



HỘI TIM MẠCH NHI & TIM BẨM SINH TP. HỒ CHÍ MINH
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Low Cardiac Output State After Surgical Ventricular Septal Defect Closure

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What is Postoperative LCOS ?

A transient and often reversible reduction in cardiac output with an associated decrease in systemic oxygen delivery following surgery for congenital heart disease.





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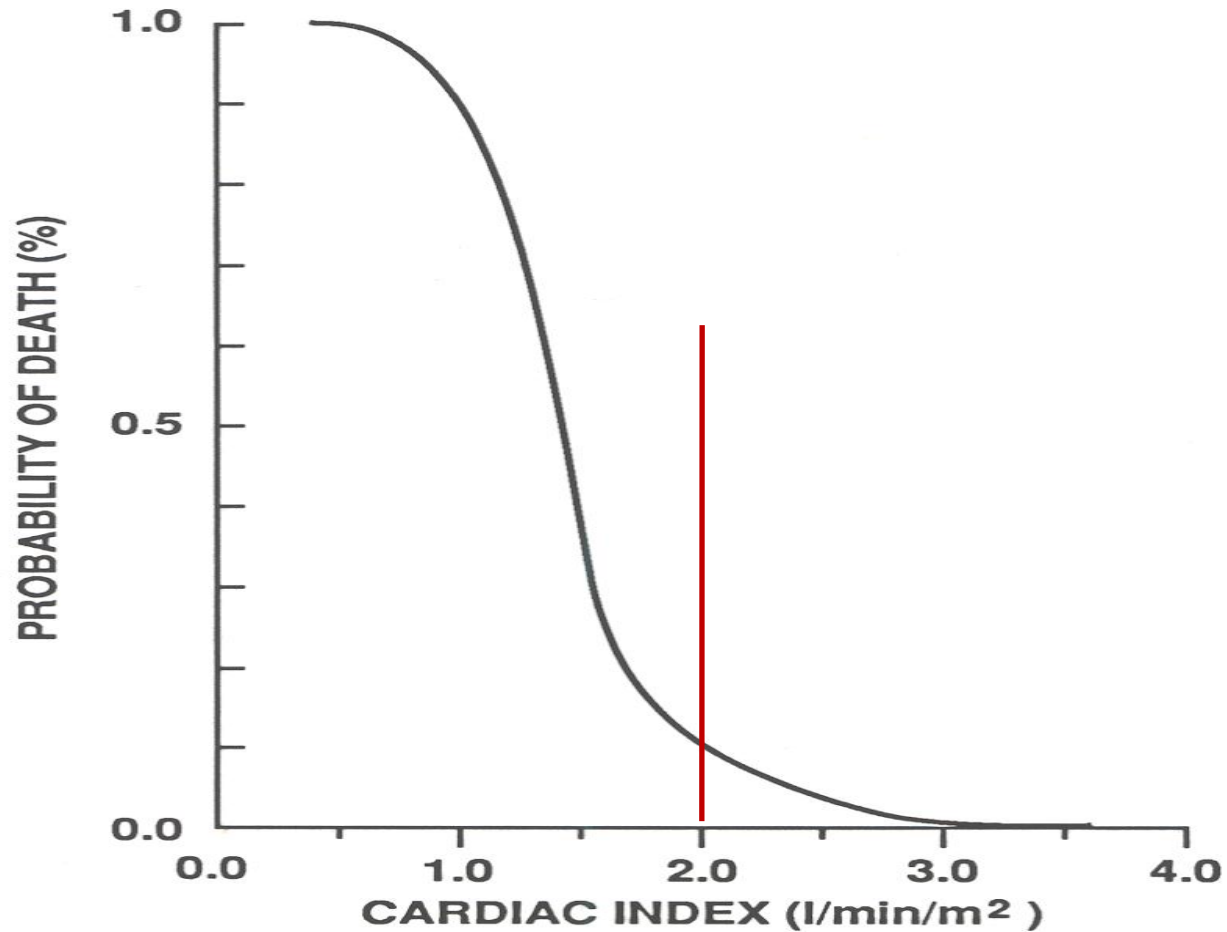


Why Does LCOS Matter?

Aggressive identification and treatment of low cardiac output conditions after cardiac surgery is central to the critical care of children with congenital heart disease.

Why Does LCOS Matter?

PREDICTION OF "ACUTE CARDIAC DEATH" AFTER HEART SURGERY



Why Does LCOS Matter?

At risk: all patient on CPB

Greatest risk:

- *Neonates & younger patients undergoing more complex surgery,*
- *Prolonged aortic cross clamp times,*
- *Presenting in circulatory collapse, and*
- *Preexisting ventricular dysfunction*

Why Does LCOS Matter?

The LCOS may be:

- *“Progressive” leading to MODS,*
- *Increased morbidity,*
- *Prolonged ICU and hospital stay, and*
- *Death.*



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Why does LCOS occur?

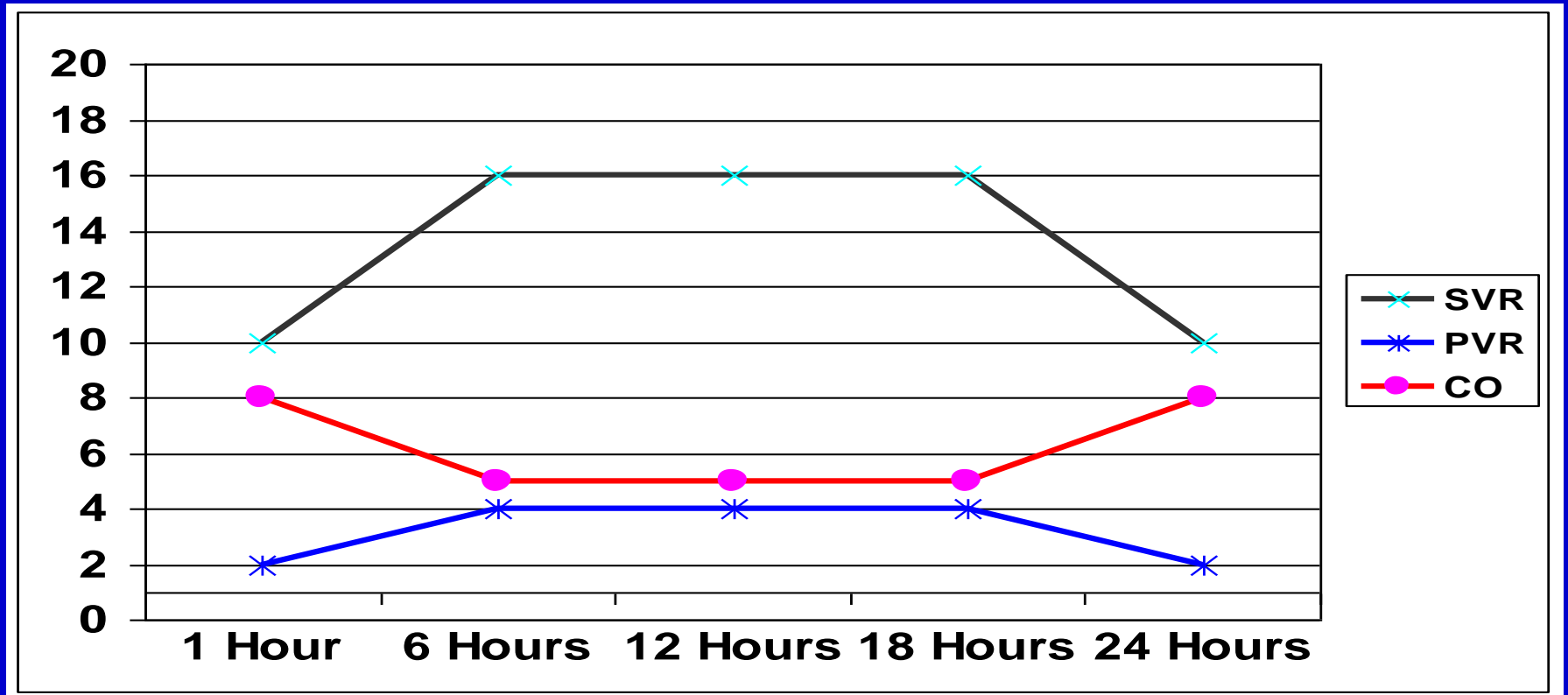
- Residual defects,
- Undiagnosed structural defects,
- Progressive low cardiac output state.

Why does LCOS occur?

Progressive low cardiac output state:

- The inflammatory response associated with CPB,
- Myocardial ischemia from aortic cross clamping,
- Hypothermia,
- Reperfusion injury,
- Inadequate myocardial protection, and
- Ventriculotomy (when performed).

Why does LCOS occur?



Courtesy: Dr. Culbertson



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When to suspect LCOS?

- Increased heart rate, cold extremities,
- Systemic hypertension or hypotension,
- Elevated atrial pressures,
- Elevated central temperature,
- Worsening acidosis, low SvO₂, high serum lactate,
- Organ dysfunction,
- Cardiac arrest.



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How to manage the LCOS?

- Clinical manifestations of these are **similar**
- Their treatment may be very **different.**

→ *Pre-emptive approach is **tailored for the individual patient** according to the **nature of the underlying lesion and surgery.***

How to manage the LCOS?

Systemic oxygen delivery can be optimized by manipulation of:

- *Systolic myocardial function,*
- *Diastolic function,*
- *Preload,*
- *The systemic and pulmonary vasculatures,*
- *Cardiopulmonary interactions.*

How to manage the LCOS?

Practical tools for circulatory manipulation:

- *Pharmacological agents which target cardiac function and vascular tone;*
- *Respiratory manipulation through cardiopulmonary interactions;*
- *Mechanical support with ECLS; and*
- *The manipulation of rate and rhythm*

How to manage the LCOS?

Classification of Cardiovascular Drugs:

Class	Important agents	Recommended Dosage
Inotropes	Epinephrine Calcium chloride (Calcium gluconate)	0.01-0.05 mcg/kg/min 10-20 mg/kg/hour (50-100) mg/kg/hour
Inodilators	Dobutamine Milrinone Levosimendan	Up to 10 mcg/kg/min 0.25-0.75 mcg/kg/min 12 mcg/kg/10min then 0.2mcg/kg/min for 24hrs
Vasoconstrictors	Norepinephrine Dopamine Vasopressin	0.01-0.05 mcg/kg/min Up to 10 mcg/kg/min 0.003-0.02 U/kg/min
Systemic Vasodilators	Phenoxybenzamine Nesiritide Nitroprusside	1-2 mg/kg over several hrs 0.01-0.03 0.5-5 mcg/kg/min
Pulmonary Vasodilators	PDE V inhibitor Bosentan	0.4 mg/kg (before discontinuation of NO)

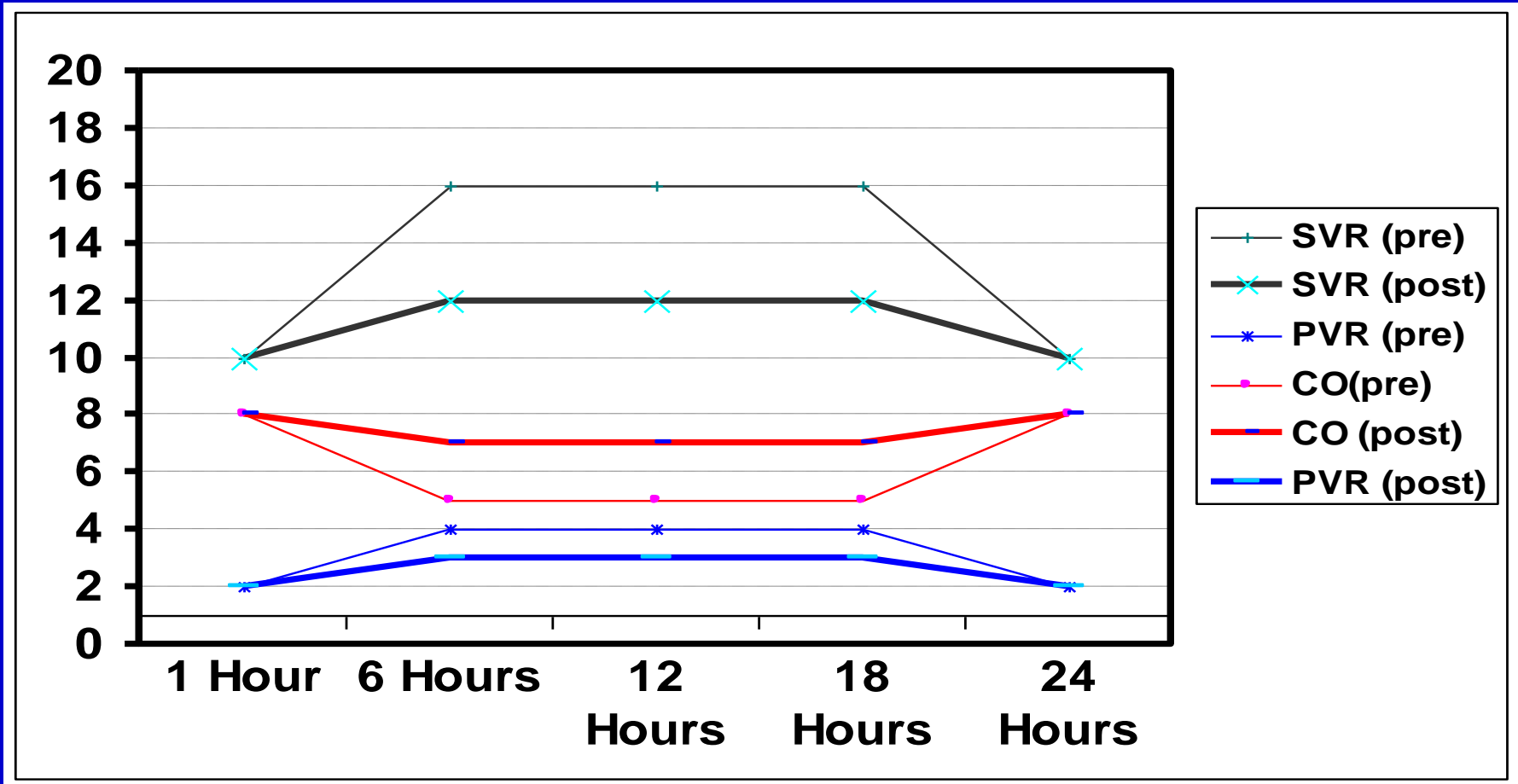
How to manage the LCOS?

*As our understanding of cardiovascular dysfunction after surgery for CHD has improved, so the focus of treatment has shifted from the manipulation of **systolic function**, to **afterload** and minimising **myocardial work**.*

How to manage the LCOS?

Milrinone:

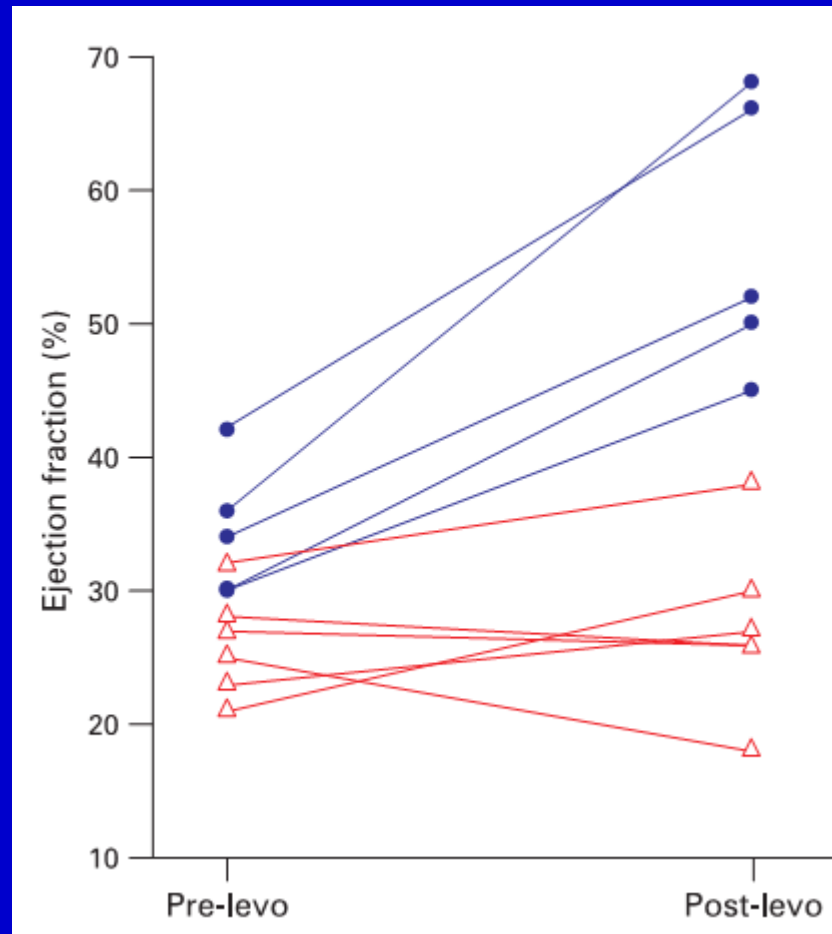
Courtesy: Dr. Culbertson



Efficacy and Safety of Milrinone in Preventing Low Cardiac Output Syndrome in Infants and Children After Corrective Surgery for Congenital Heart Disease Hoffman, Tim et al Circ 2003; 107:996-1002

How to manage the LCOS?

Levosimedan:



Namachivayam P, Crossland DS, Butt WW, *et al.* Early experience with levosimendan in children with ventricular dysfunction. *Pediatr Crit Care Med* 2006;7: 445–8.

How to manage the LCOS?

Manipulation of cardiopulmonary interaction:

Pathology	Positive pressure ventilation	Guide for routine ventilation
Systolic dysfunction (early after CPB)	Reduce work of breathing; obliterates negative swings in pleural pressure	Positive pressure ventilation is beneficial Consider extubating to CPAP
Tetralogy of Fallot with restrictive RV	Reduce RV preload; Reduce diastolic pulmonary flow	Low airway pressure early after surgery; early extubation
Post-op Fantan	Reduce preload; Reduce pulmonary flow	Low airway pressure early after surgery; early extubation
Post-op BCPS	Reduce pulmonary flow Increased cavopulmonary pressure	Keep upper body elevated Low airway pressure Aim at mild respiratory acidosis Early extubation
Shunt (or duct) dependent systemic flow	Enable pre- and postoperative control of pulmonary flow, pH and pulmonary resistance	Maintain stable PVR; normal PCO ₂ and pH



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LCOS without ECLS?

New Delhi's Experience:

1. Intraoperative strategies,
2. Aggressive afterload reduction,
3. Lusitropy,
4. Exclusion of structural defects,
5. Harnessing cardiopulmonary interactions, and
6. Addressing metabolic and endocrine abnormalities



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LCOS after surgical VSD Closure?

1. Large VSD and heart failure in younger age
2. Myocardial protection, tamponade
3. Severe pulmonary arterial hypertension (**Dr. Teiji**)
4. Postoperative arrhythmia (**Dr. Wu**)



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