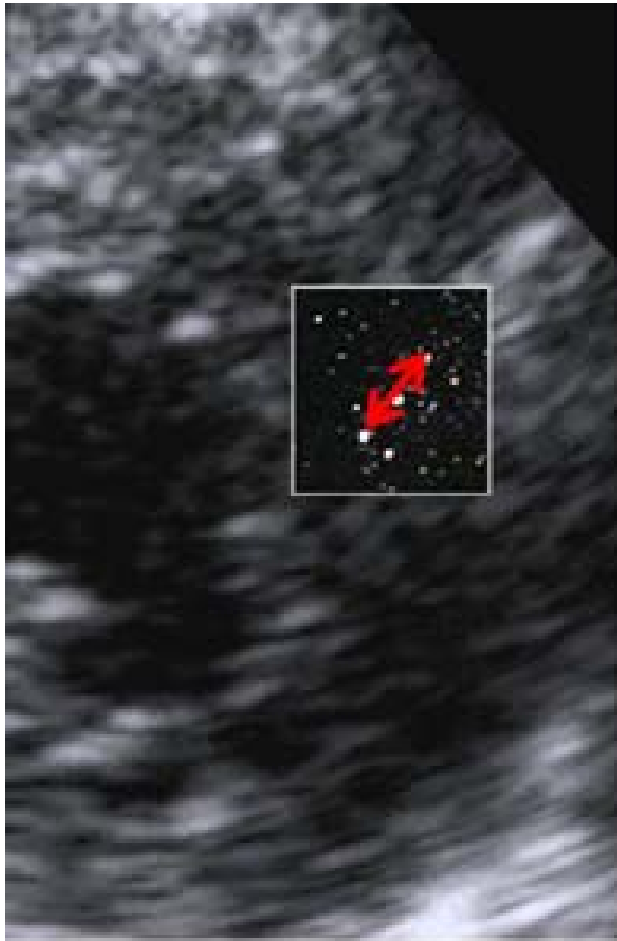


**IVV:** Isovolumic contraction velocity

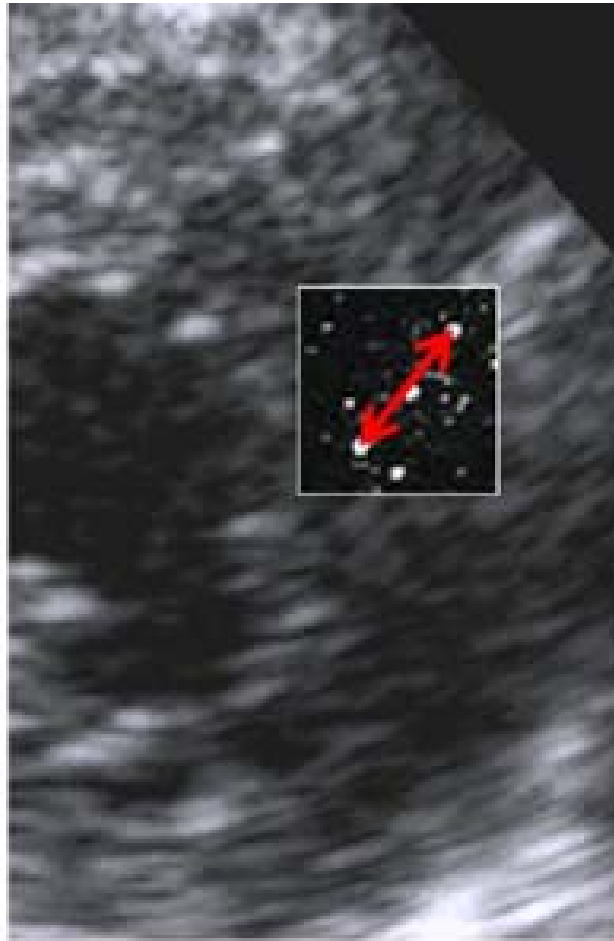
**S':** Systolic ejection velocity

**E':** Early diastolic velocity (active relaxation)

**A':** Late diastolic velocity (atrial contraction)

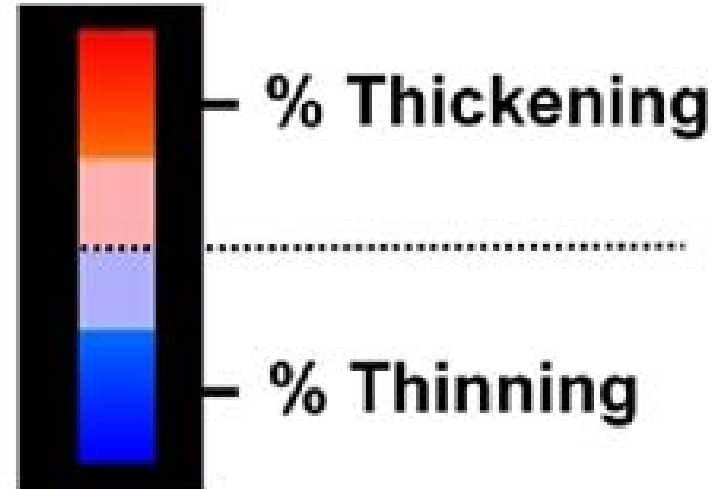


Frame 1



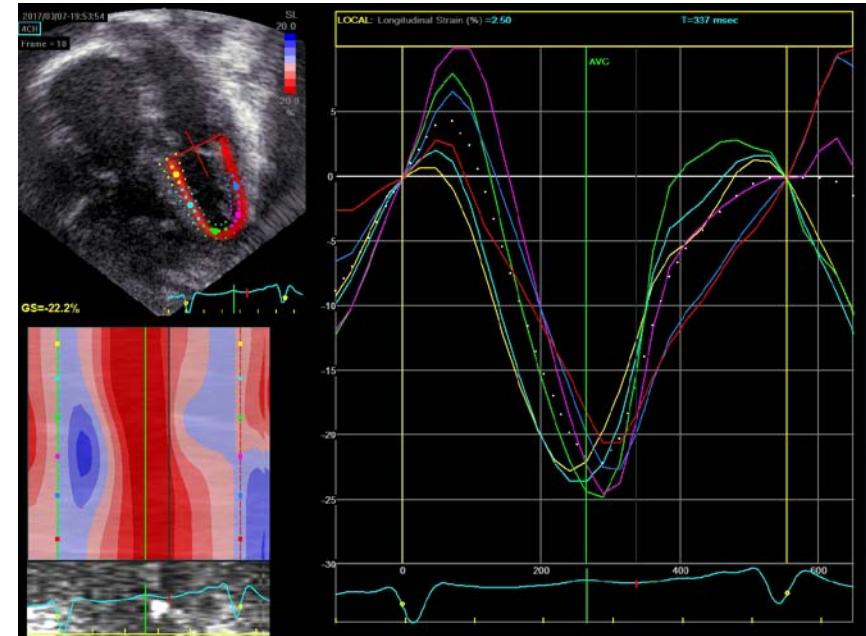
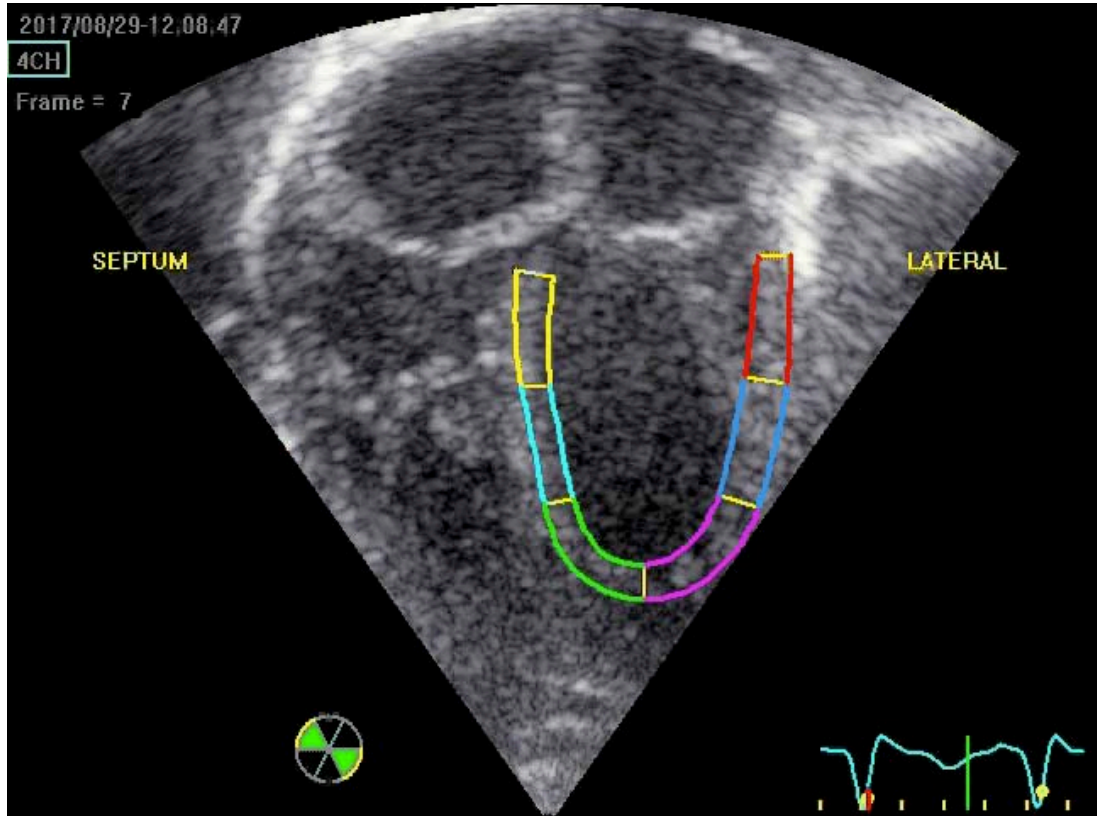
Frame 1 + n

$$\text{Strain} = \frac{\Delta \text{Length}}{\text{Length}_0}$$





# LV dysfunction in PH: Speckle Tracking Echocardiography

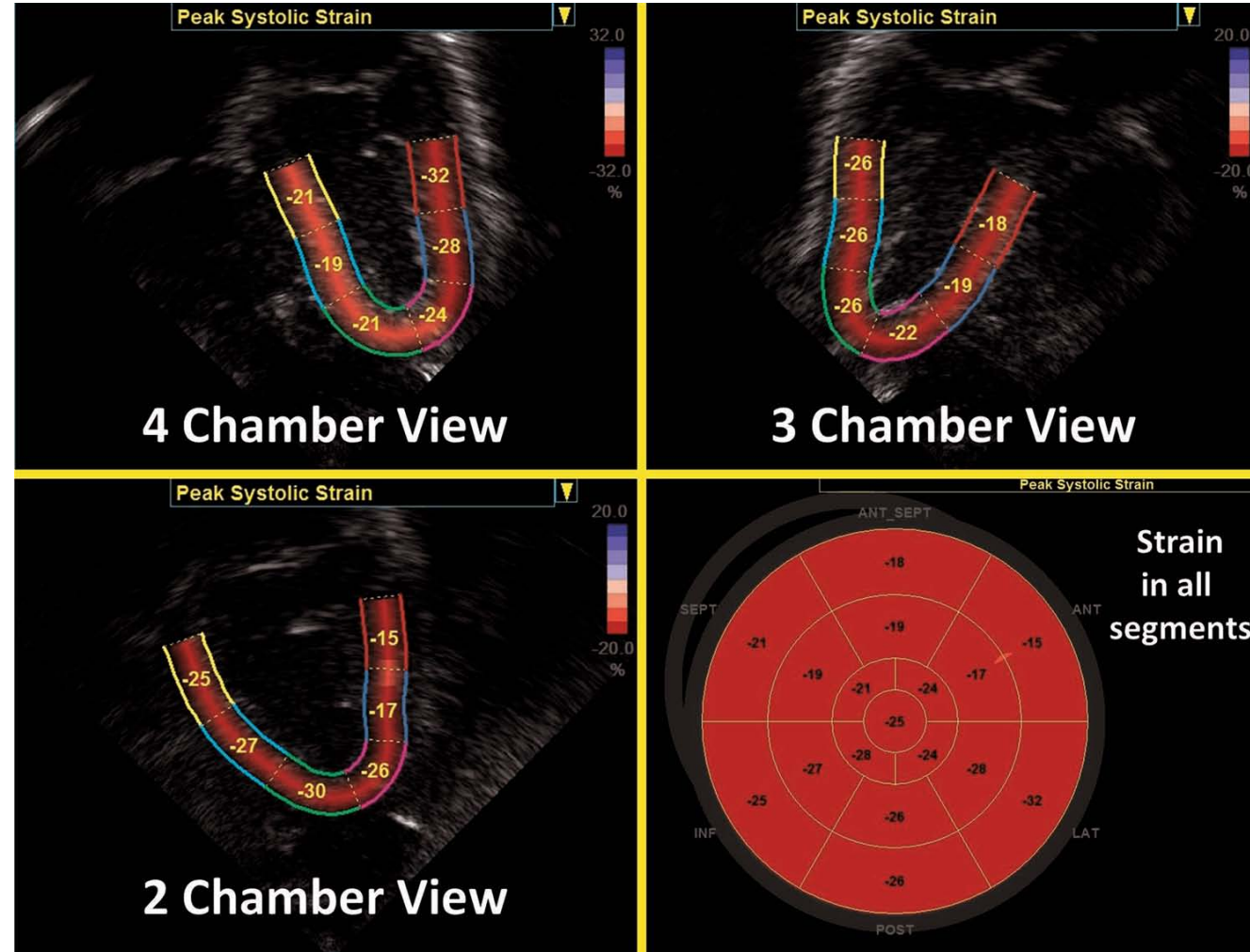


In each of 6 segments, *peak systolic strain (% shortening)* measured



Global strain (6 segment)

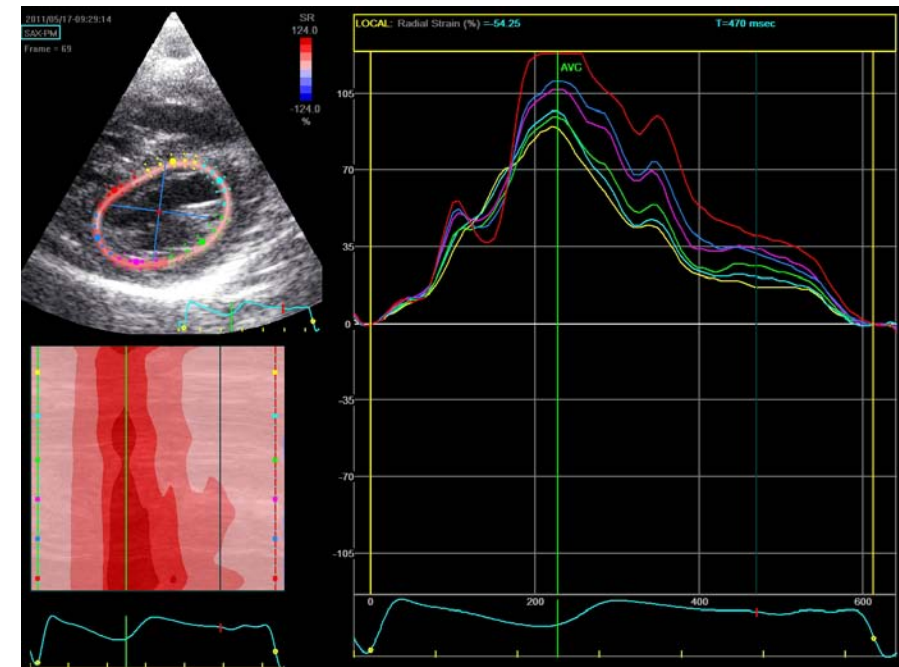
# LV longitudinal strain



## LV CIRCUMFERENTIAL STRAIN (SYSTOLIC SHORTENING)



## LV RADIAL STRAIN (SYSTOLIC LENGTHENING)



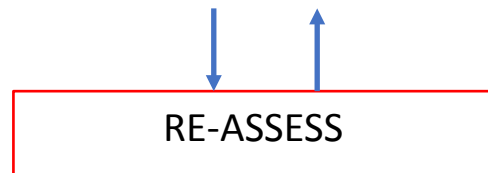


Chateau de Medan, Paul Cezanne



# Utility of functional cardiac assessment

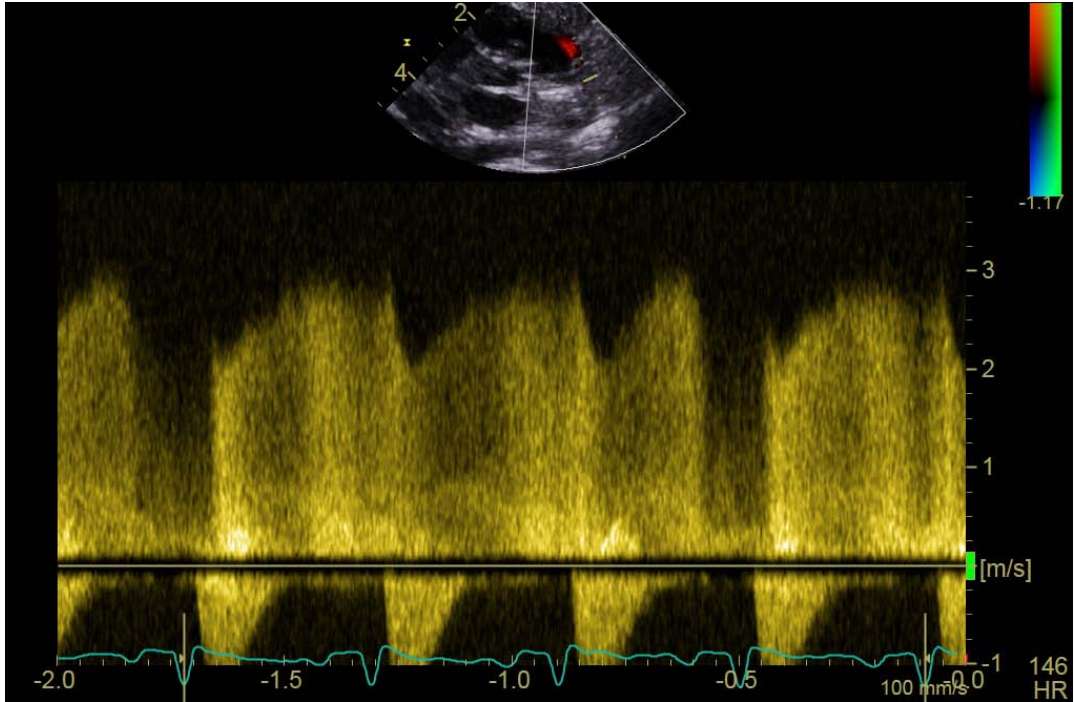
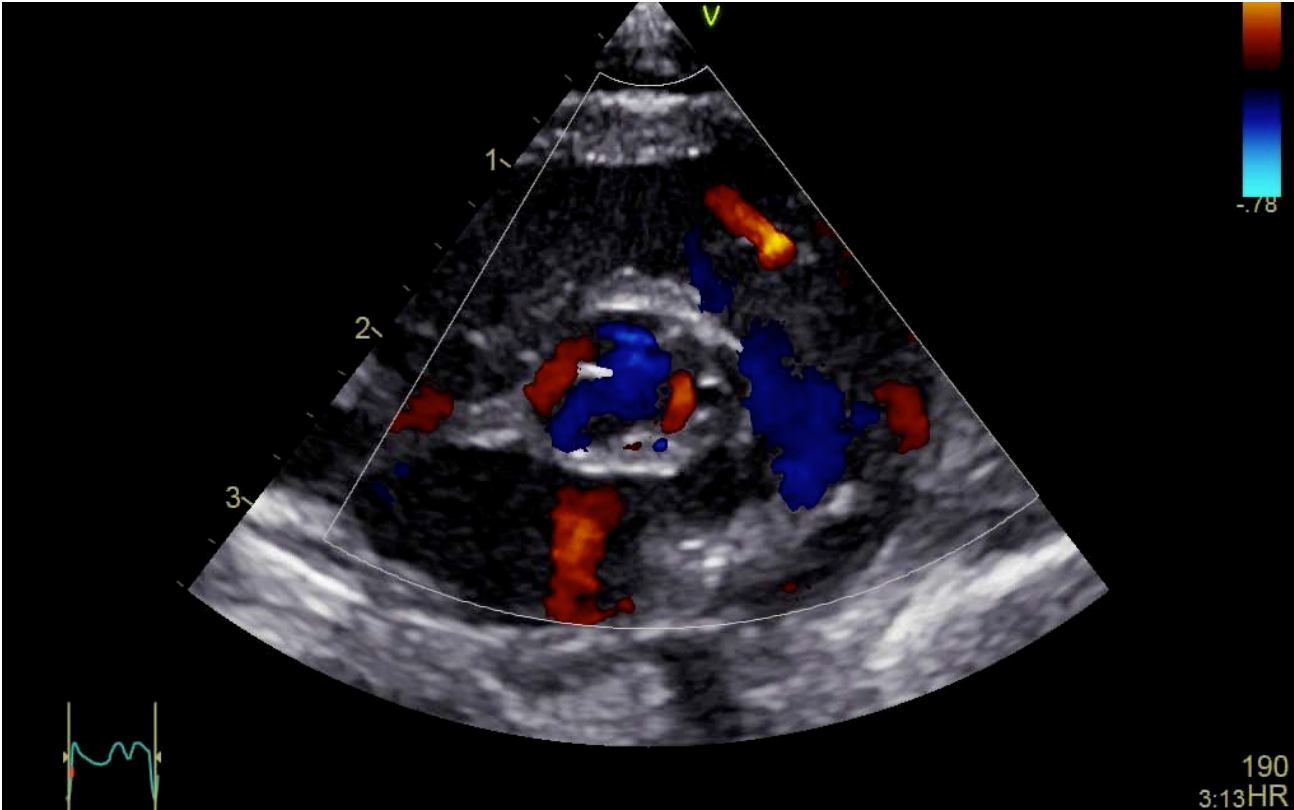
- Understand normal ventricular function
- Appreciate mechanisms of cardiovascular dysfunction in disease
- New understanding of the effect of therapies on cardiac function
- Guide targeted choice of therapy and assess response



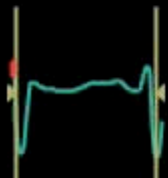
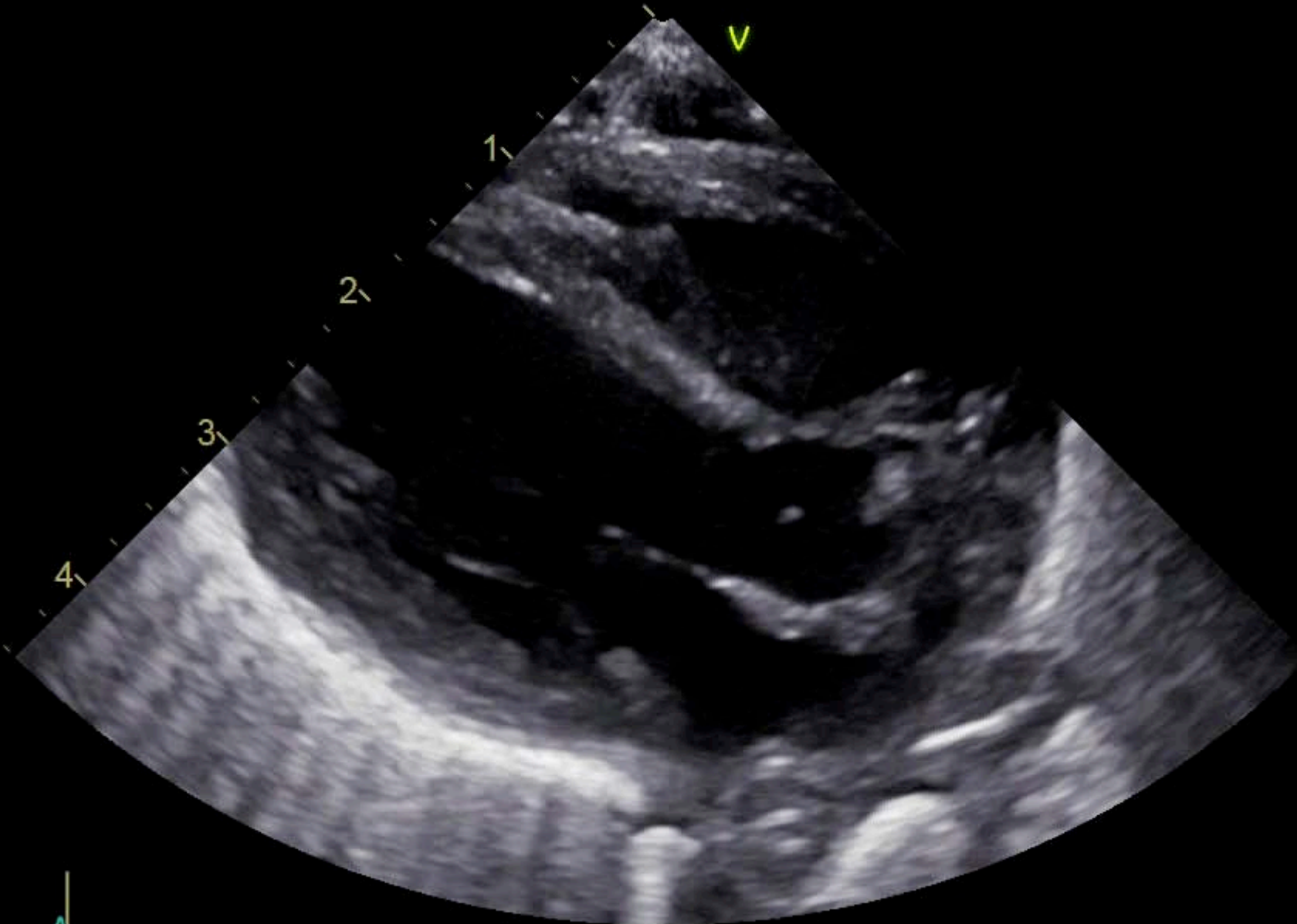
# Targeted therapies based on cardiovascular (dys)function:

Site	Type of agent	Action
<b>HEART</b>	INOTROPE	improved contraction
	LUSITROPE	improves relaxation
	CHRONOTROPE	Increases heart rate
<b>Systemic circulation</b>	VASOCONSTRICTOR (pressor)	increases SVR
	VASODILATOR	decreases SVR
<b>Pulmonary circulation</b>	PUL. VASOCONSTRICTOR	increases PVR
	PUL. VASODILATOR	decreases PVR

# Preterm infant with patent arterial duct



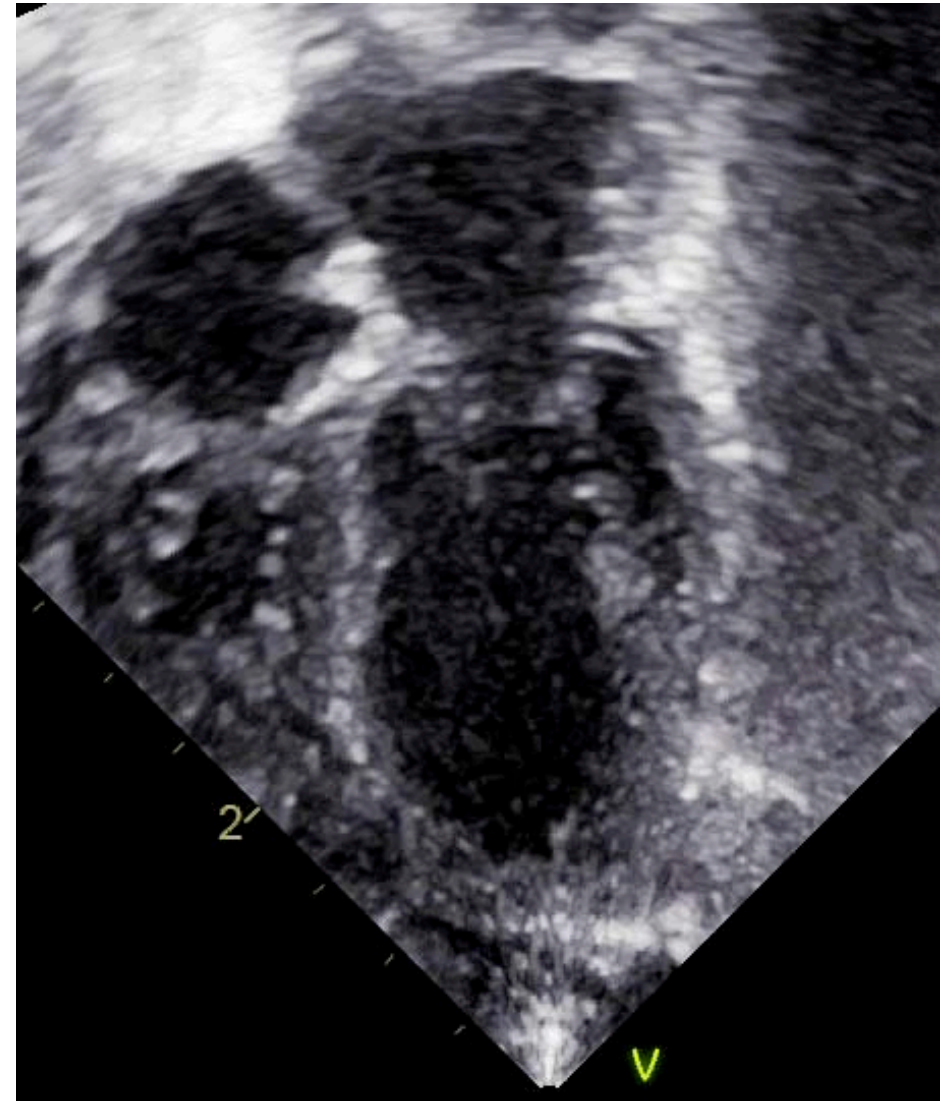




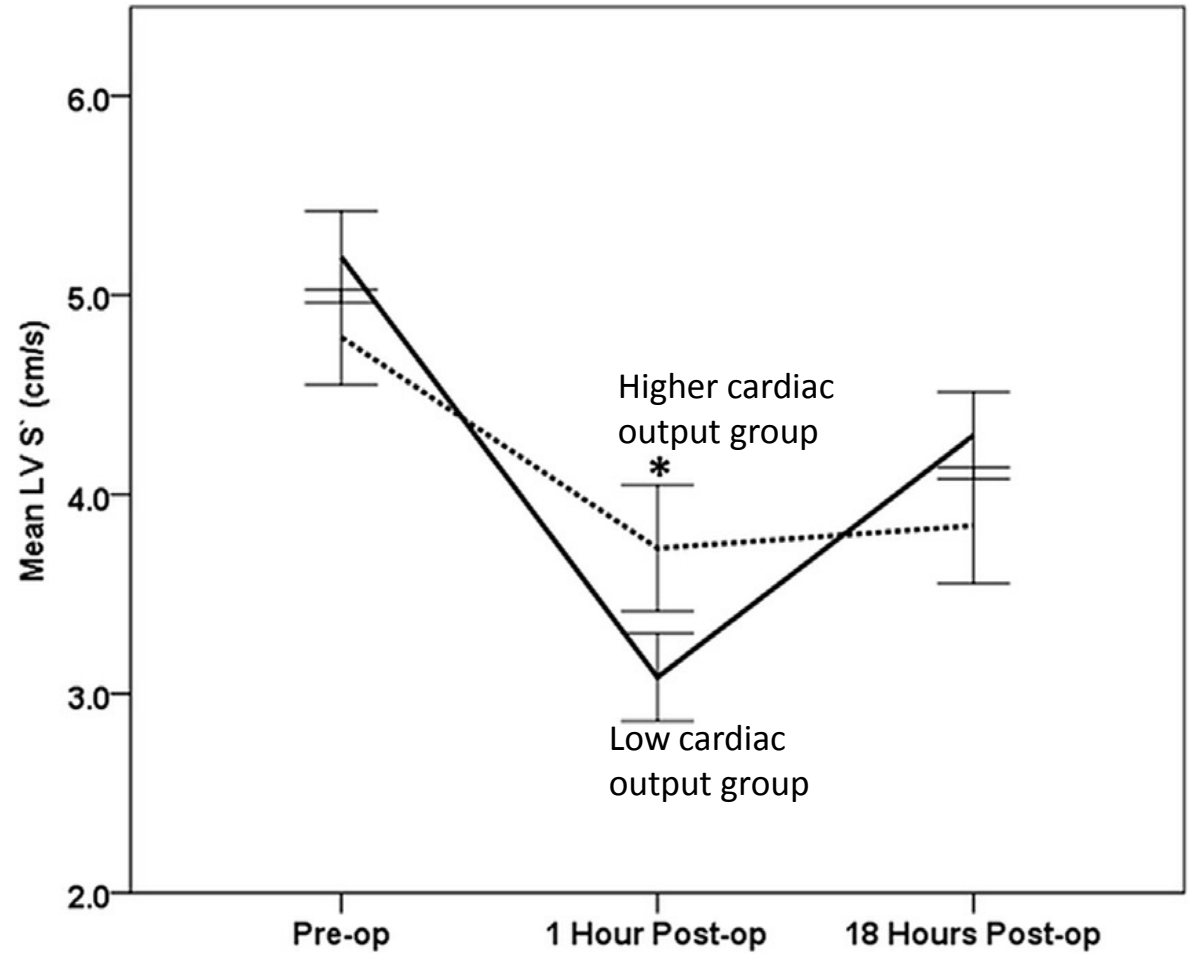
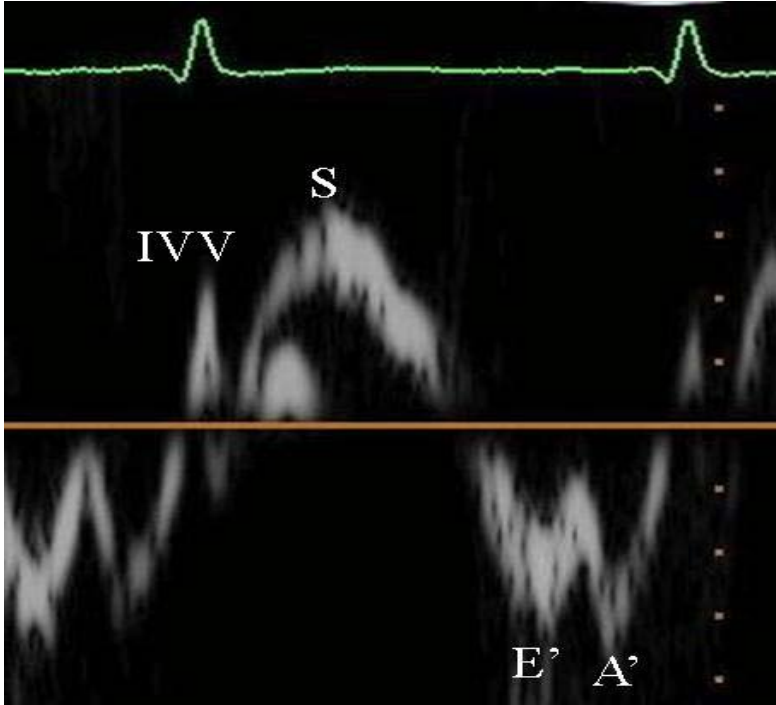
# Surgical PDA ligation

5 hours post ligation

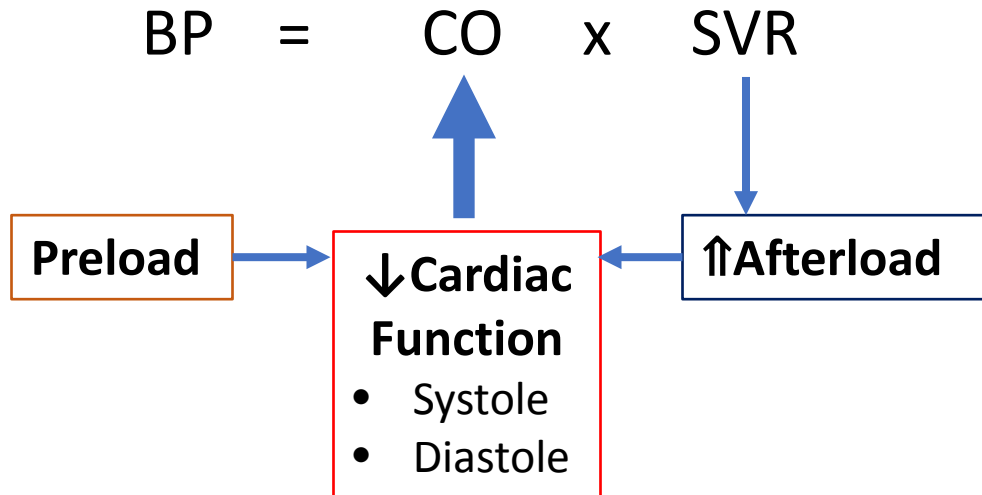
- FiO<sub>2</sub> 0.95
- PIP 28
- BP 27/20 (23)
- Lactate 4.5 mmol/L
- Urine output < 0.5 mls/kg/hour



# Assessment and Treatment of Post Patent Ductus Arteriosus Ligation Syndrome



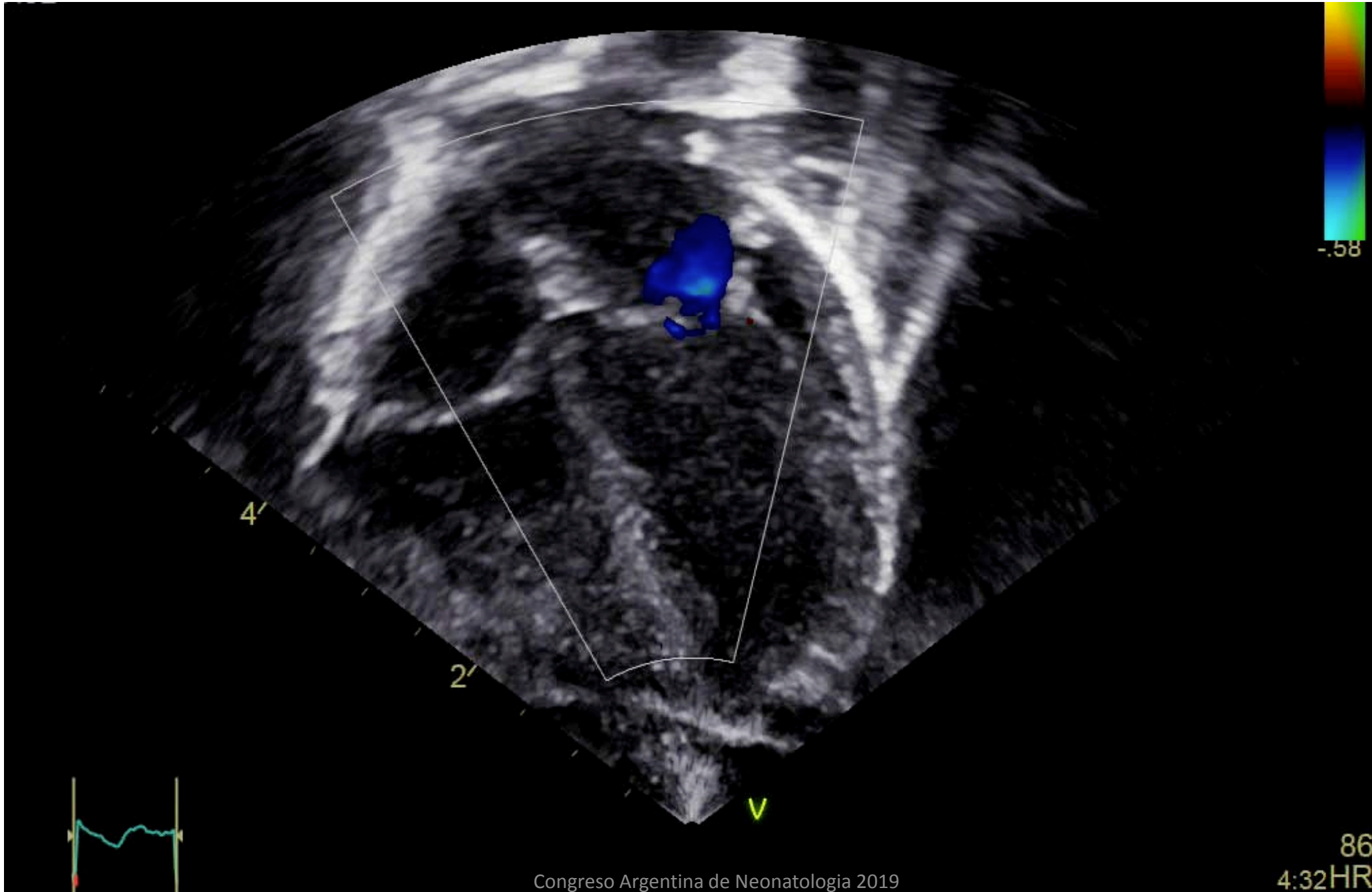
# Post PDA ligation: Targeted therapeutic approach



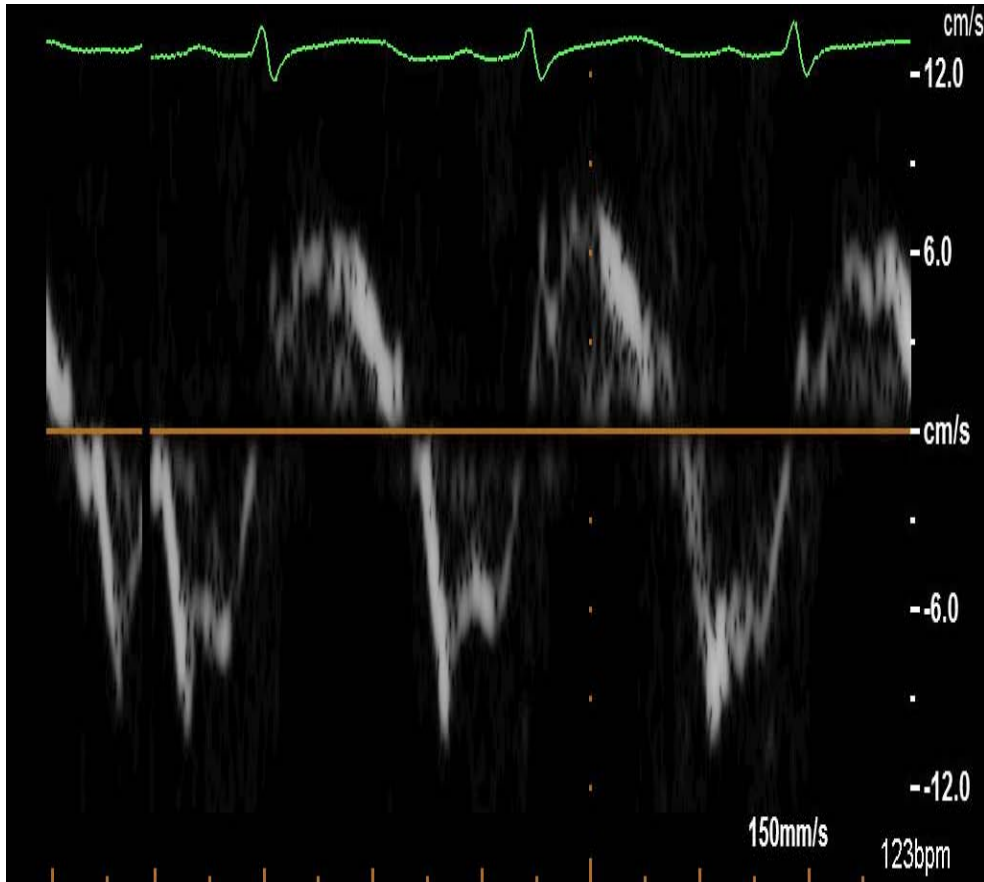
- Support LV systolic function
- Minimize LV afterload (SVR)
- Allow time for recovery

# Case 2: Hypoxic ischaemic encephalopathy

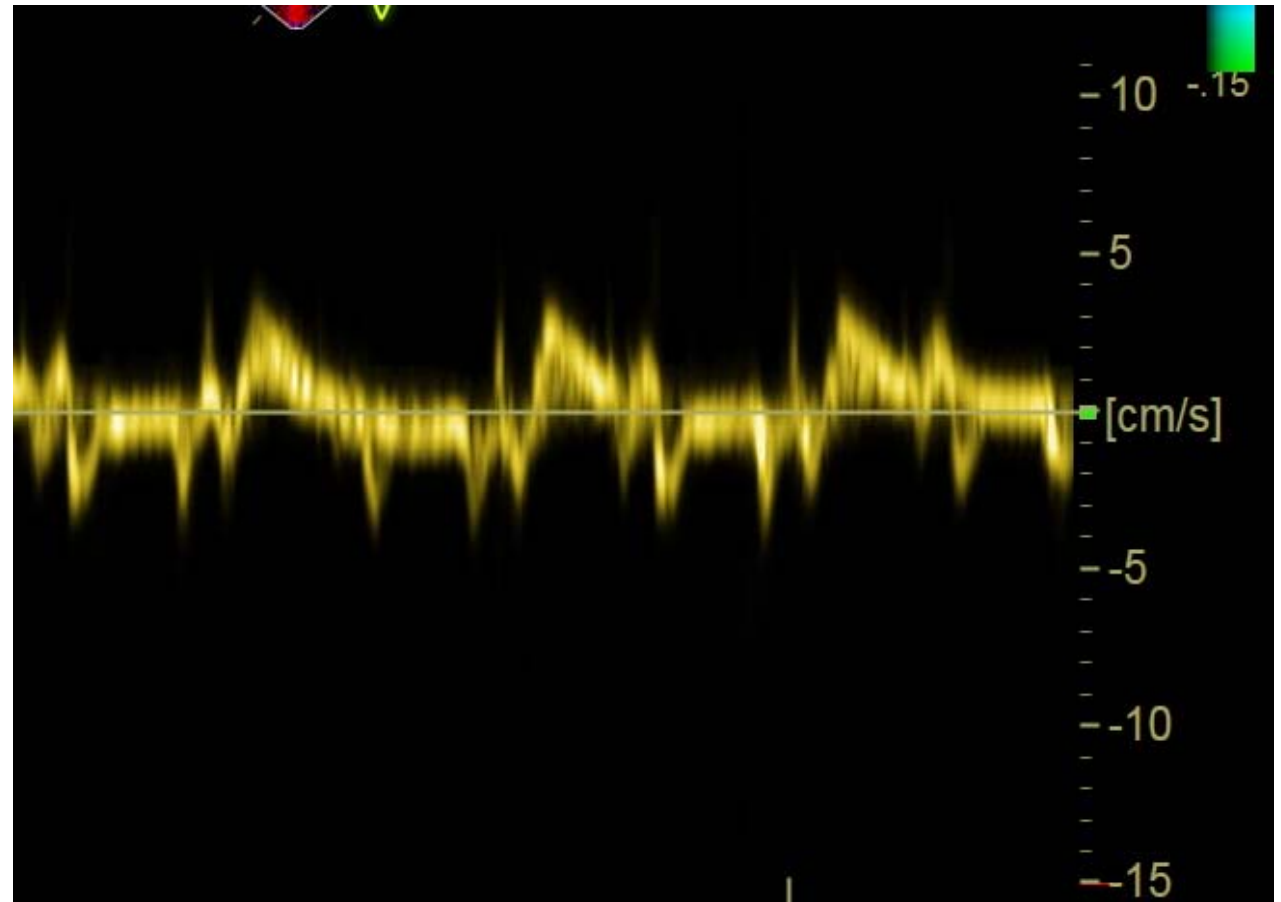
- Term infant
- Poor condition at birth
- pH 6.7
- Lactate 10
- BP: **42/37 (39)**
- Therapeutic hypothermia



# Tissue Doppler imaging: LV



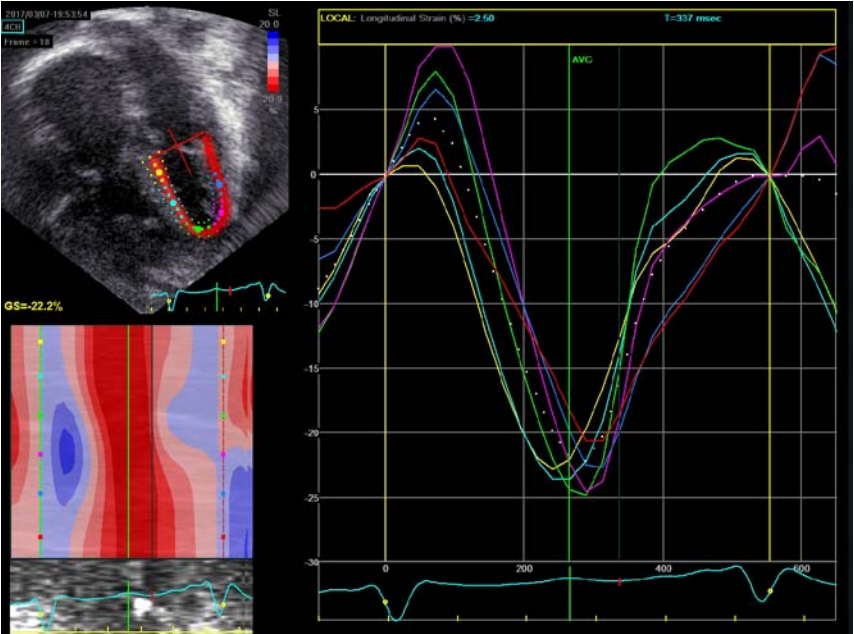
NORMAL



CASE: reduced LV systolic (S') and early diastolic (E') velocities

# Speckle tracking derived strain in infants with severe perinatal asphyxia: a comparative case control study

Arvind Sehgal<sup>1,2\*</sup>, Flora Wong<sup>1,2</sup> and Samuel Menahem<sup>2,3</sup>

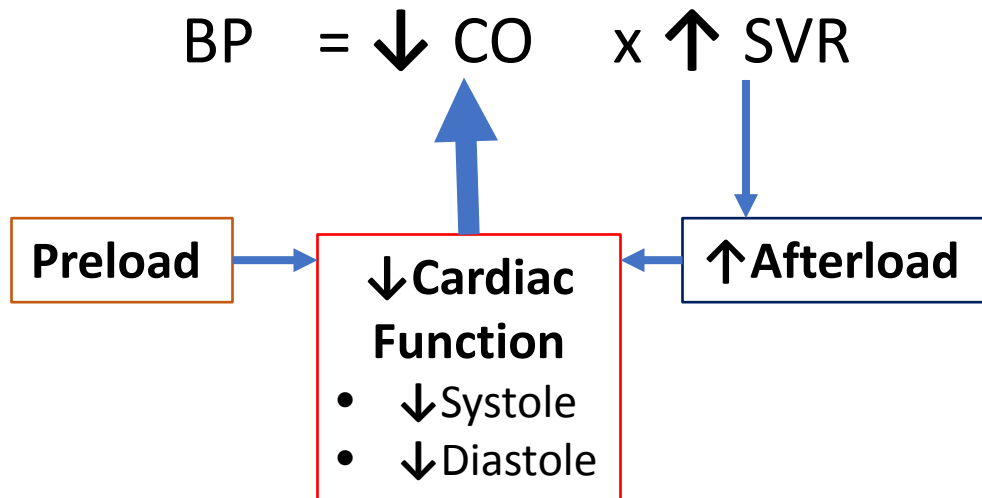


	Asphyxiated infants (n=21)	Controls (n=21)	P
Average LV peak systolic strain	-13.2%	-24.5%	<0.001

Cardiovasc Ultrasound, 2013

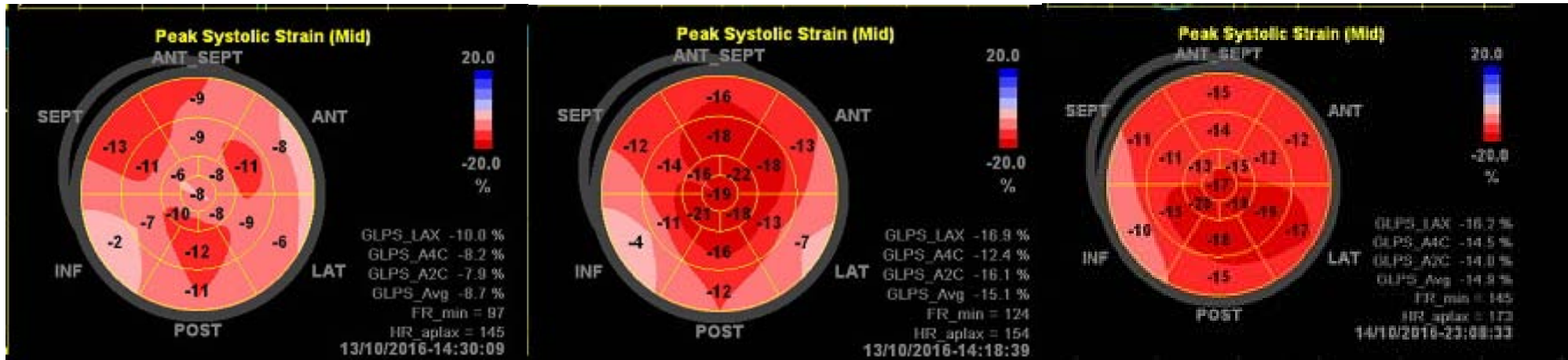


# HIE: targeted therapeutic approach



- Support LV systolic and diastolic function
- Minimize LV afterload (systemic vascular resistance)
- Reduce metabolic demand
- Allow time for recovery

# LV strain to monitor therapeutic response



Day 1

Day 2

Day 5

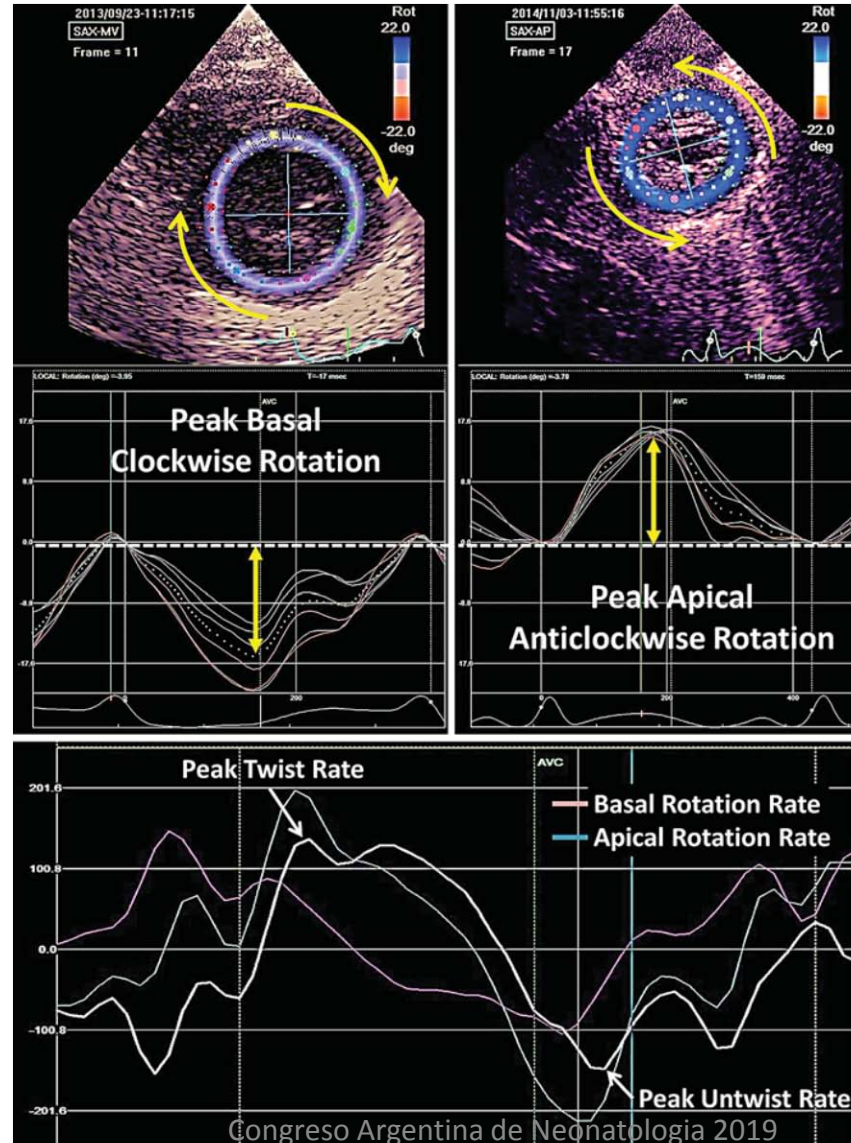
**LOW DOSE EPINEPHRINE (0.05-0.1mcg/kg/min)**

**Milrinone (0.3-0.7mcg/kg/min)**

**VENTILATION AND THERAPEUTIC HYPOTHERMIA**

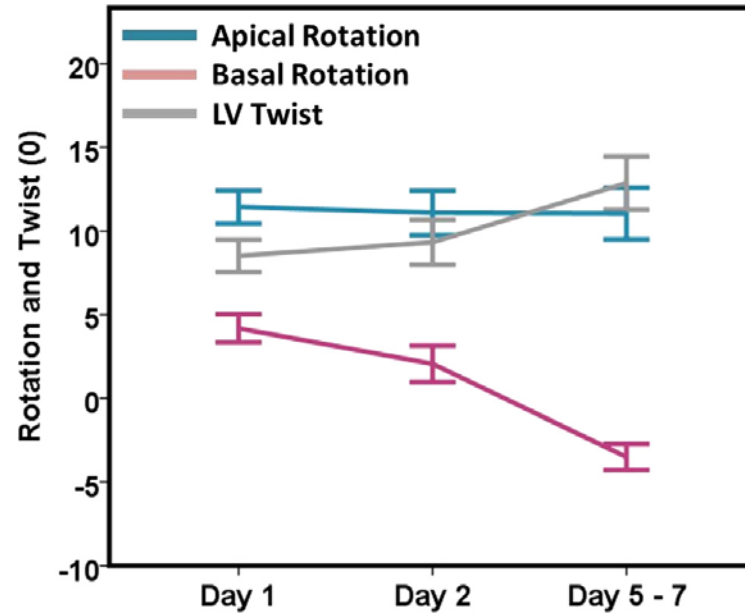
# Novel Echocardiography Methods in the Functional Assessment of the Newborn Heart

Colm R. Breathnach<sup>a</sup> Philip T. Levy<sup>d,e</sup> Adam T. James<sup>a</sup> Orla Franklin<sup>b</sup> Colm R. Breathnach<sup>a</sup> Philip T. Levy<sup>d,e</sup> Adam T. James<sup>a</sup> Orla Franklin<sup>b</sup>  
Afif El-Khuffash<sup>a,c</sup> Afif El-Khuffash<sup>a,c</sup>

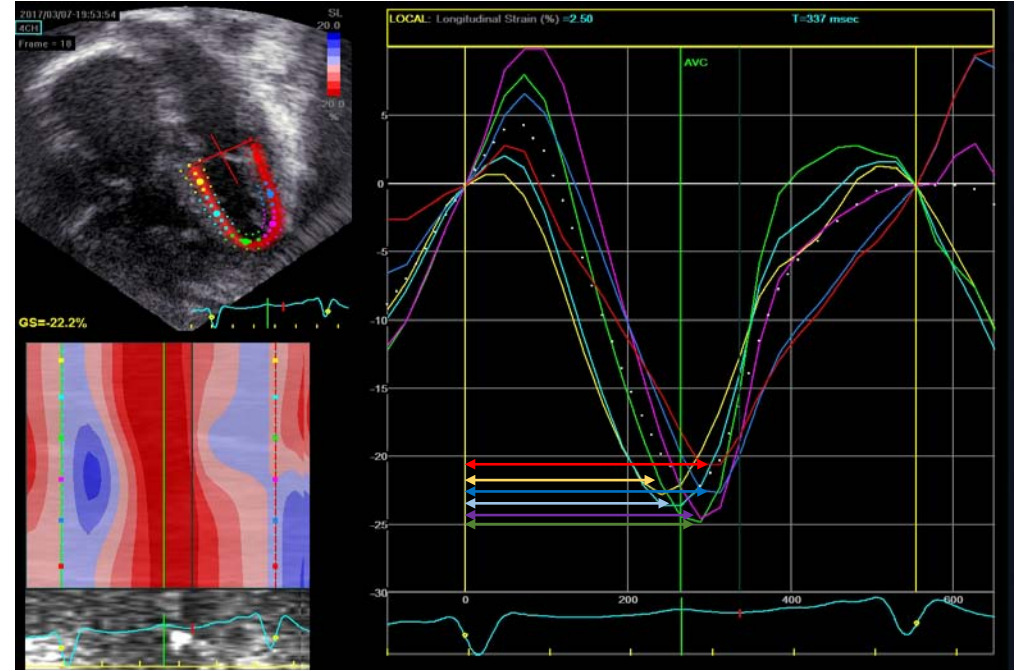
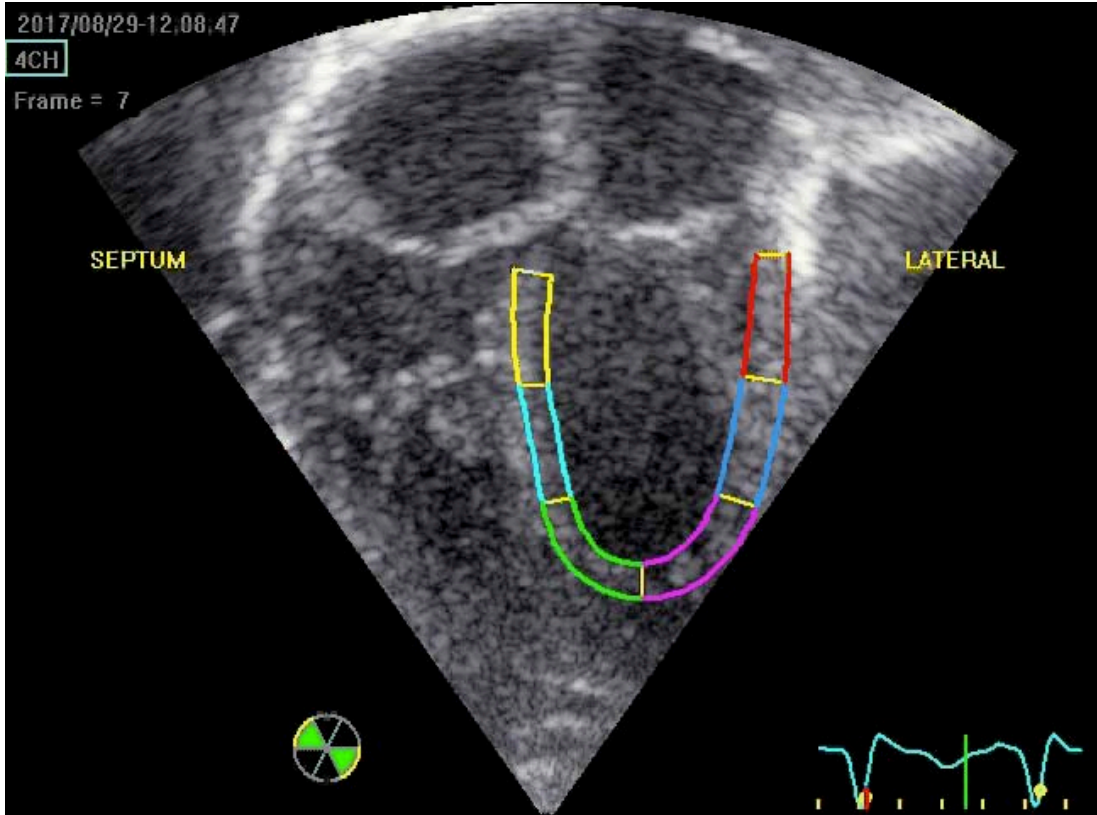


# Left Ventricular Rotational Mechanics in Preterm Infants Less Than 29 Weeks' Gestation over the First Week after Birth

Adam James, MB, John David Corcoran, MD, Luc Mertens, PhD, Orla Franklin, MRCPCH, and Afif EL-Khuffash, MD, DCE, FRCPI, *Dublin, Ireland; and Toronto, Ontario, Canada*



# Ventricular synchrony assessed by STE

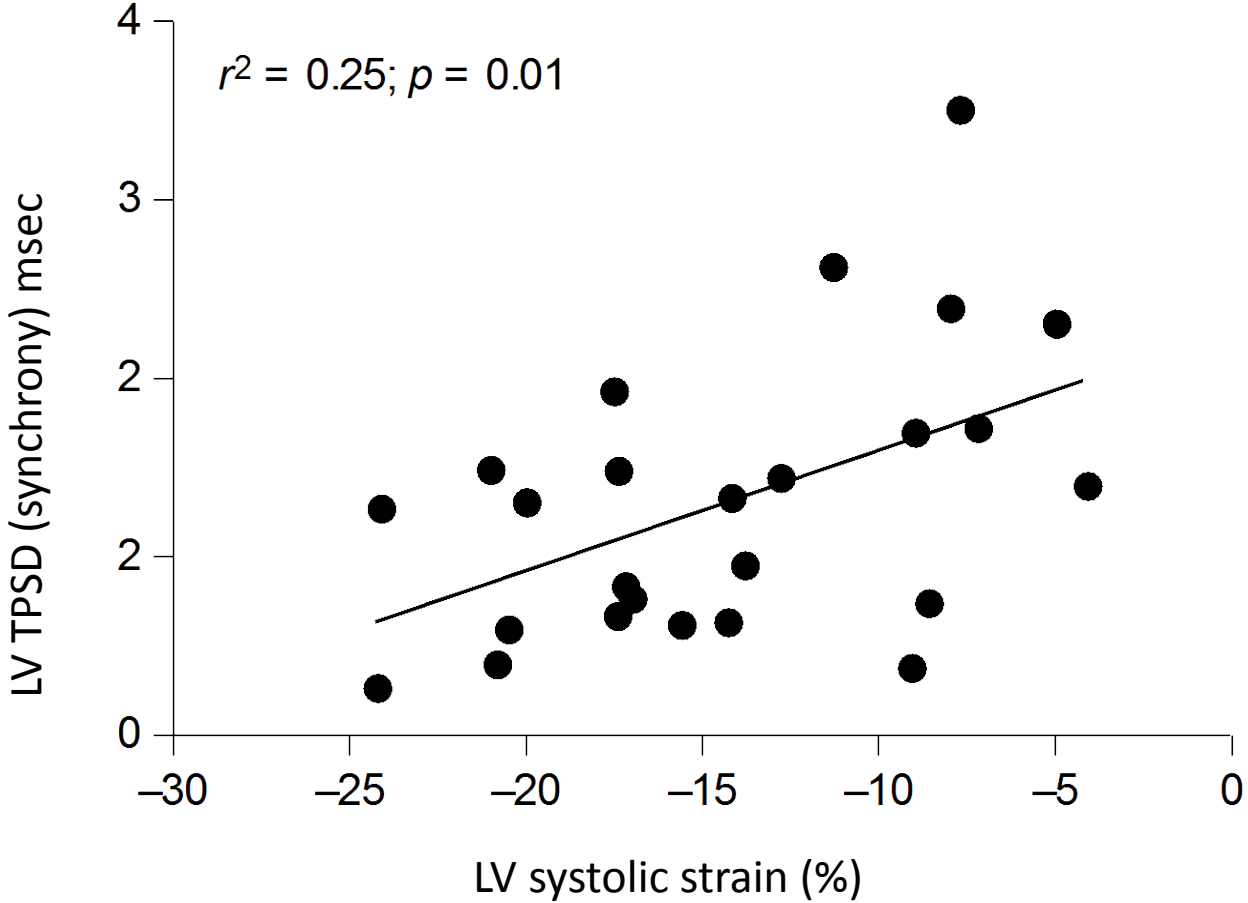


*Time to peak strain (TP)*  
measured for each segment



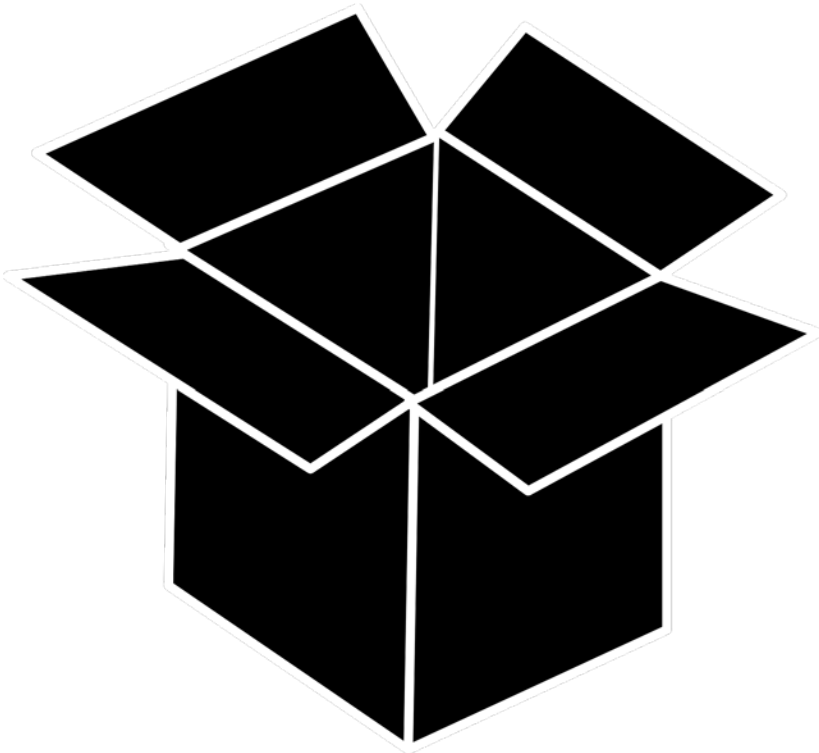
*Standard deviation of TP for 6  
segments calculated (TDSD6)*

# Ventricular strain (function) and synchrony in CDH



Massolo et al, Neonatology, 2019

# Take home message 1:



THINK BEYOND  
BLOOD PRESSURE



CONSIDER CARDIAC  
FUNCTION



SELECT A TARGETTED  
THERAPY





# Surgical demonstration of cardiac function:



# Thank you!

## Staff and patients of the:

Royal Hospital for Children, Glasgow  
Royal Children's Hospital Melbourne

Claudia Massolo

Florian Moenkemeyer, Florian Kipfmueller  
Lindsey Hunter, Emma Finlay, Anshu Paria

