Perioperative Management of Children with Pulmonary Hypertension

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Objectives

- Review basic known principles of anesthetic management.

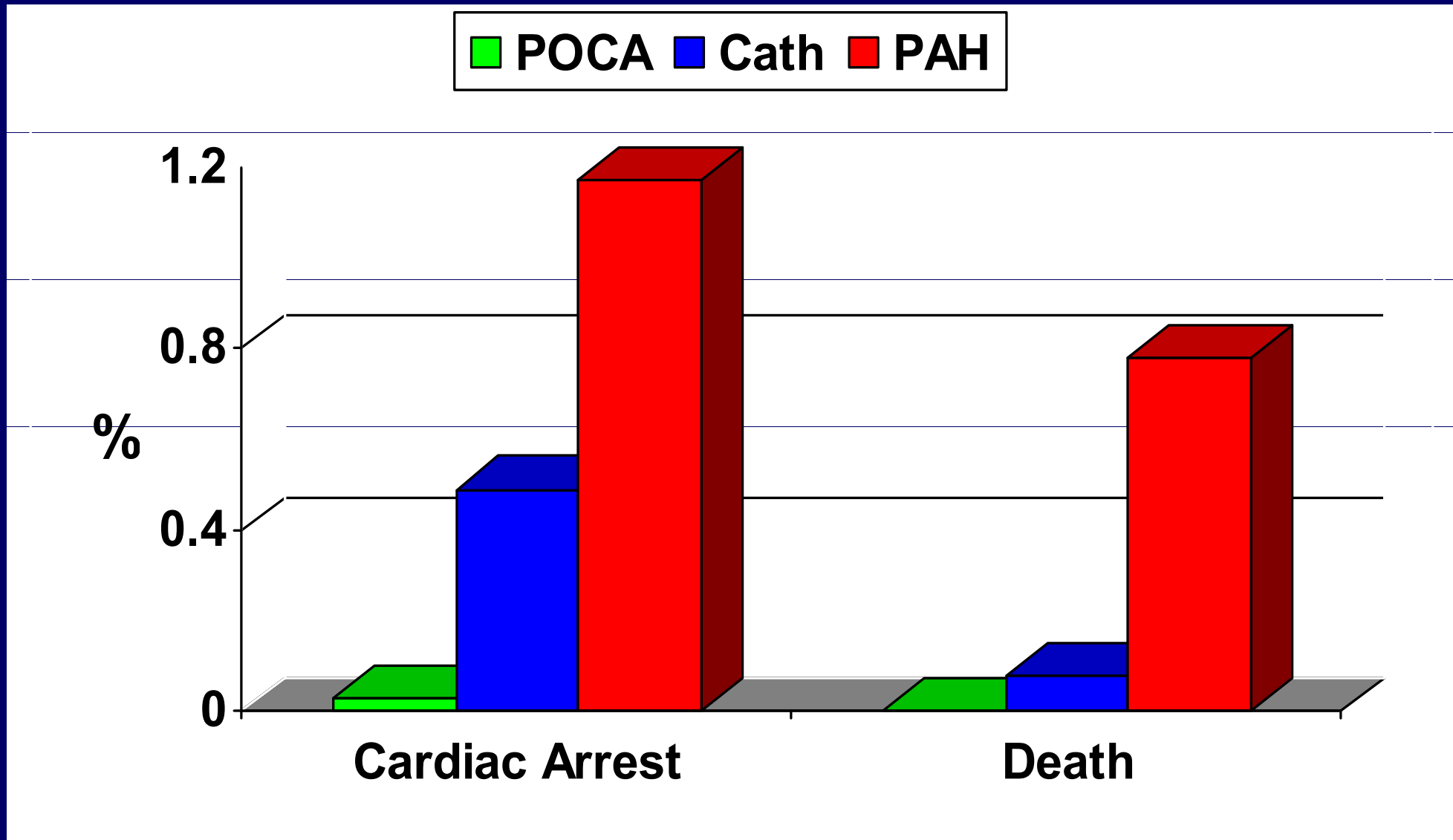
- Inform of new developments.

Disclosures

- No relevant financial relationships or professional conflicts of interest

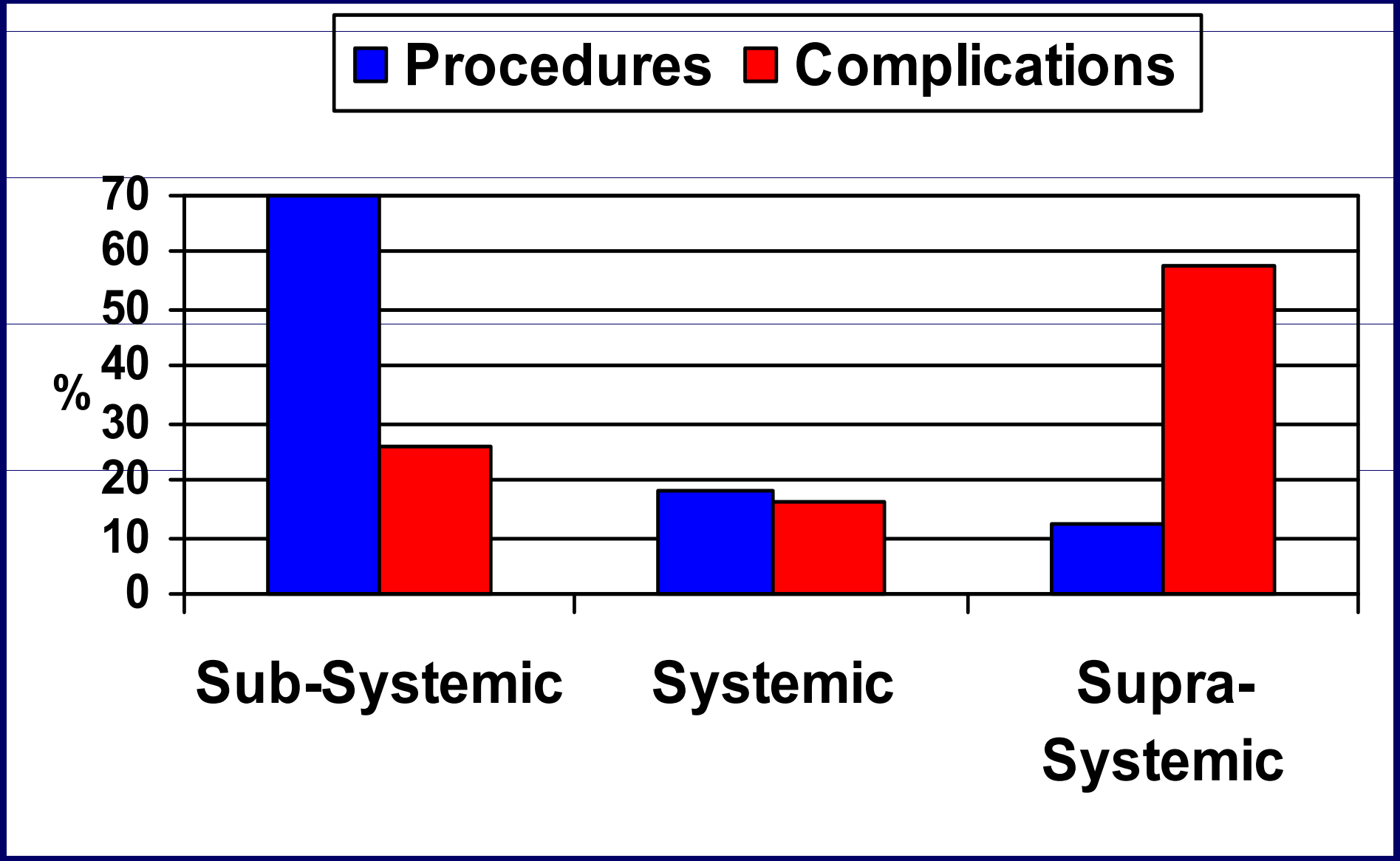
Perioperative Risk

POCA: Morray: Anesthesiology 2000;93:6
Cath: Bennett: Pediatr Anesth 2005;15:1083
PAH: Carmosino: Anesth Analg 2007;104:521



Baseline PAP & Complications

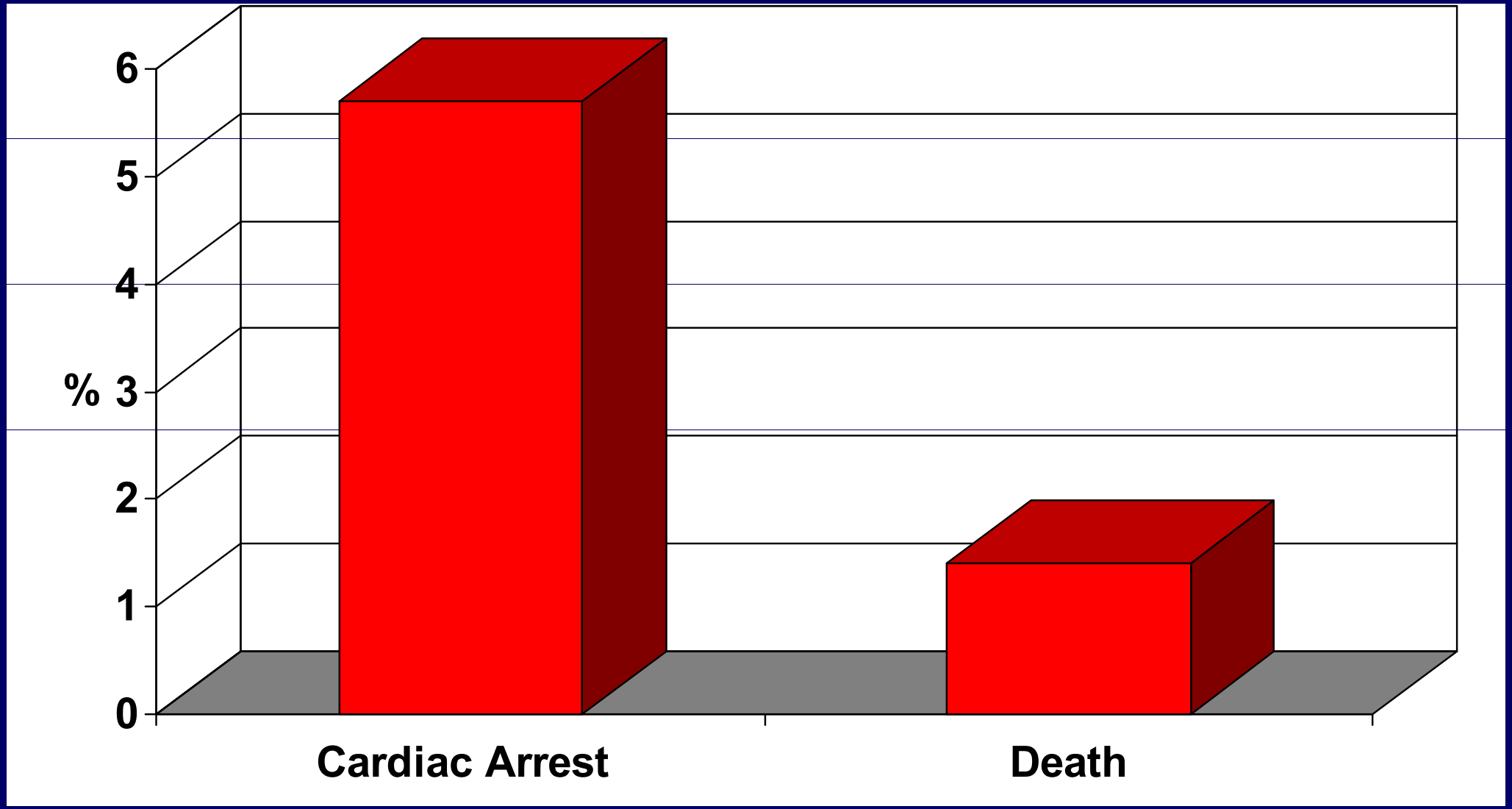
Carmosino: Anesth Analg 2007;104:521



Cardiac Arrest Cath Lab

70 children with PAH

Taylor: Br J Anaesth 2007;98:657



Adults: mild – moderate PAH

28 non-cardiac, non-obstetric

Price: Eur Respir J 2010 (in press)

- Complication 29%
- Perioperative death 7%
- Emergency P < 0.001
- Major operation P = 0.008
- Long duration P = 0.003

Pediatric Anesthesia

Pediatric Anesthesia 2010 20: 28–37 doi:10.1111/j.1460-9592.2009.03166.x

Perioperative complications in children with pulmonary hypertension undergoing general anesthesia with ketamine

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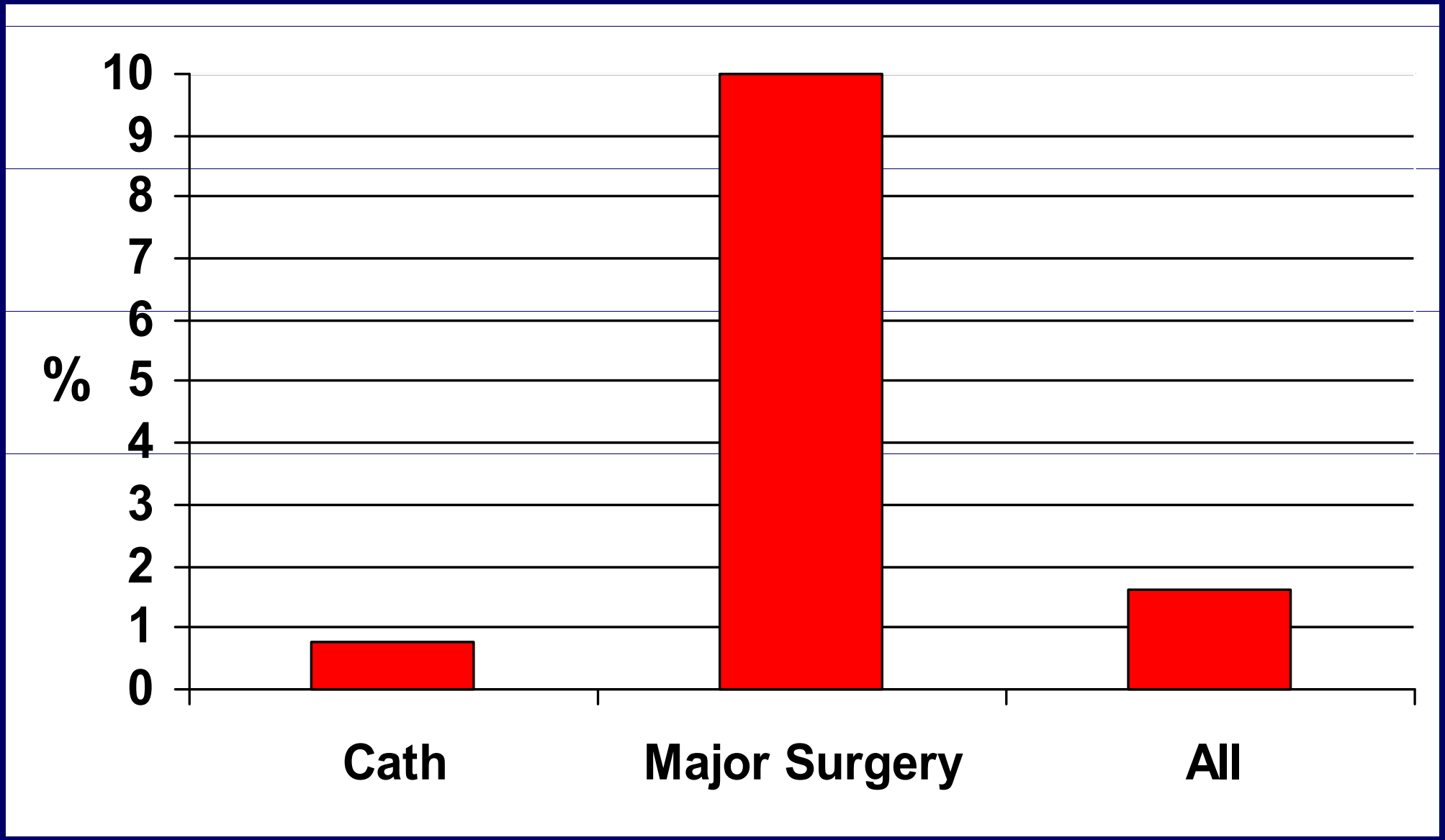
Perioperative Cardiac Arrest

192 children with PAH

Williams: Pediatr Anesth 2010;20:28



Perioperative Complications

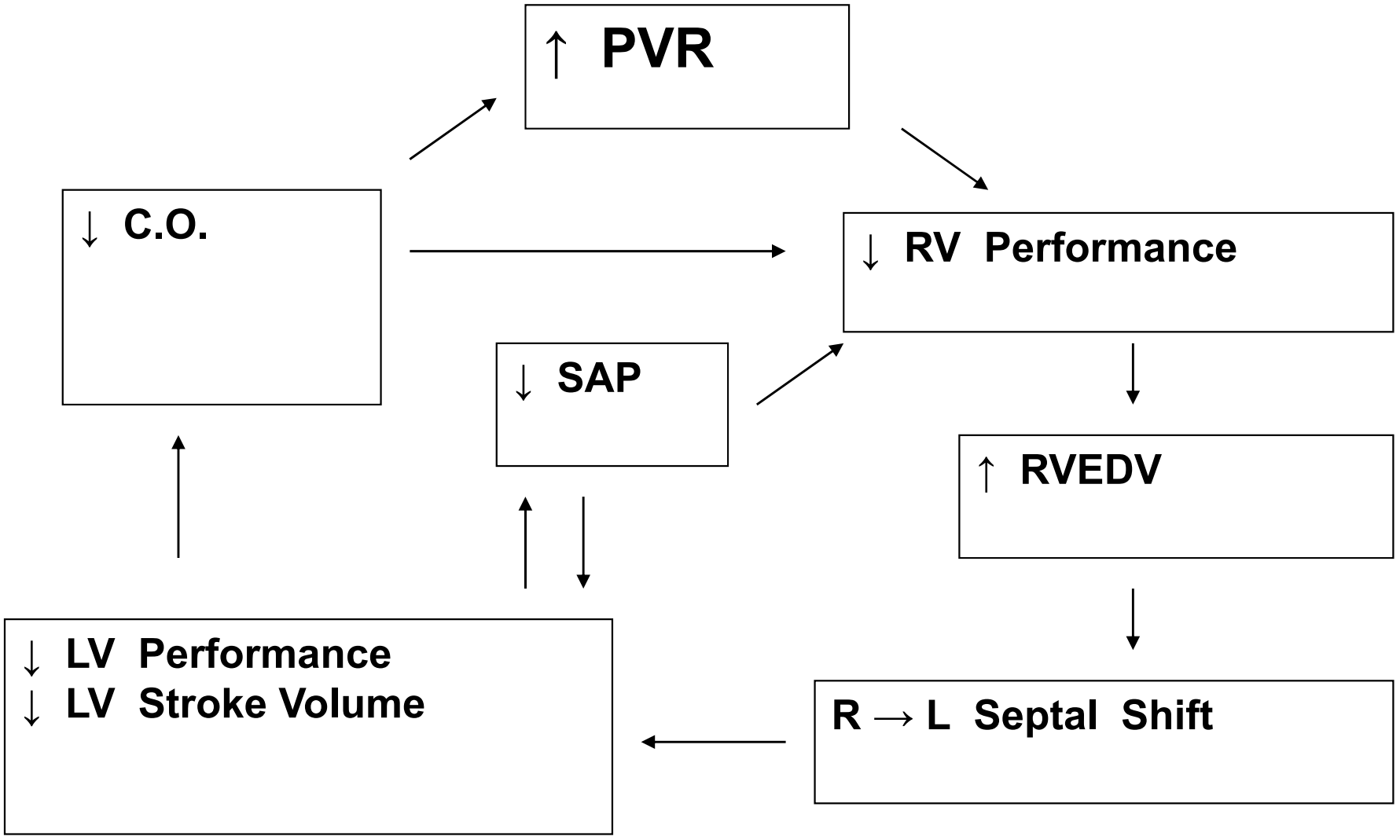
192 cases

Williams: Pediatr Anesth 2010;20:28

	Odds Ratio	95% CI
Major Surgery	3.1	1.1 - 9
Pre-op Vasodilator	0.31	0.13 - 0.7
Ketamine	NS	

Hemodynamics of PAH

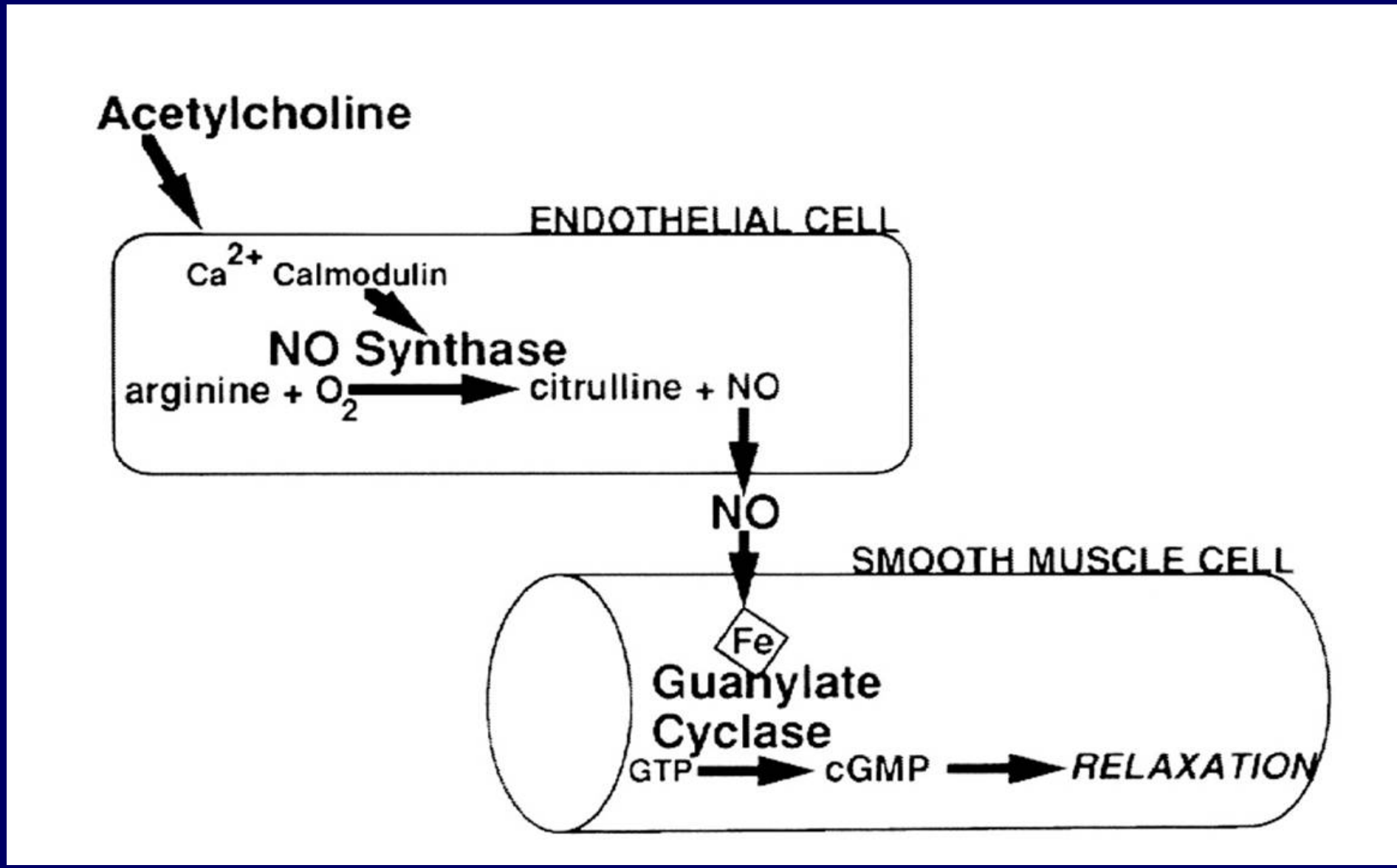
Via & Braschi: Minerva Anestesiol 2004;70:233



Pulmonary Vasodilators

- Inhaled nitric oxide (iNO)
- Prostacyclin analogs
- Phosphodiesterase inhibitors

Nitric Oxide mechanism



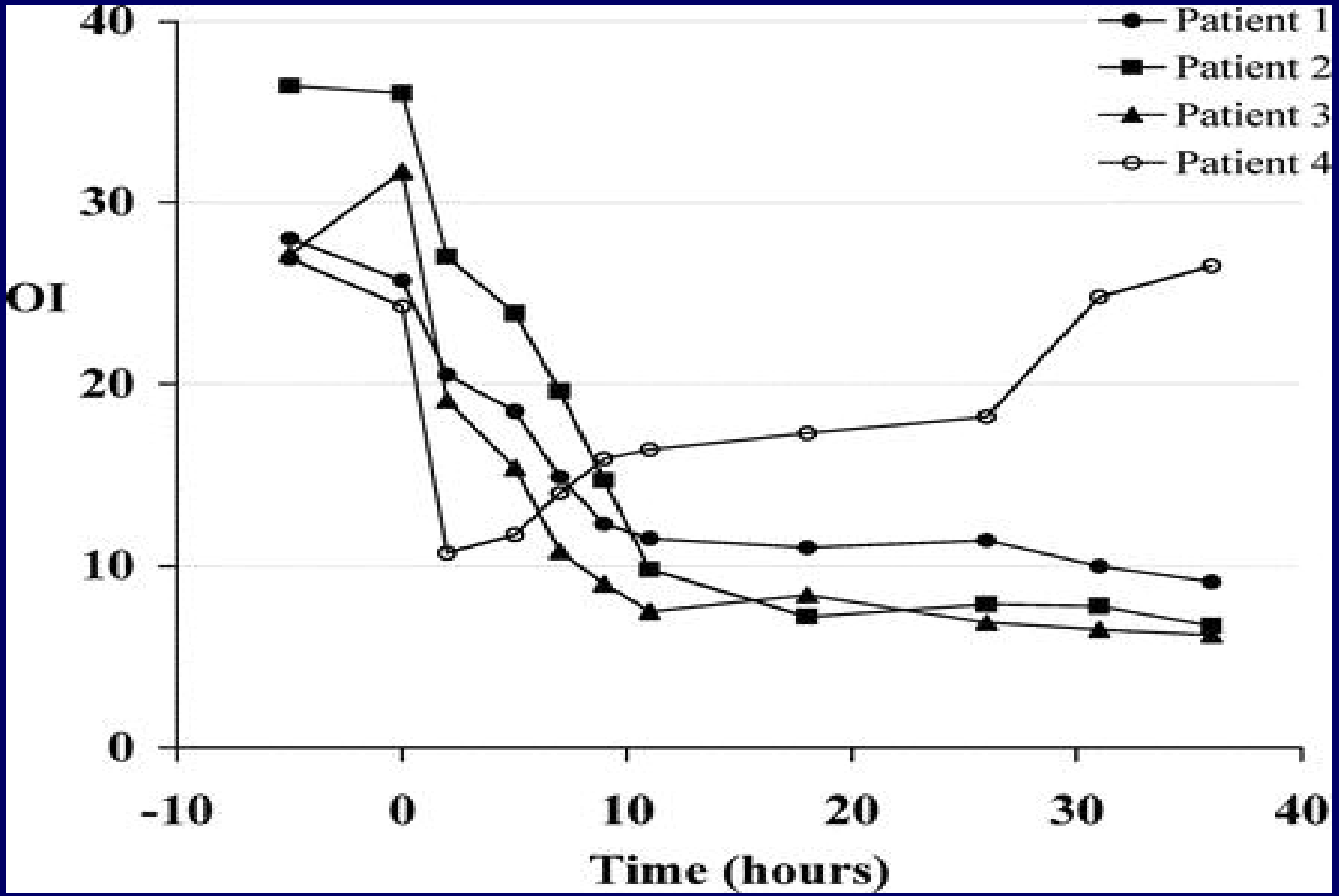
iNOvent Datex-Ohmeda

Pulmonary Vasodilators

- Inhaled nitric oxide (iNO)
- Prostacyclin analogs
  - Epoprostenol (intravenous)
  - Iloprost (inhaled)
  - Treprostinil (subcutaneous)
  - Beraprost (oral)

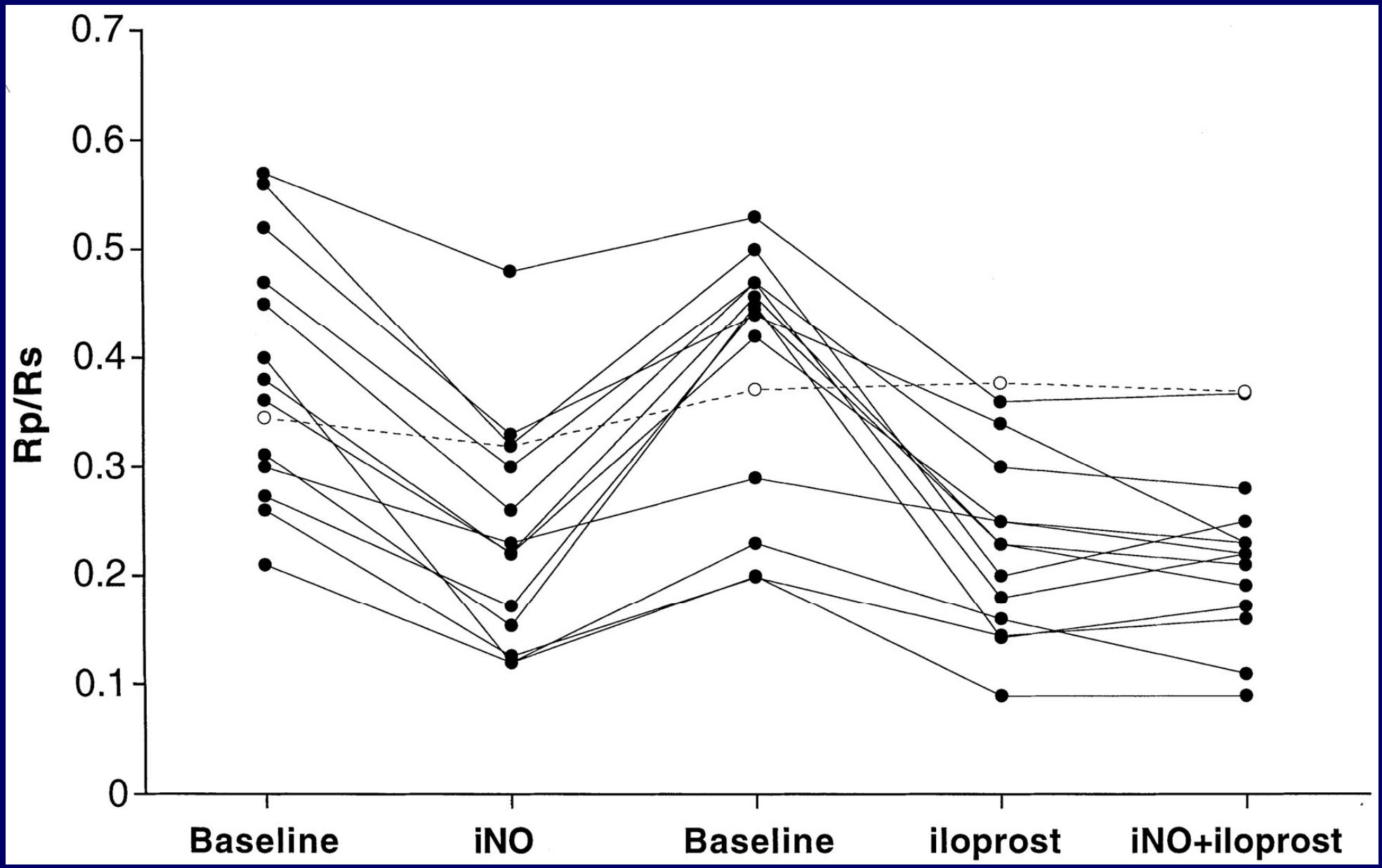
Inhaled epoprostenol: PPHN

Kelly: J Pediatr 2002;141:830



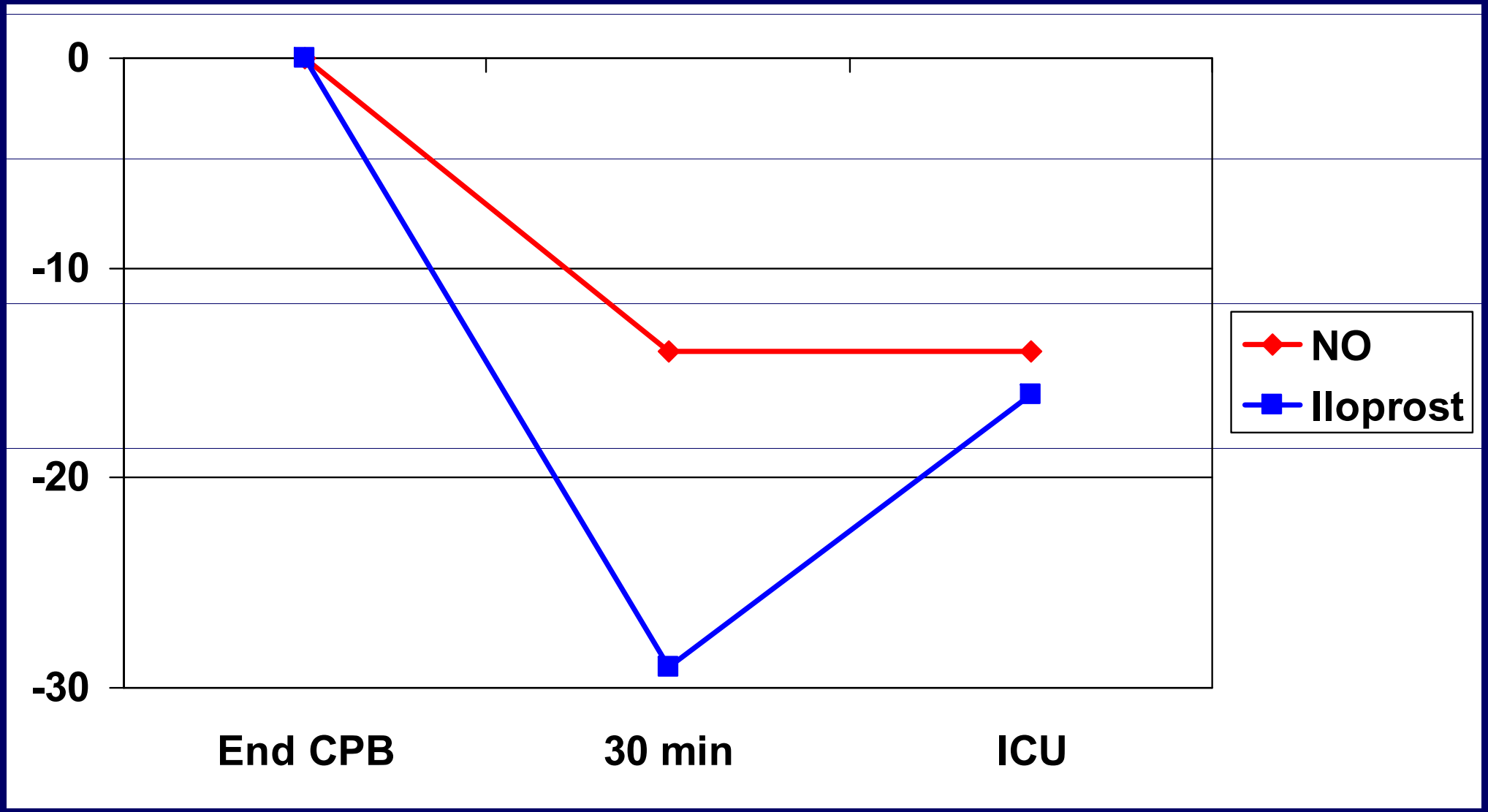
iNO vs iloprost in Children with CHD

Rimensberger: Circulation 2001;103:544-548



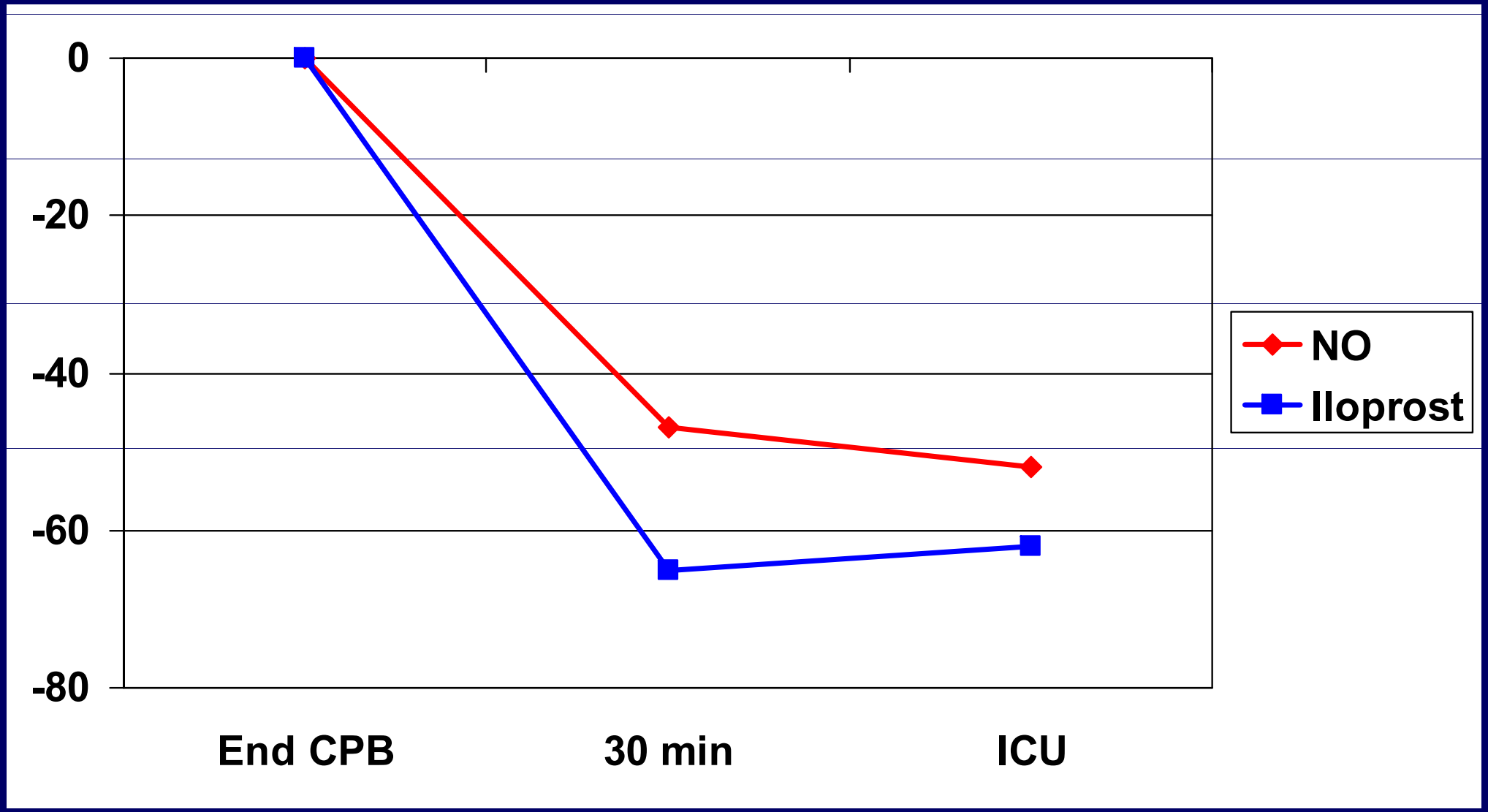
Iloprost vs NO – PAP

Winterhalter: J Cardiothorac Vasc Anesth 2008;22:406



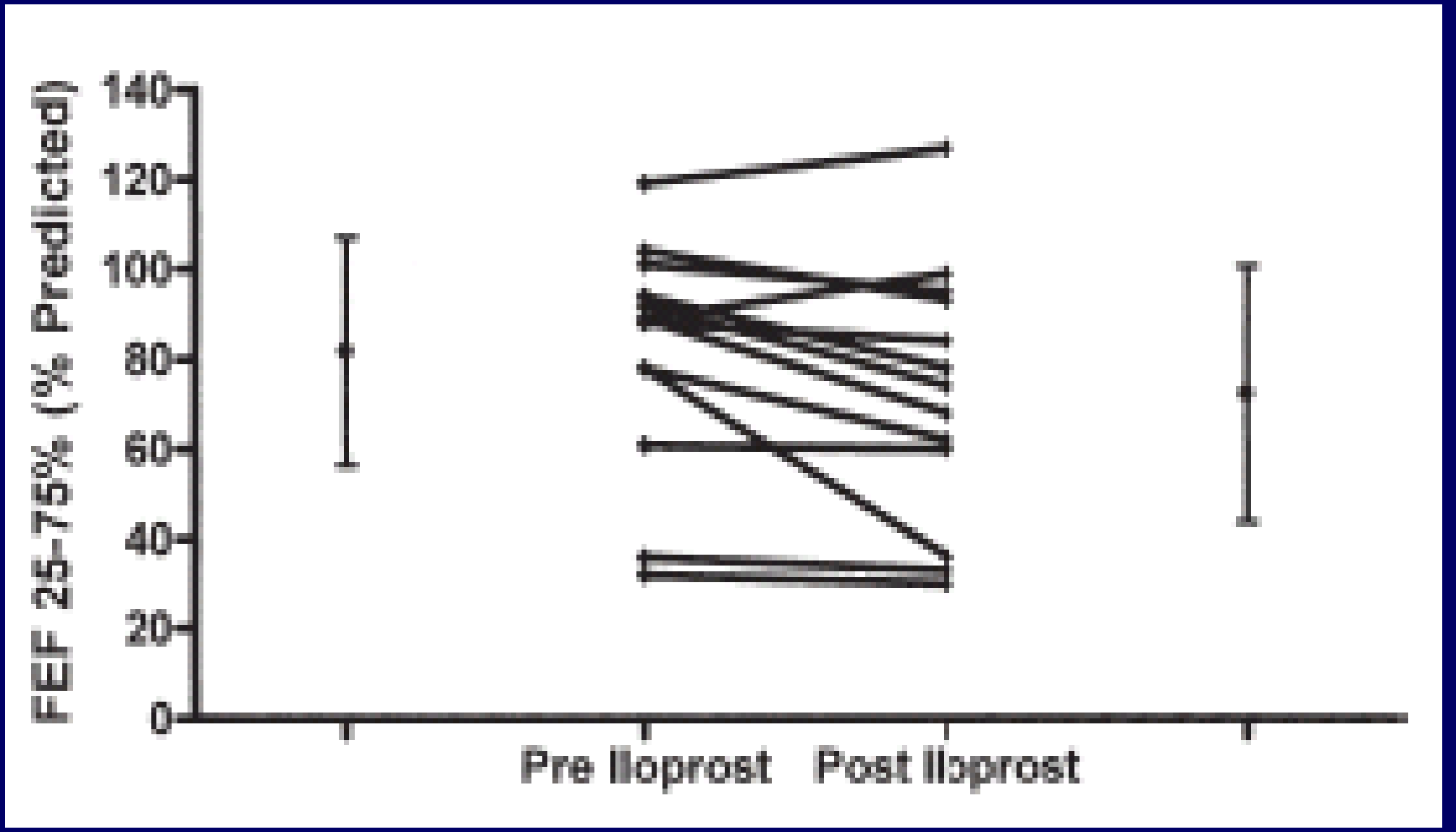
Iloprost vs NO – PVR

Winterhalter: J Cardiothorac Vasc Anesth 2008;22:406



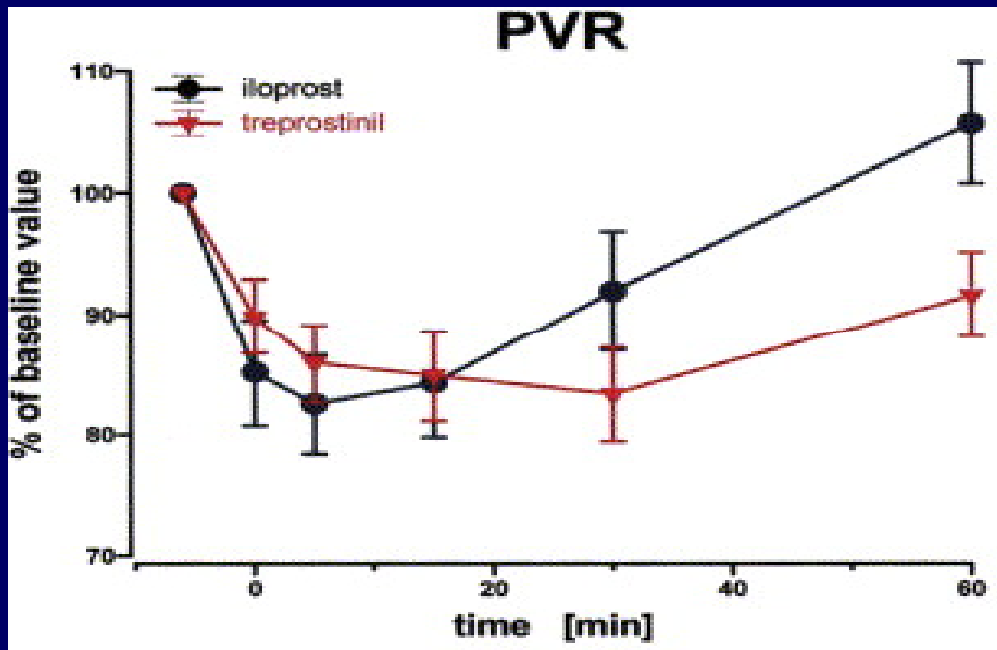
Iloprost: Airway reactivity

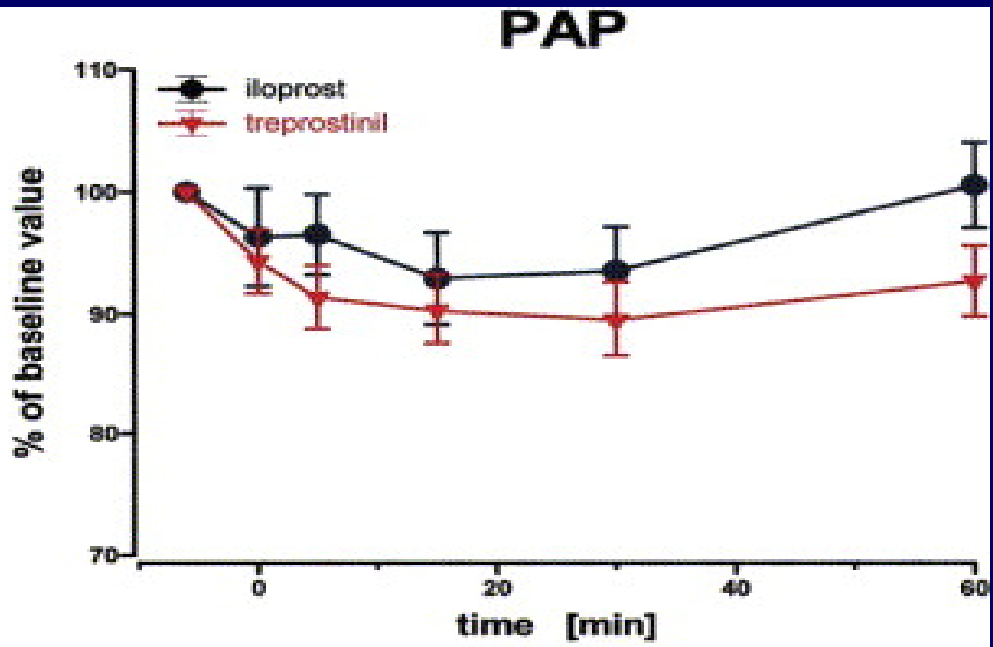
Ivy: J Amer Coll Cardiol 2008;51:161

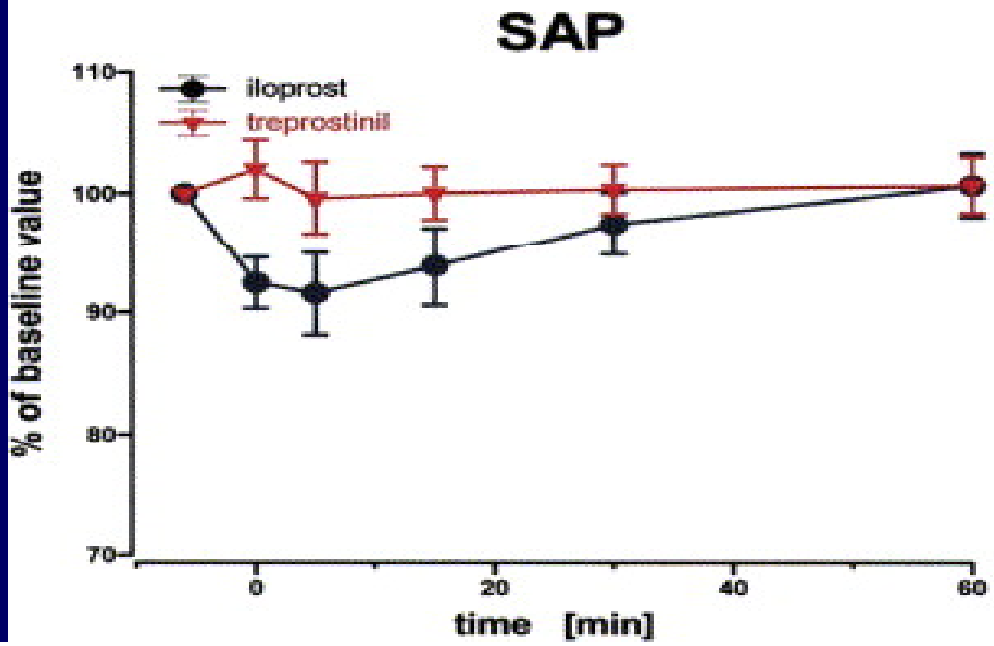


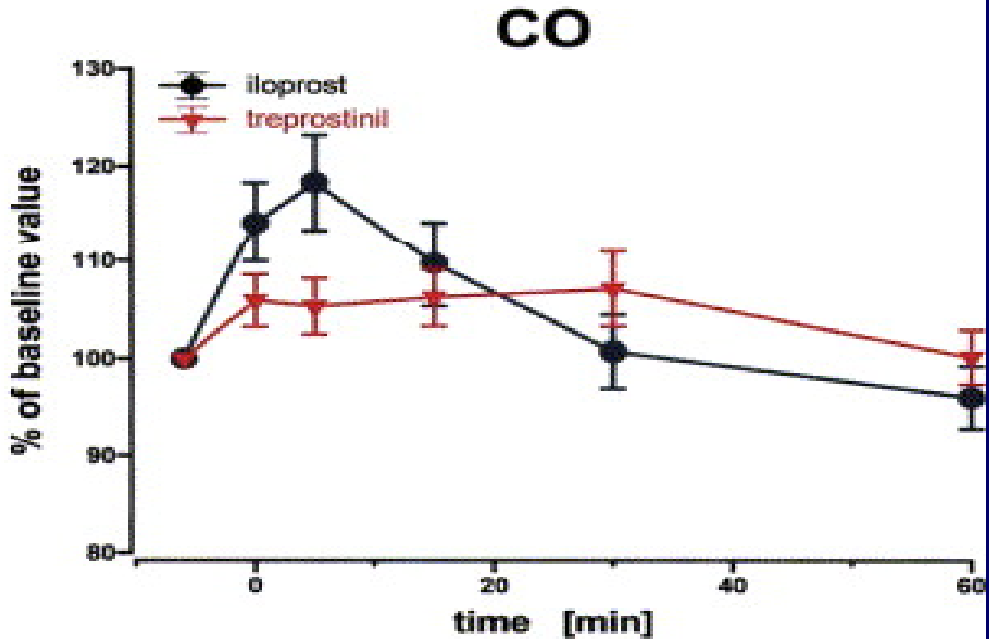
Inhaled Treprostinil vs Iloprost

Voswinckel: J Am Coll Cardiol 2006;48:1672



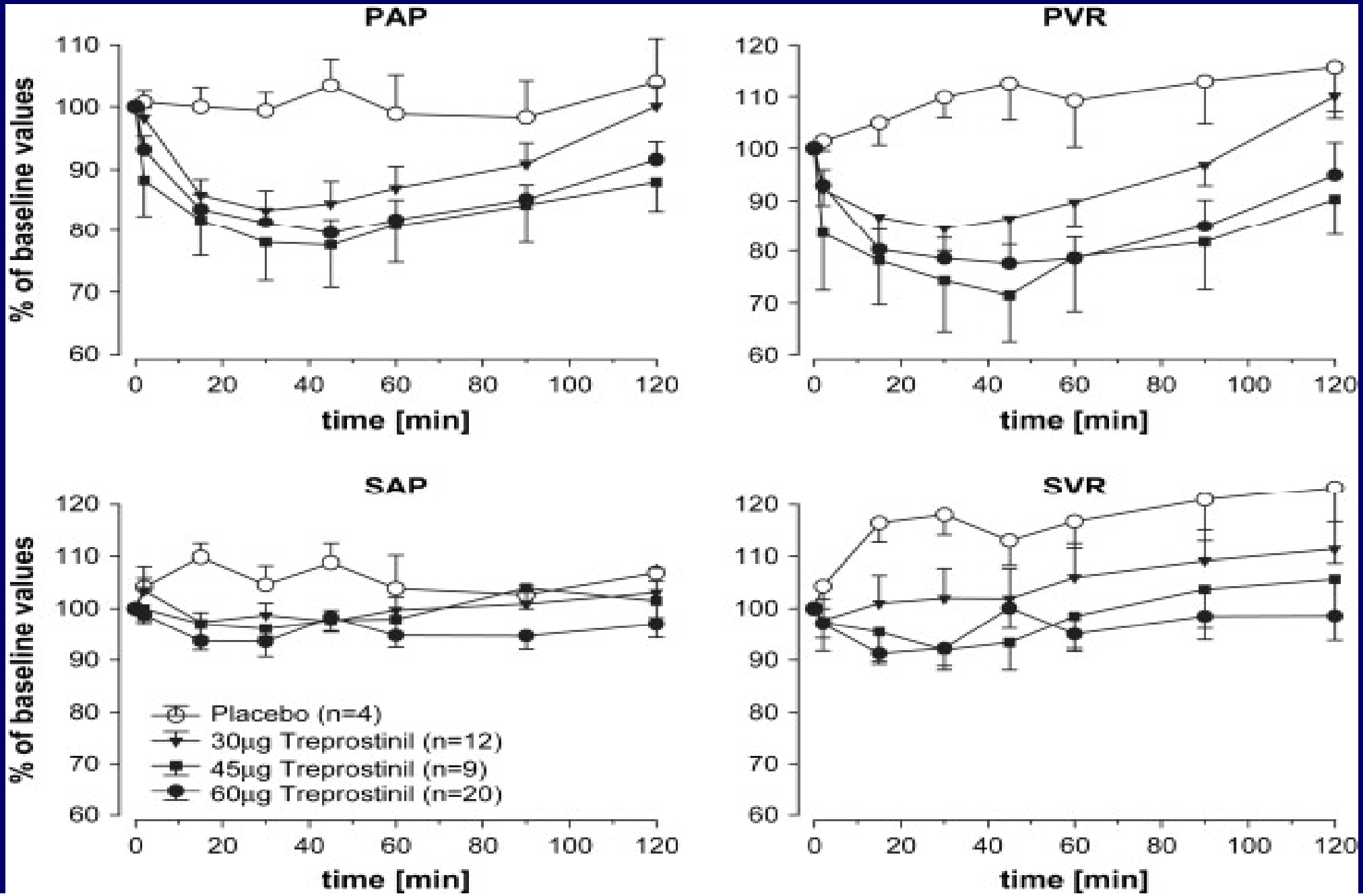






Treprostinil: metered dose inhaler

Voswinckel: Pulm Pharmacol Ther 2009;22:50

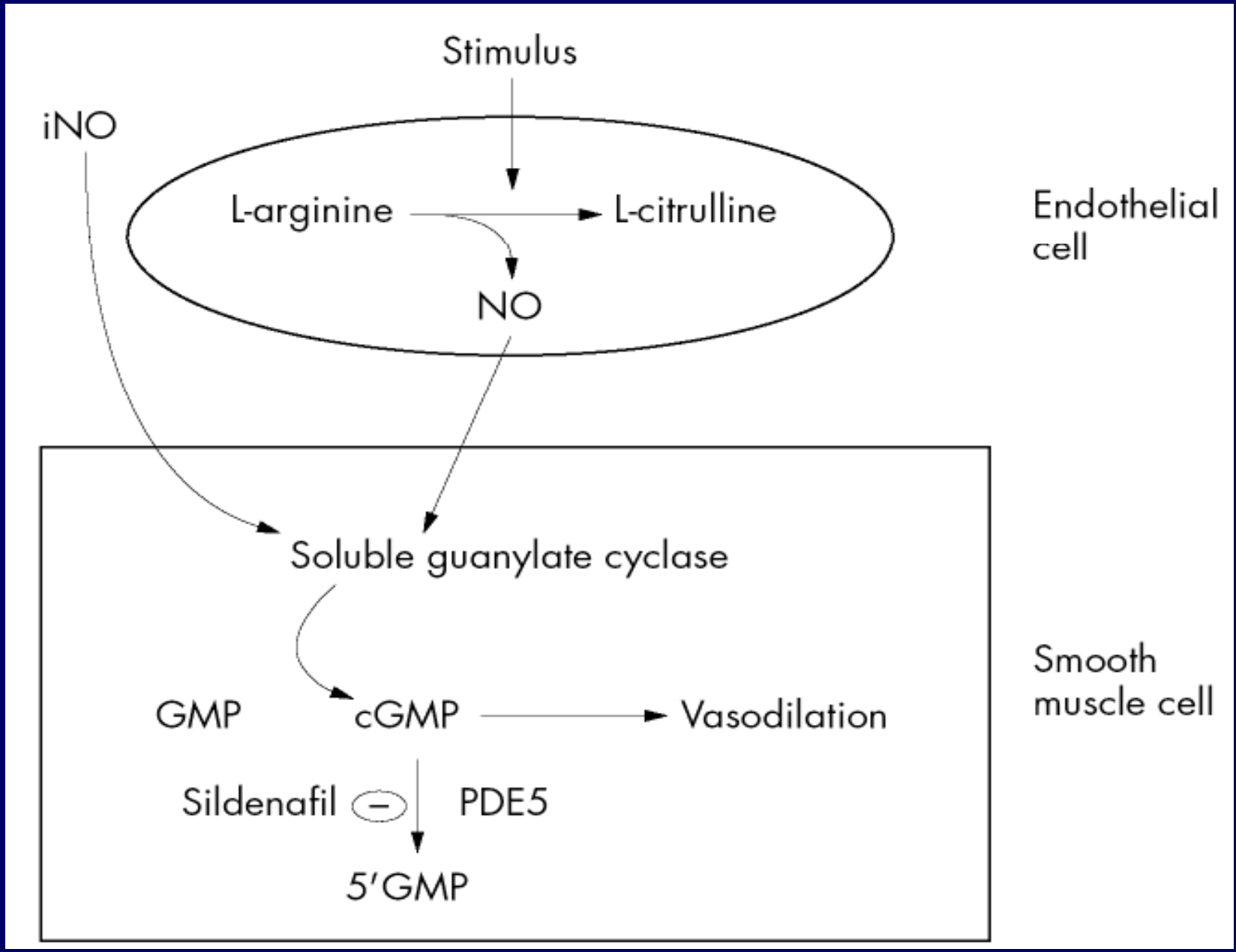


Pulmonary Vasodilators

- Inhaled nitric oxide (iNO)
- Prostacyclin analogs
- Phosphodiesterase inhibitors
  - Sildenafil (PDE-5)
  - Dipyridamole (PDE-5)
  - Milrinone (PDE-3)

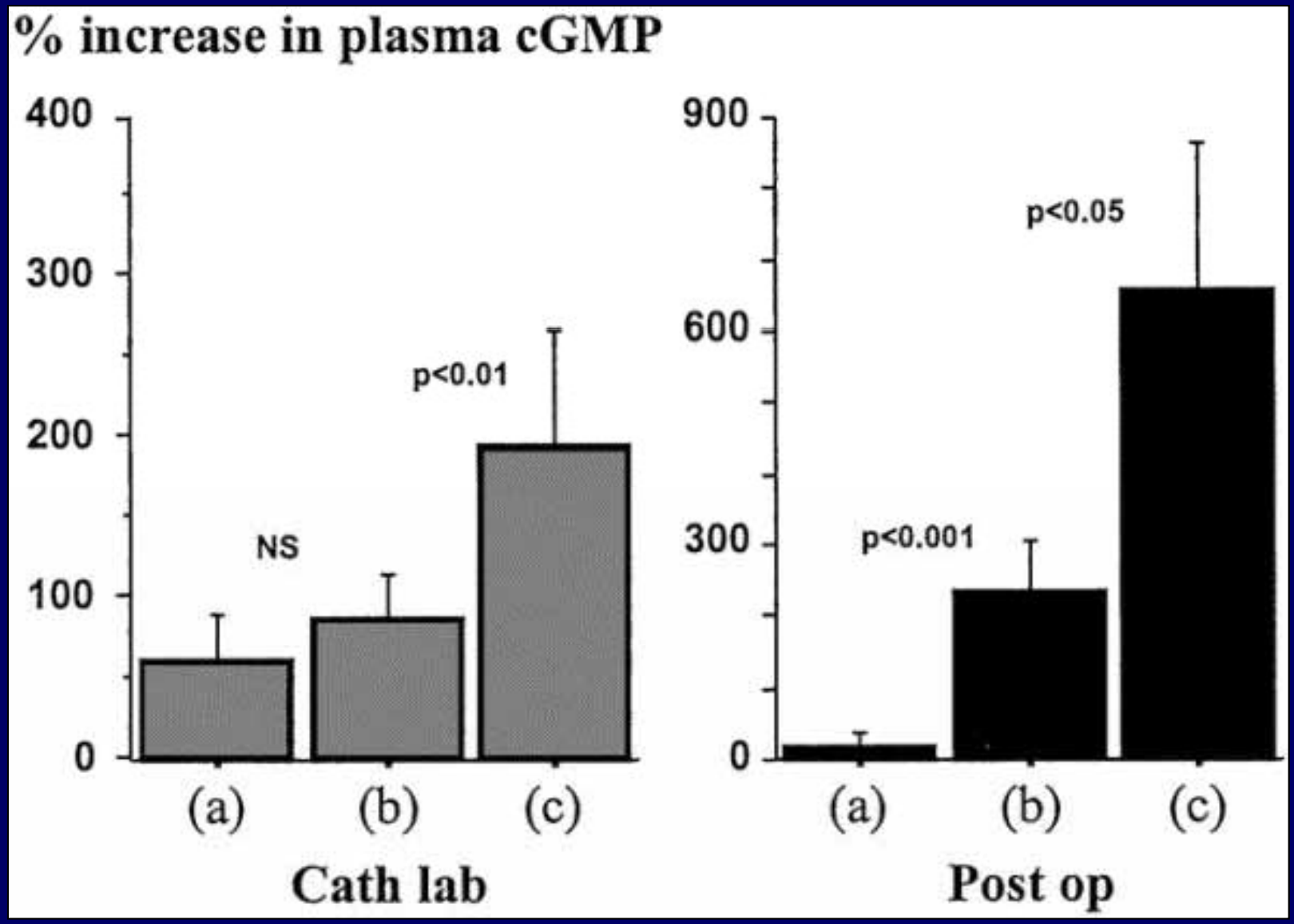
PDE-5 Inhibitor

Rashid: Arch Dis Child 2005;90:92



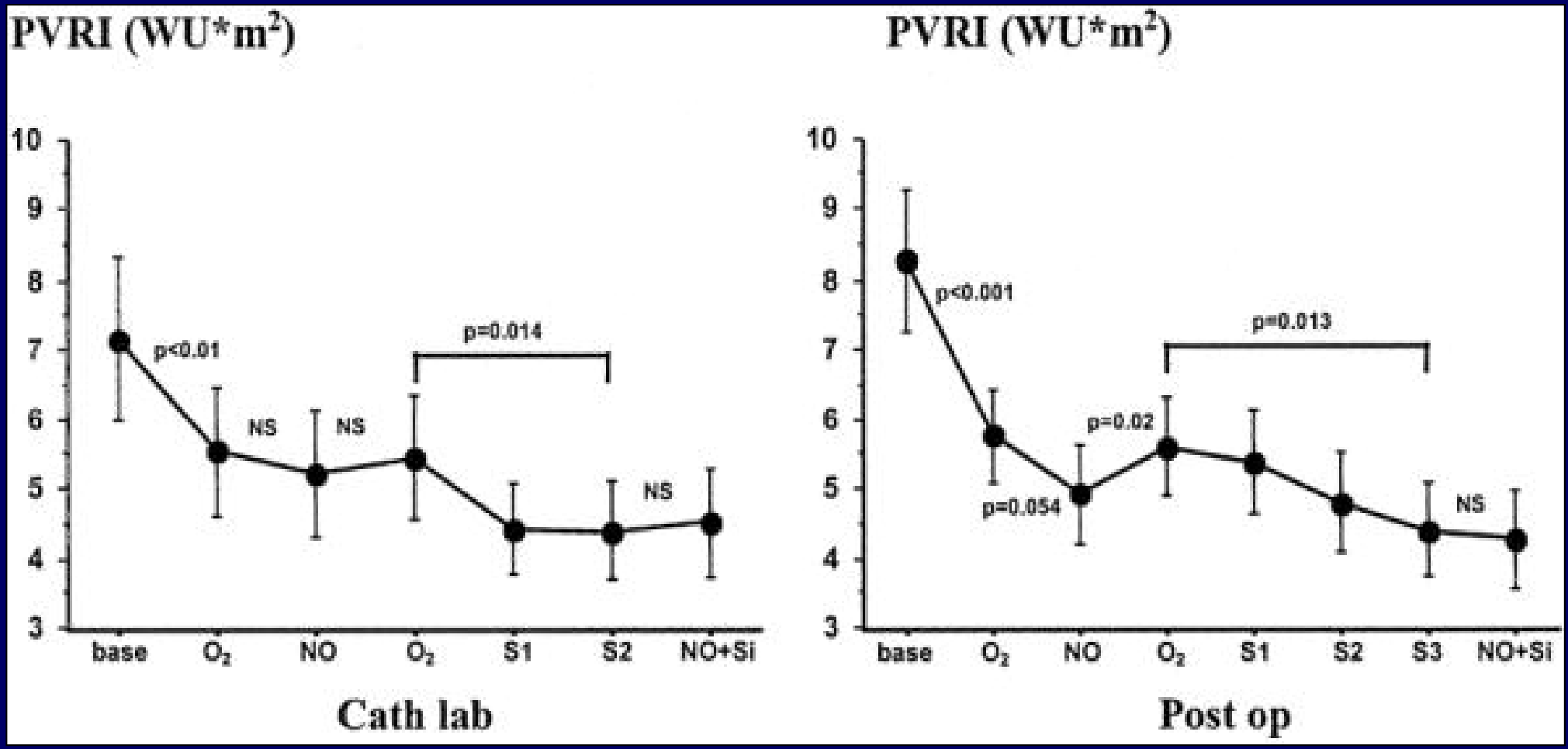
IV Sildenafil cGMP

Schulze-Neick: Circulation 2003;108 [suppl II]:167



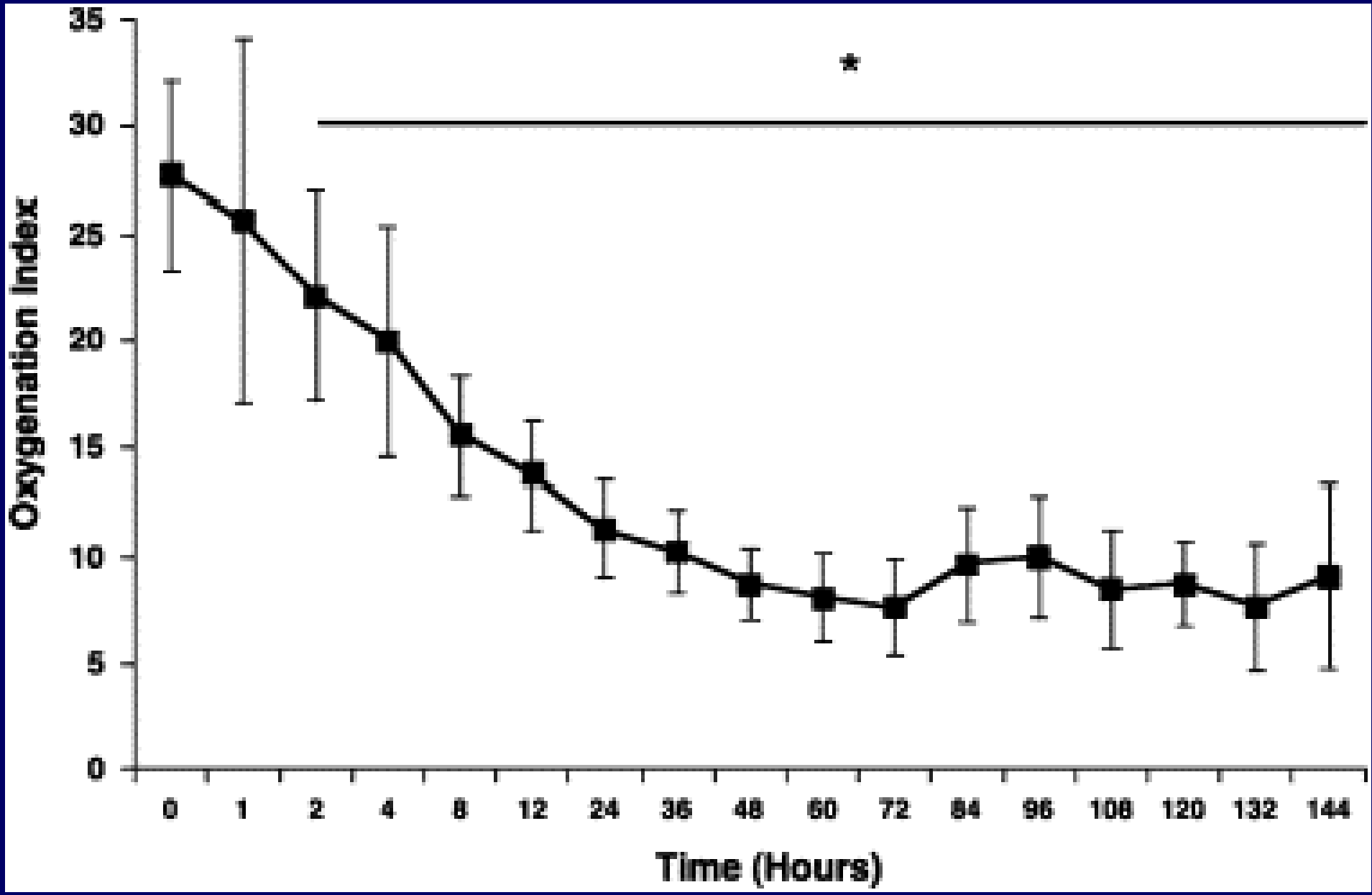
IV Sildenafil PVR

Schulze-Neick: Circulation 2003;108 [suppl II]:167



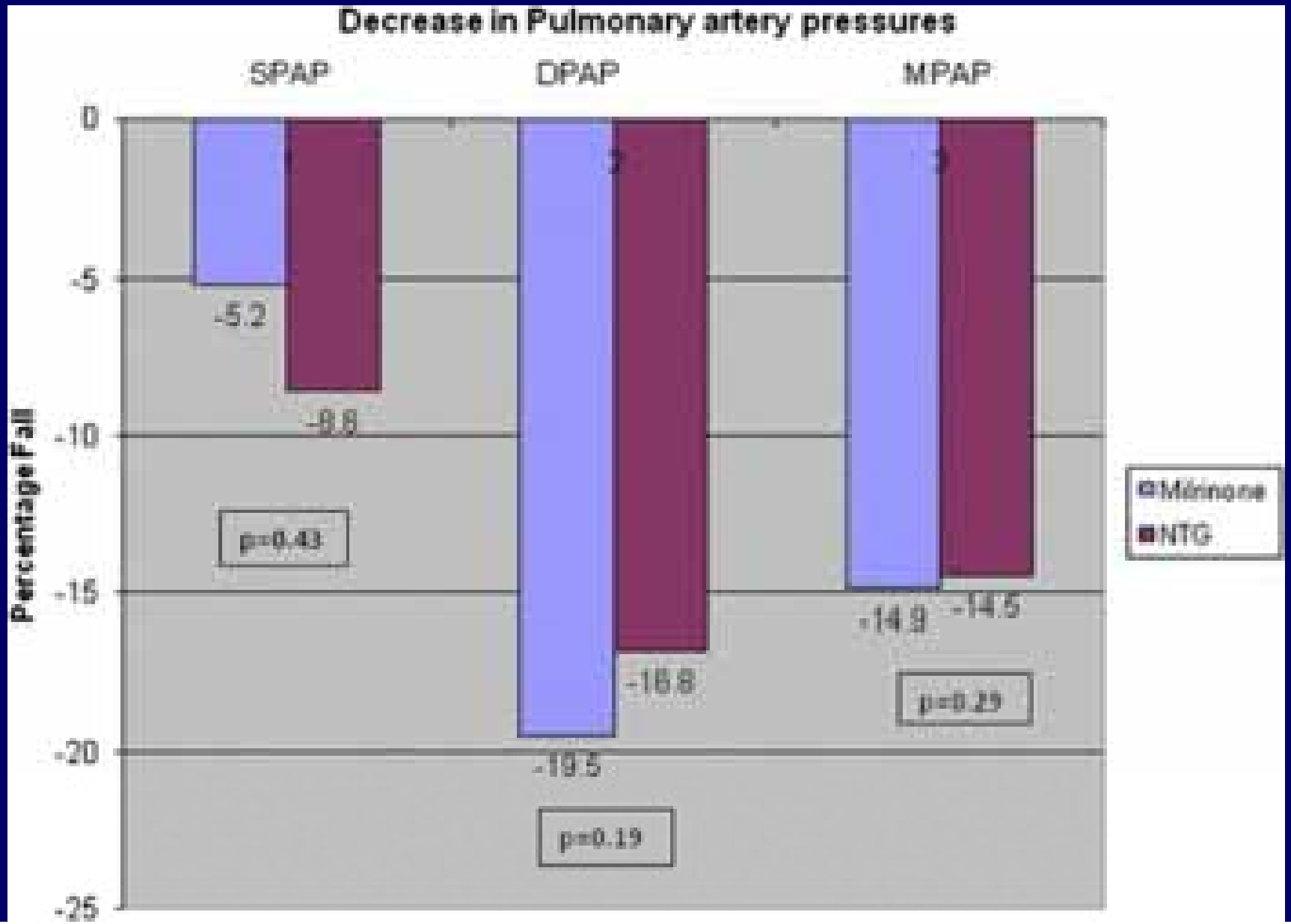
IV Sildenafil PPHN

Steinhorn: J Pediatr 2009;155:841



Inhaled Milrinone vs NTG

Singh: J Cardiothorac Vasc Anesth 2009; in press



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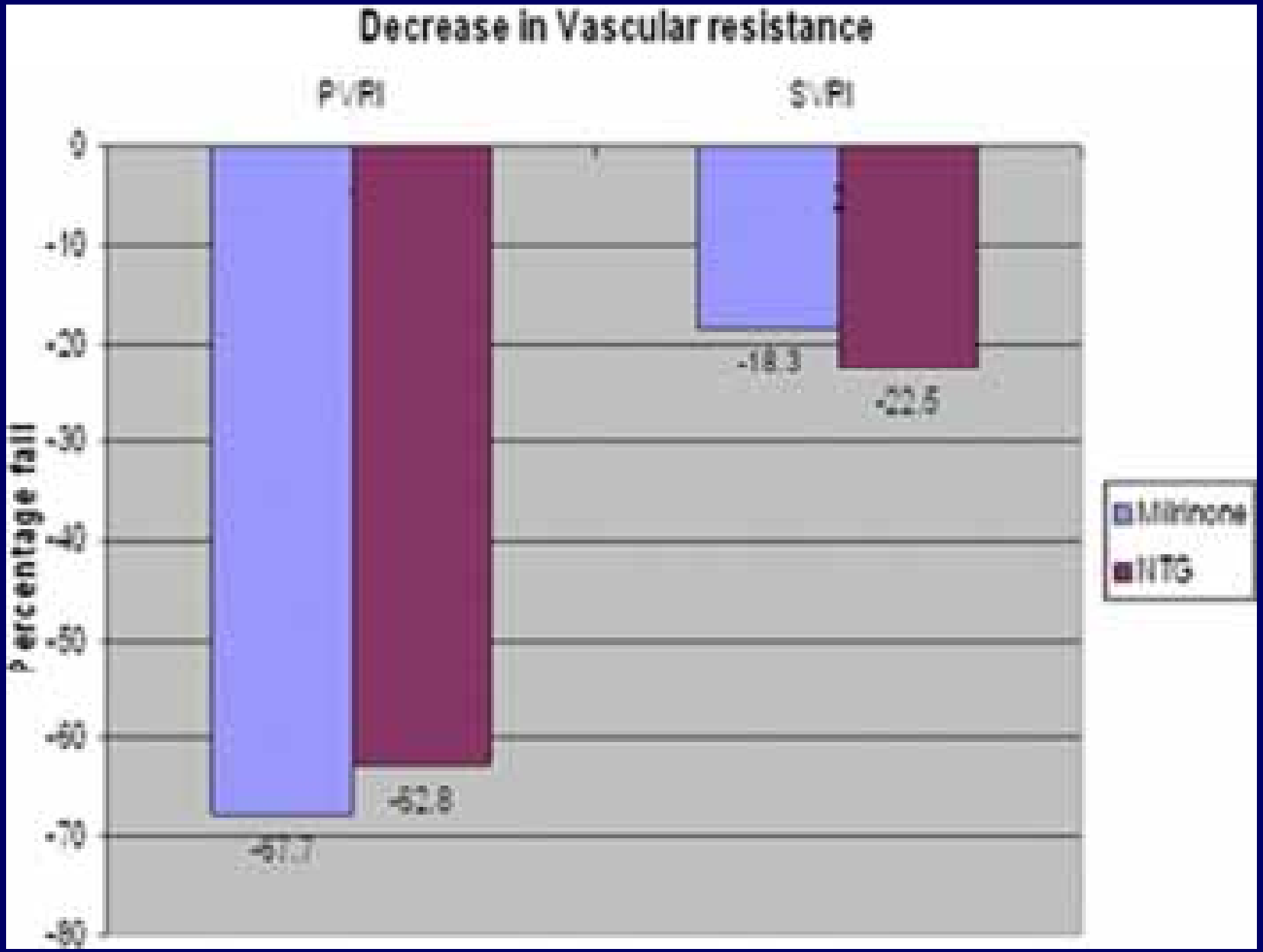
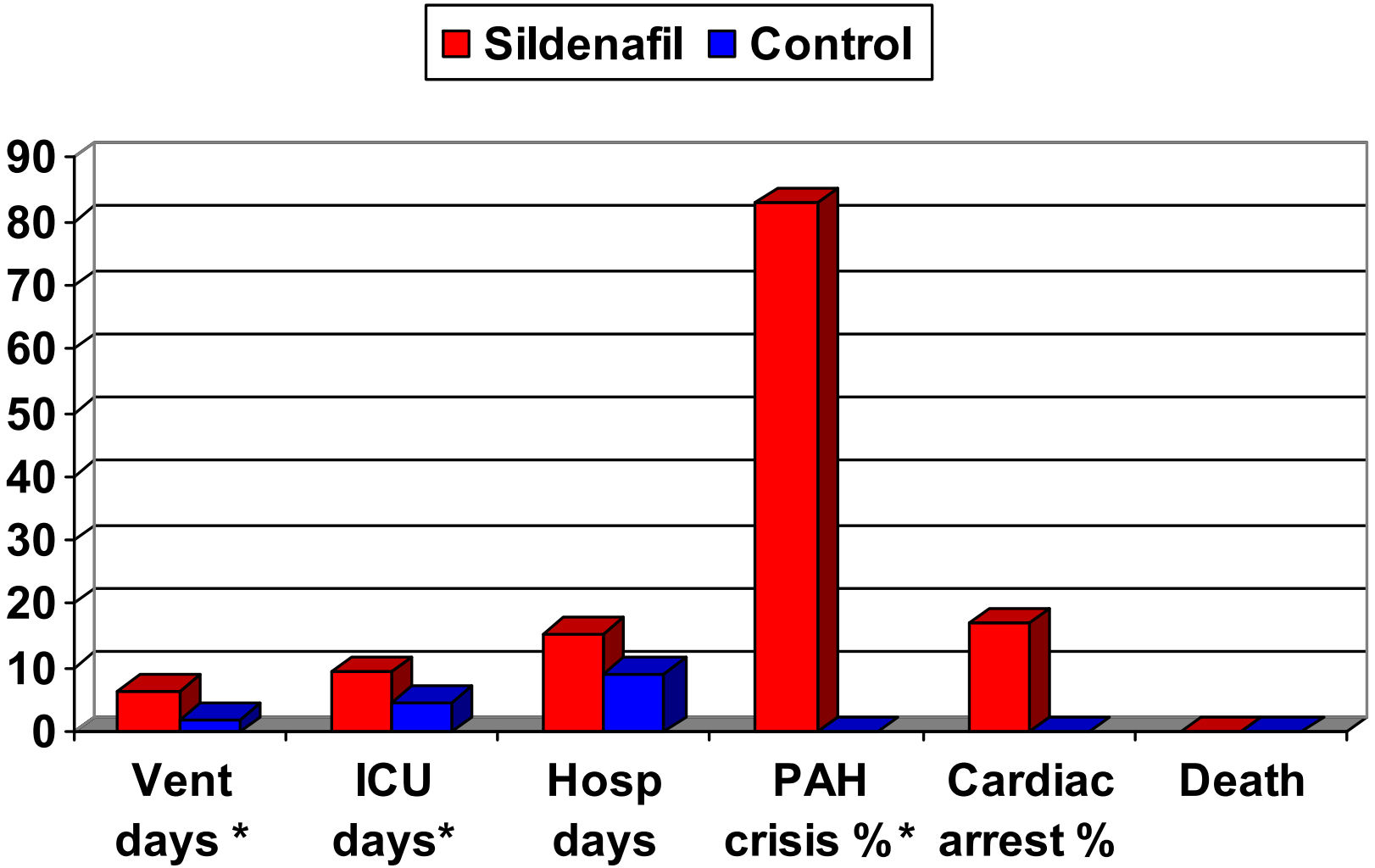



Thank you !

Preoperative Sildenafil AVSD

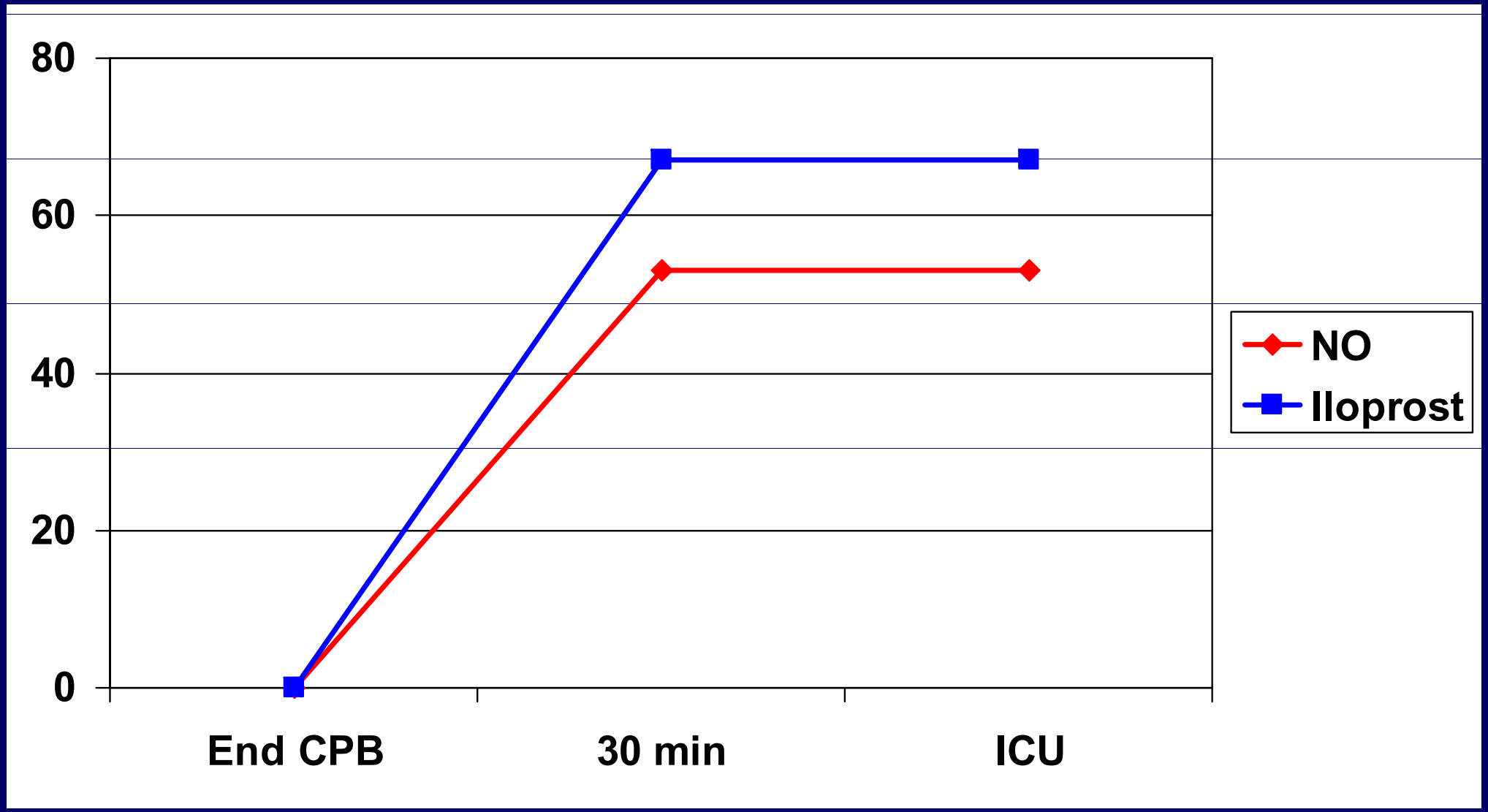


Acute Pulmonary Hypertension Triggering Stimuli

- Hypoxia
- Acidosis
- Hypercarbia
- Agitation, pain
- Tracheal suctioning

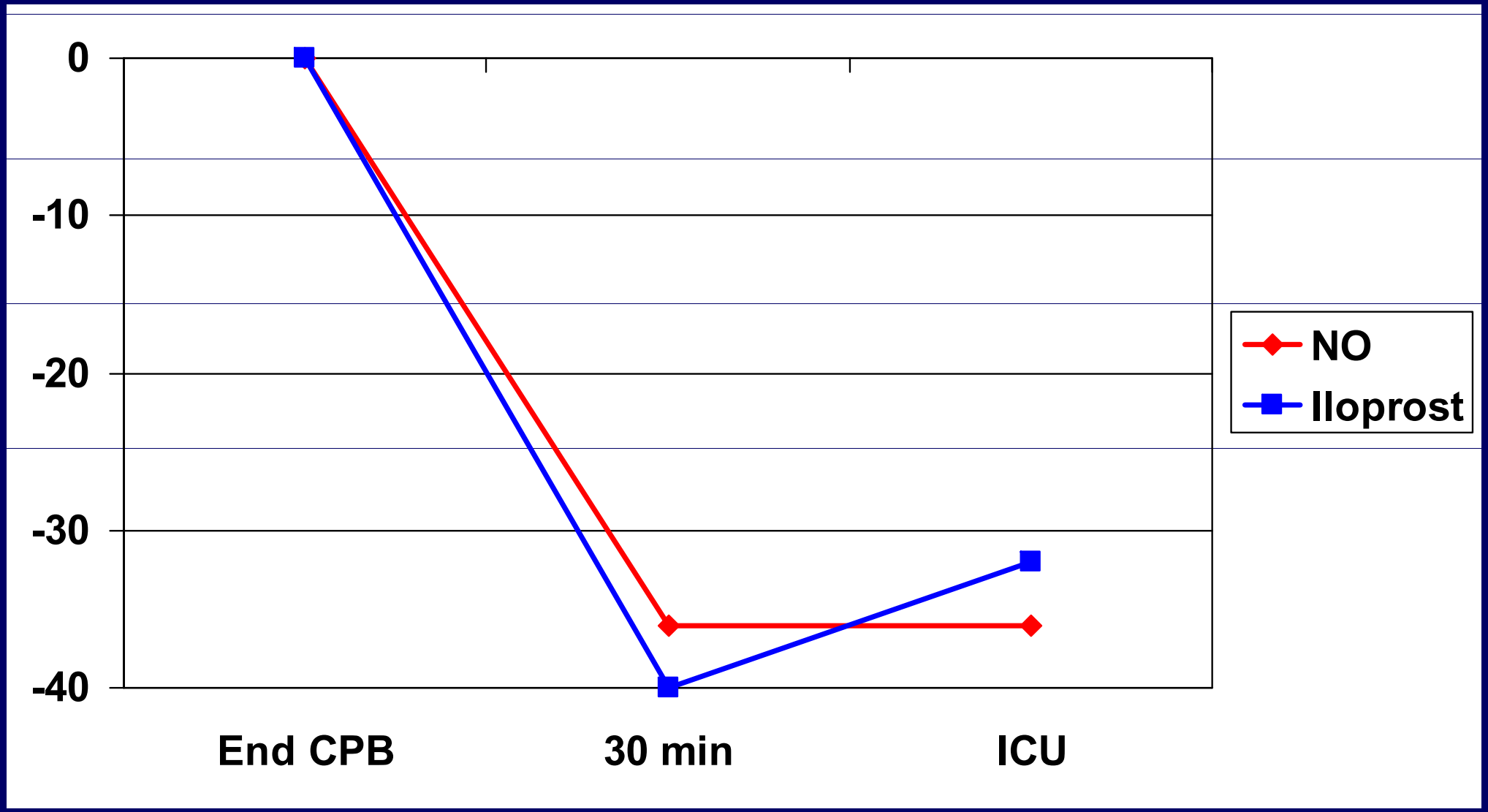
Iloprost vs NO – C.O.

J Cardiothorac Vasc Anesth 2008;22:406



Iloprost vs NO – SVR

J Cardiothorac Vasc Anesth 2008;22:406



Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

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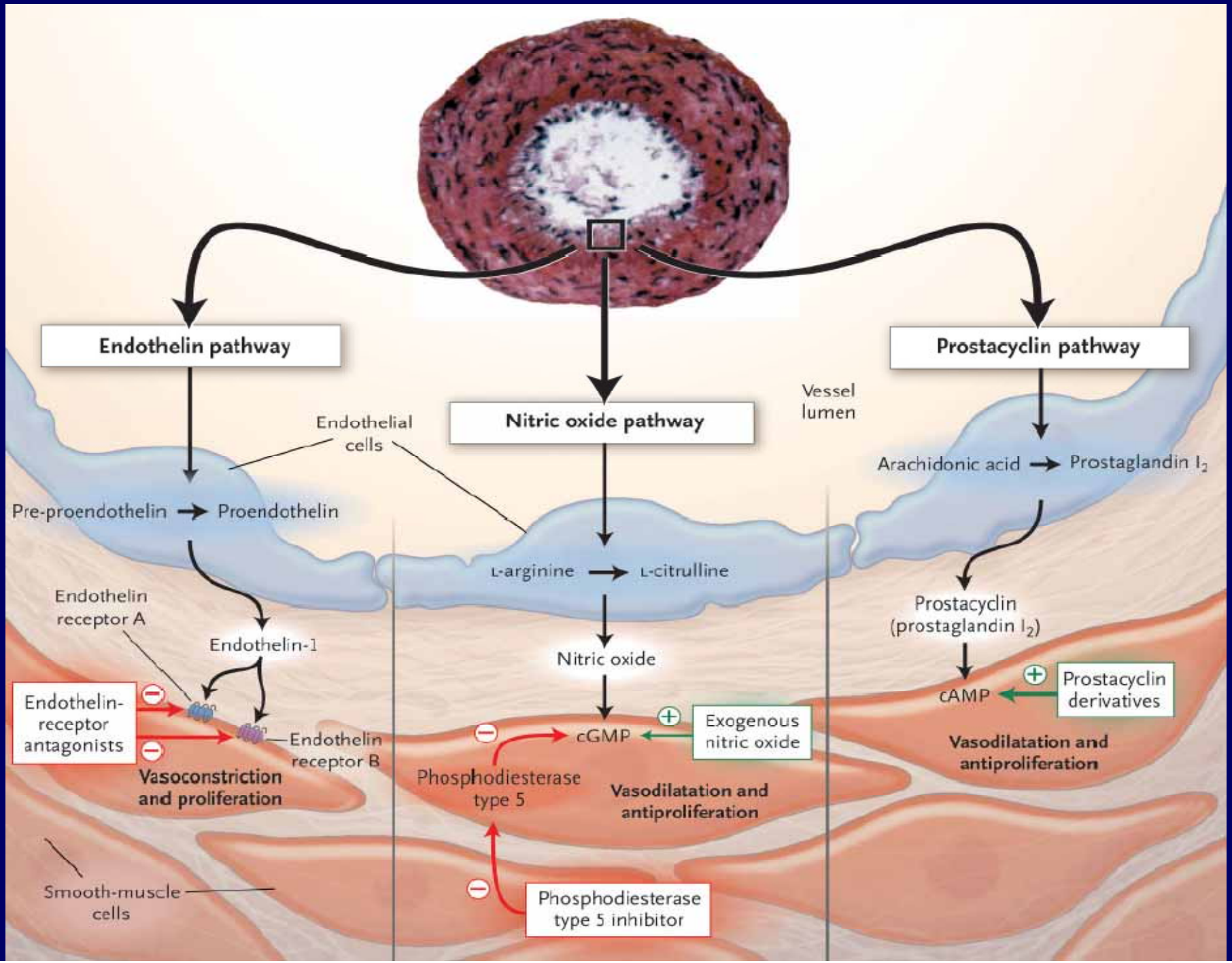
Inhaled Nitric Oxide Versus Aerosolized Iloprost in Secondary Pulmonary Hypertension in Children With Congenital Heart Disease : Vasodilator Capacity and Cellular Mechanisms

Peter C. Rimensberger, Isabelle Spahr-Schopfer, Michel Berner, Edgar Jaeggi, Afksendiyos Kalangos, Beat Friedli and Maurice Beghetti

Circulation 2001;103;544-548


Endothelin pathway
Nitric oxide pathway
Prostacyclin pathway
Vessel lumen
Endothelial cells
Pre-proendothelin
Proendothelin
L-arginine
L-citrulline
Arachidonic acid
Prostaglandin I_2
Endothelin receptor A
Endothelin-1
Endothelin-receptor antagonists
Endothelin receptor B
Vasoconstriction and proliferation
Nitric oxide
cGMP
Exogenous nitric oxide
Phosphodiesterase type 5
Vasodilatation and antiproliferation
Prostacyclin (prostaglandin I_2)
cAMP
Prostacyclin derivatives
Vasodilatation and antiproliferation
Smooth-muscle cells
Phosphodiesterase type 5 inhibitor

Ideal anesthetic

- Pulmonary vasodilator
- No systemic CV depression
- Maintenance of
  - Contractility
  - Cardiac output
  - SVR
- Short acting