

# XII

## Congreso Nacional de Anestesia y Reanimación Pediátrica

Sección de Anestesia  
Pediátrica. SEDAR.

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Avalado por:



Autora del cartel: **Trini Trull Ventura**



# What do You Think...

*Minimally Invasive Surgery in Newborn and Infants  
Means Minimally-Invasive Anesthesia?*



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Riyadh. Kingdom of Saudi Arabia

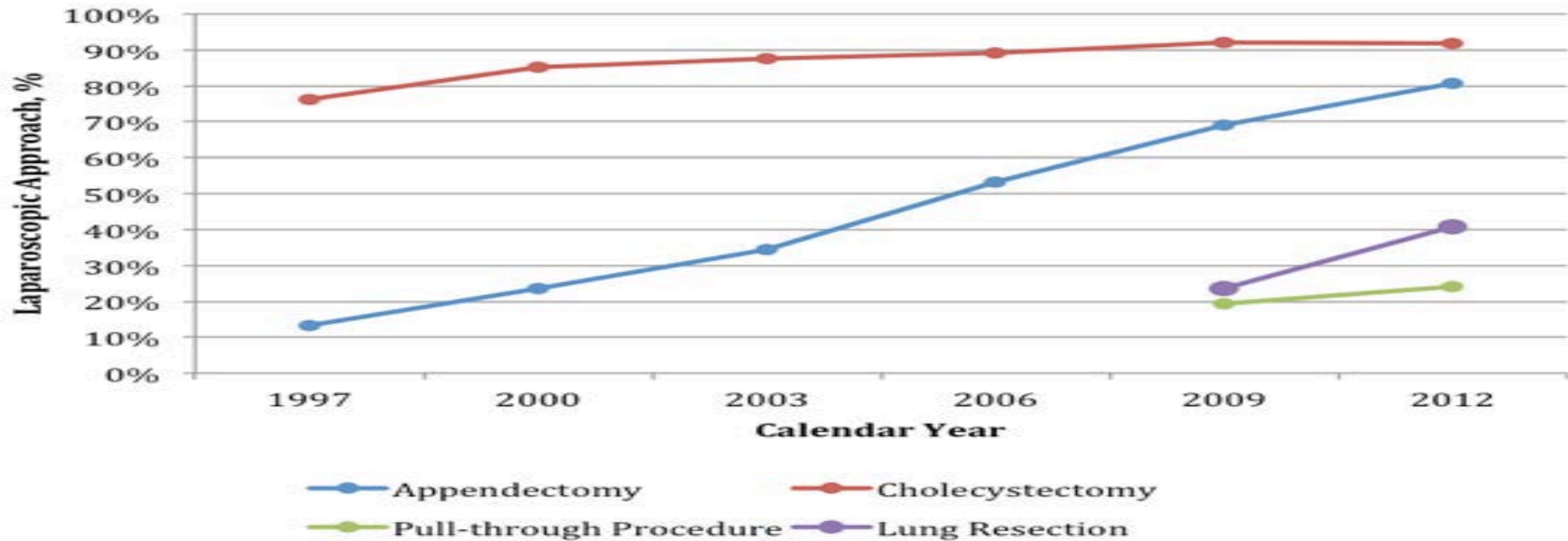
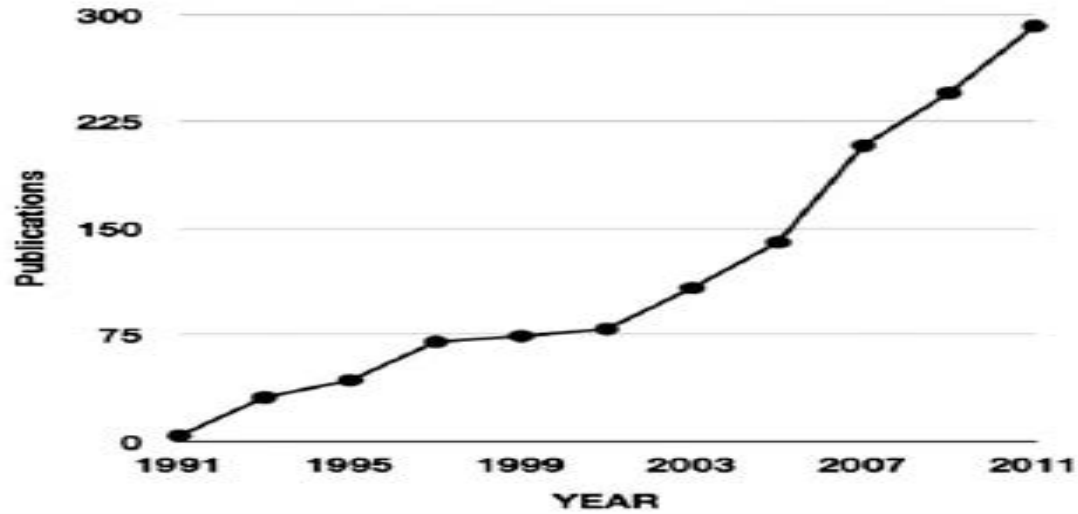
# Disclosures

- None.

# Objectives

- History and development of MIS
- Neonatal physiology and MIS
- Anesthesia for MIS of newborns and infants
- Training curve in anesthesia

# History



# MIS Indications

**Table 1 Laparoscopy Indications for Pediatrics<sup>5</sup>**

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## Diagnostic Laparoscopy

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Acute abdomen Akut abdomen

Unpalpable testis

Recurrent abdominal pain

Blunt abdominal trauma

*Staging* tumor, biopsy

Abnormalities of genital organs

Dysfunction of *VP shunt catheter*

## Therapeutic Laparoscopy

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Appendisectomy

Fundoplication

Orchidopexy

Splenectomy

Pyloromyotomy

Inguinal hernia repair

Nefrektomy and heminefrectomi

Pyeloplasty

Cholecystectomy

Esophageal atresia (thoracoscopy)

*Hirschprung pull through*

Adhesiolisis

Ooverectomy and cystectomy ovarii

Adrenalectomy

Varicocele

Porto-enterostomy

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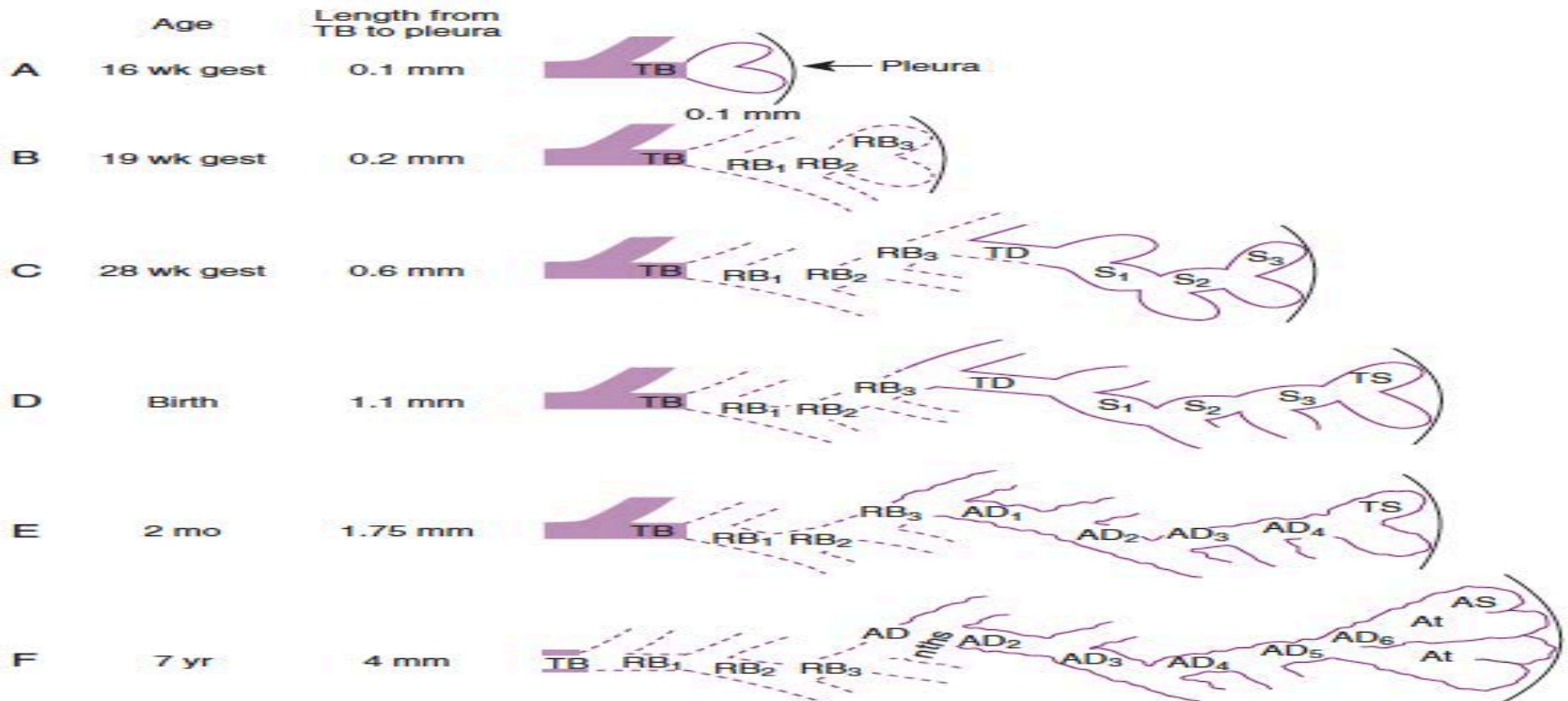


**Madonna and Child  
(Giotto, 1330)**



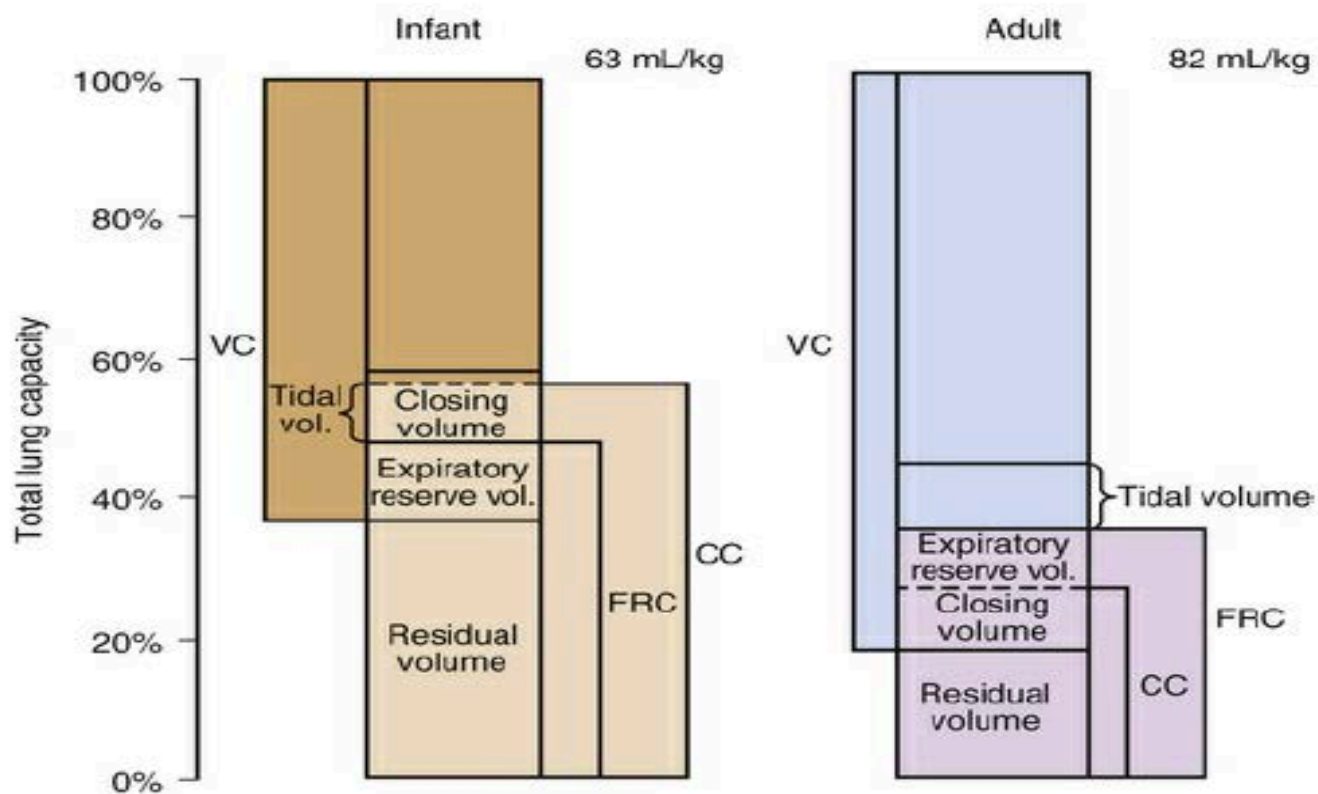
**The Small Cowper Madonna  
(Raphael, 1505)**

# Development of the Respiratory System



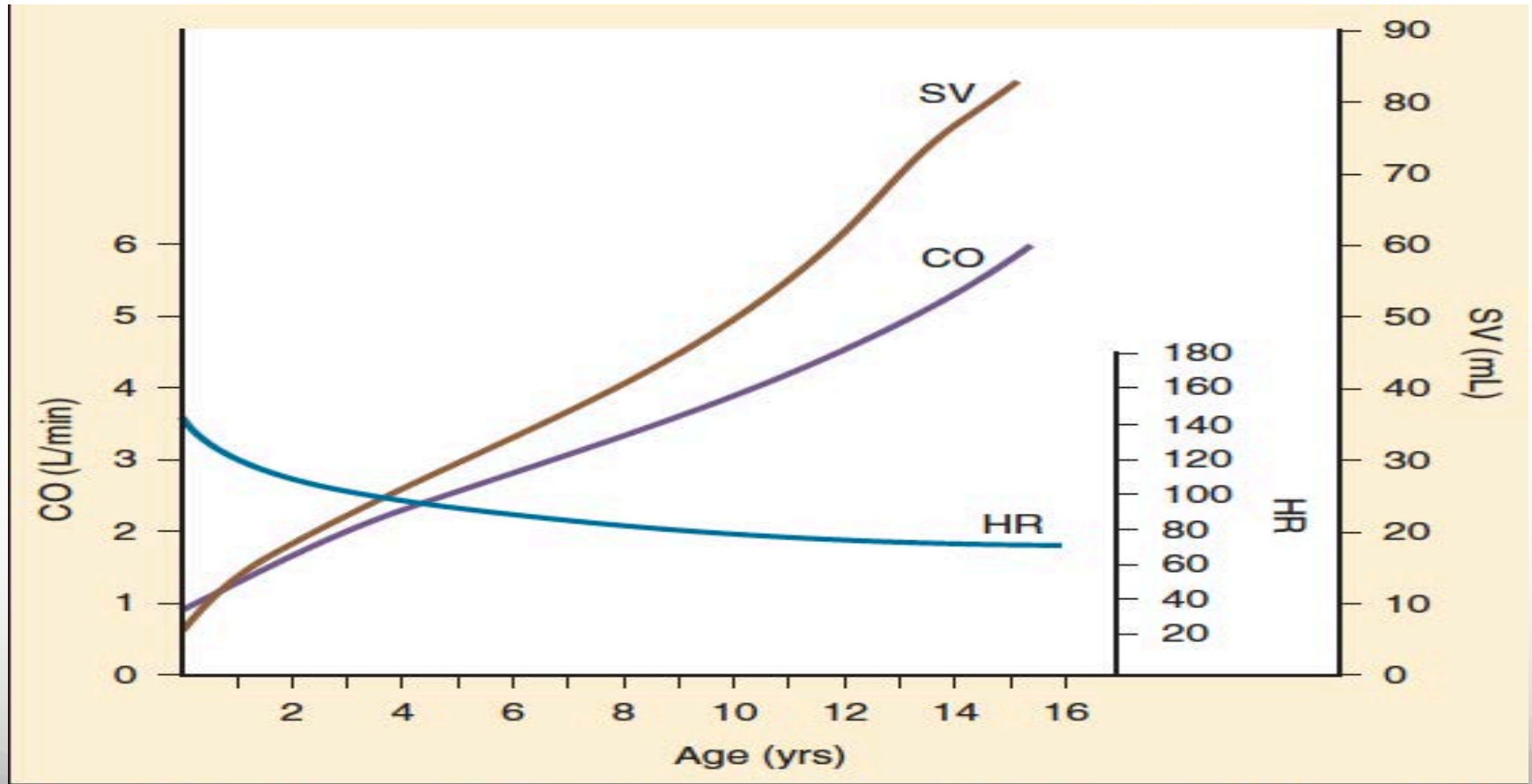
**FIG 3-2 Development of the Acinus in Human Lungs at Various Ages.** *TB*, Terminal bronchiole; *RB*, respiratory bronchiole; *TD*, transitional duct; *S*, saccule; *TS*, terminal saccule; *AD*, alveolar duct; *At*, atrium; *AS*, alveolar sac. (From Hislop A, Reid L. Development of the acinus in the human lung. *Thorax*. 1974;29:90.)

# Chest Wall



**FIGURE 2.7** Lung Volumes in Infants and Adults. Note that in infants, tidal volume breathing occurs at the same volume as closing volume. CC, Closing capacity; FRC, functional residual capacity; VC, vital capacity. (Modified from Nelson NM.)

# CV Physiology in the Newborn



# Myocardium in the Newborn

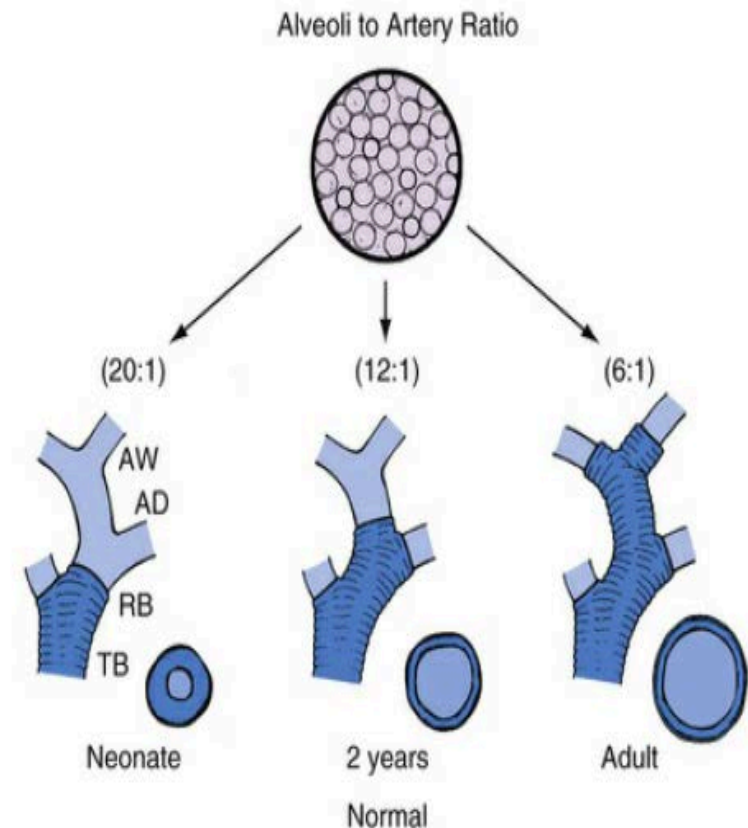
**TABLE 4-1 Differences between Neonatal and Adult Myocardium**

|                 | <b>Neonate</b>   | <b>Adult</b>  |
|-----------------|--|---|
| <b>Function</b> | <p>Decreased compliance</p> <p>Limited CO augmentation with increased preload</p> <p>Decreased tolerance to afterload</p> <p>Immature autonomic innervation:<br/>parasympathetic dominance, incomplete sympathetic innervation</p> | <p>Normally developed tension</p> <p>Able to improve CO with increased preload and to maintain CO with increasing afterload</p> |

# Pulmonary Vascular Physiology

The fetal pulmonary vasculature reactive:

- Hypoxia
- Acidosis
- Increased levels of leukotrienes
- Mechanical stimulation



# Be careful...

## Children

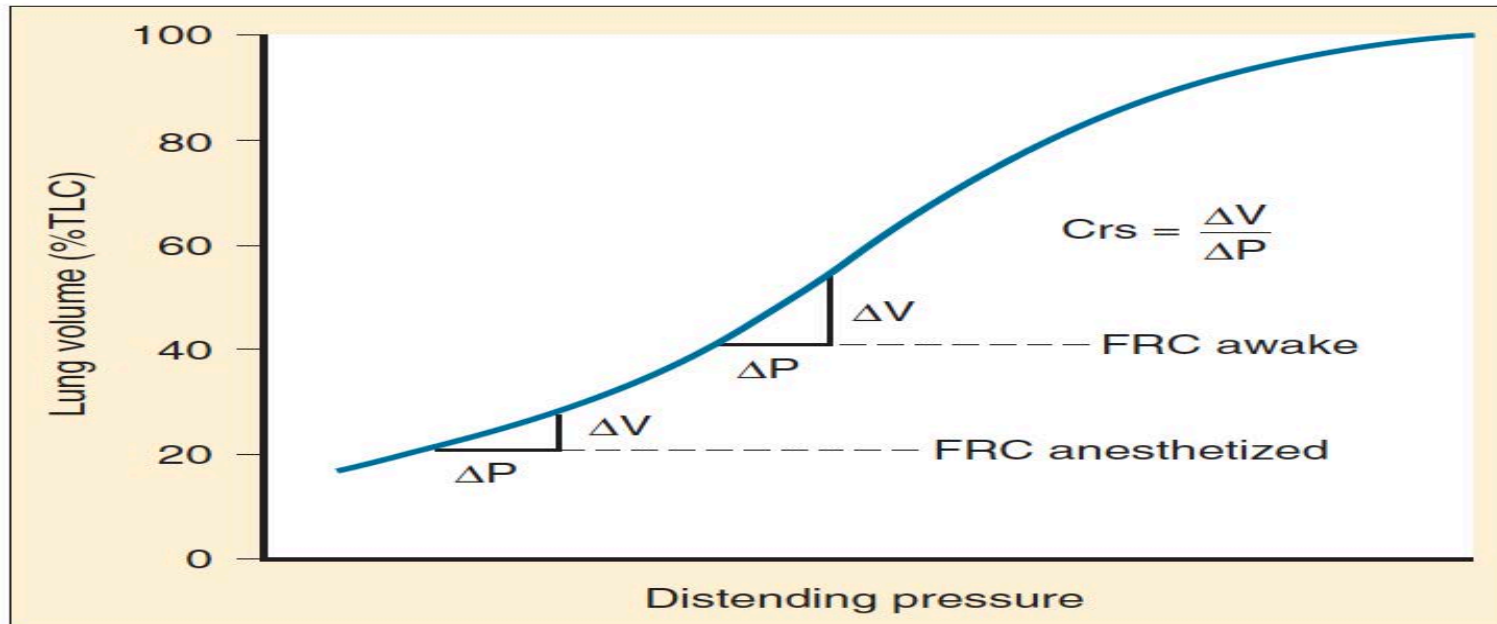
are not small adults,  
they require  
treatment tailored  
to their needs



# How does Pediatric Anesthesia Alter this Incipient Balance?



# Effects of General Anesthesia on Functional Residual Capacity



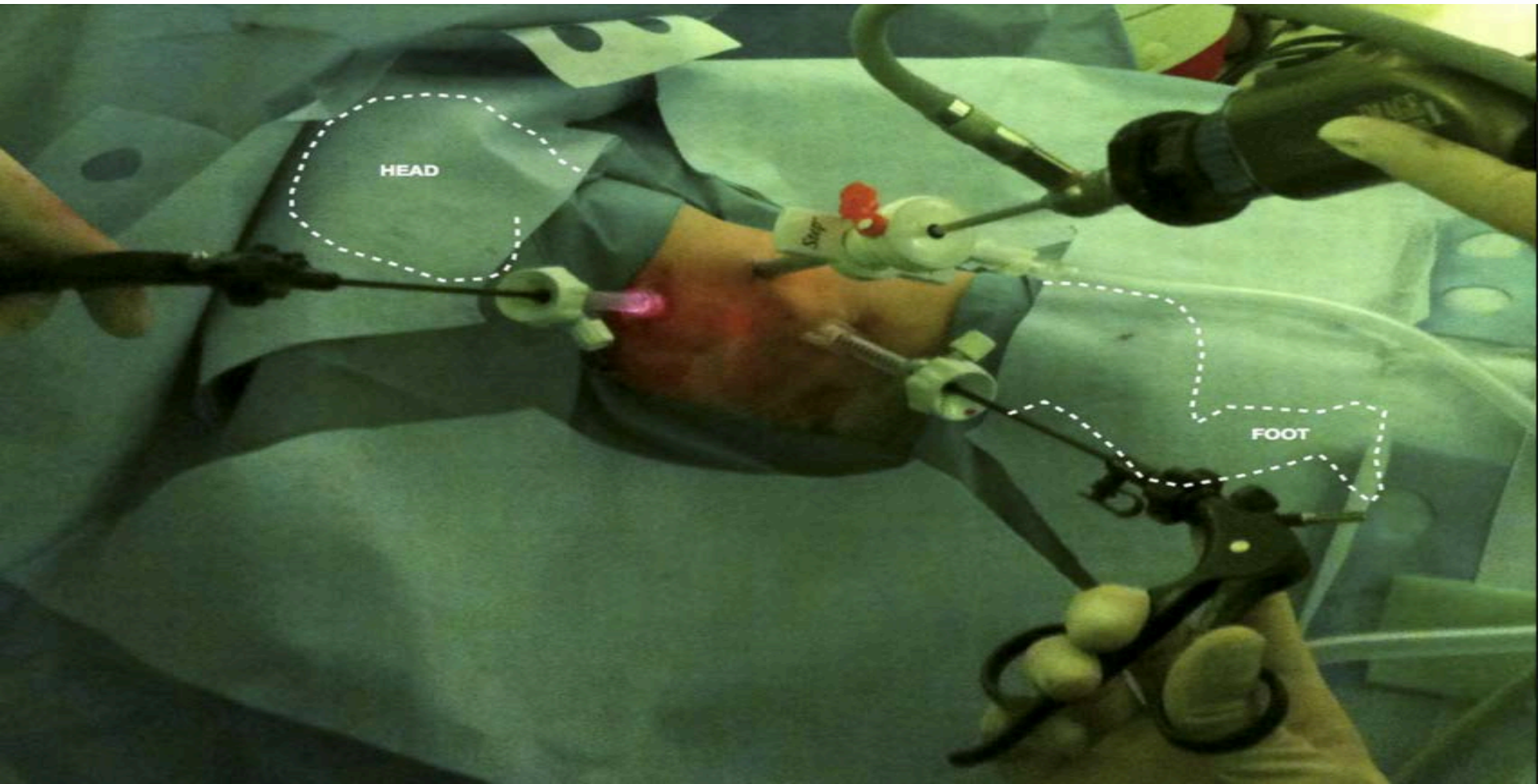
**FIG 3-22** Schematic Representation of the Pressure-Volume (P-V) Curve and Compliance of the Respiratory System ( $C_{rs}$ ). At the midpoint of the P-V curve (indicated as FRC awake), the slope and compliance ( $C_{rs} = \Delta P/\Delta V$ ) are the highest. When FRC is decreased to the lower, flatter portion of the P-V curve under general anesthesia or paralysis (indicated as FRC anesthetized),  $C_{rs}$  decreases even without changes in the mechanics of the lungs or the respiratory system.

# Effects of General Anesthesia on CV System

- Anesthetic Effects on Ion Currents
- Anesthetic Effects on the Conduction System
- Anesthetic Effects on Myocardial Metabolism
- Anesthetic Effects on Systolic Function
- Anesthetic Effects on Diastolic Function
- Anesthetic Effects on Autonomic Control

# *“The Perfect Storm”*

Infant Physiology + Anesthesia +  
MIS Approach

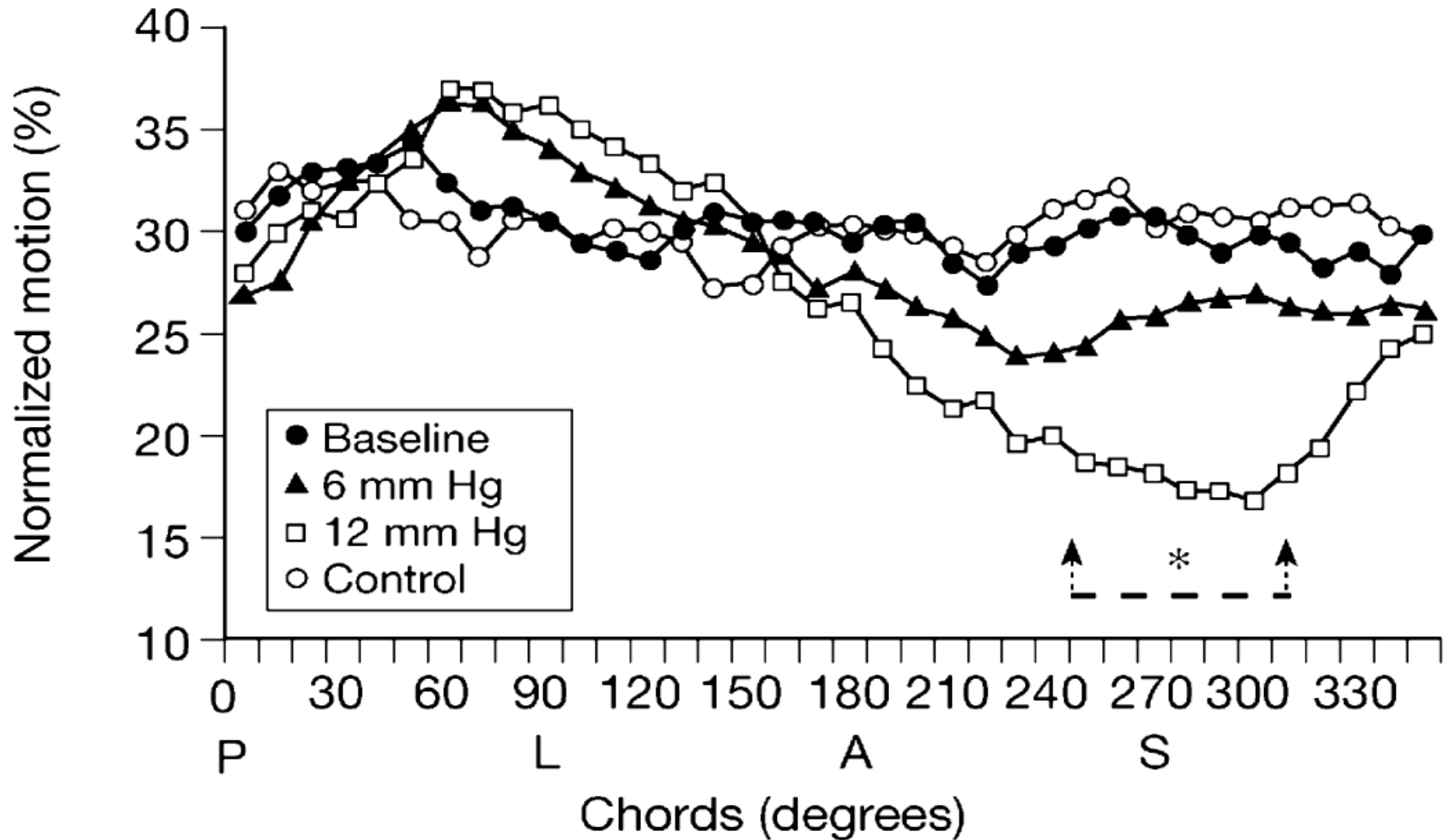


# Pneumoperitoneum

Three major factors may contribute to adverse cardiovascular responses during pneumoperitoneum:

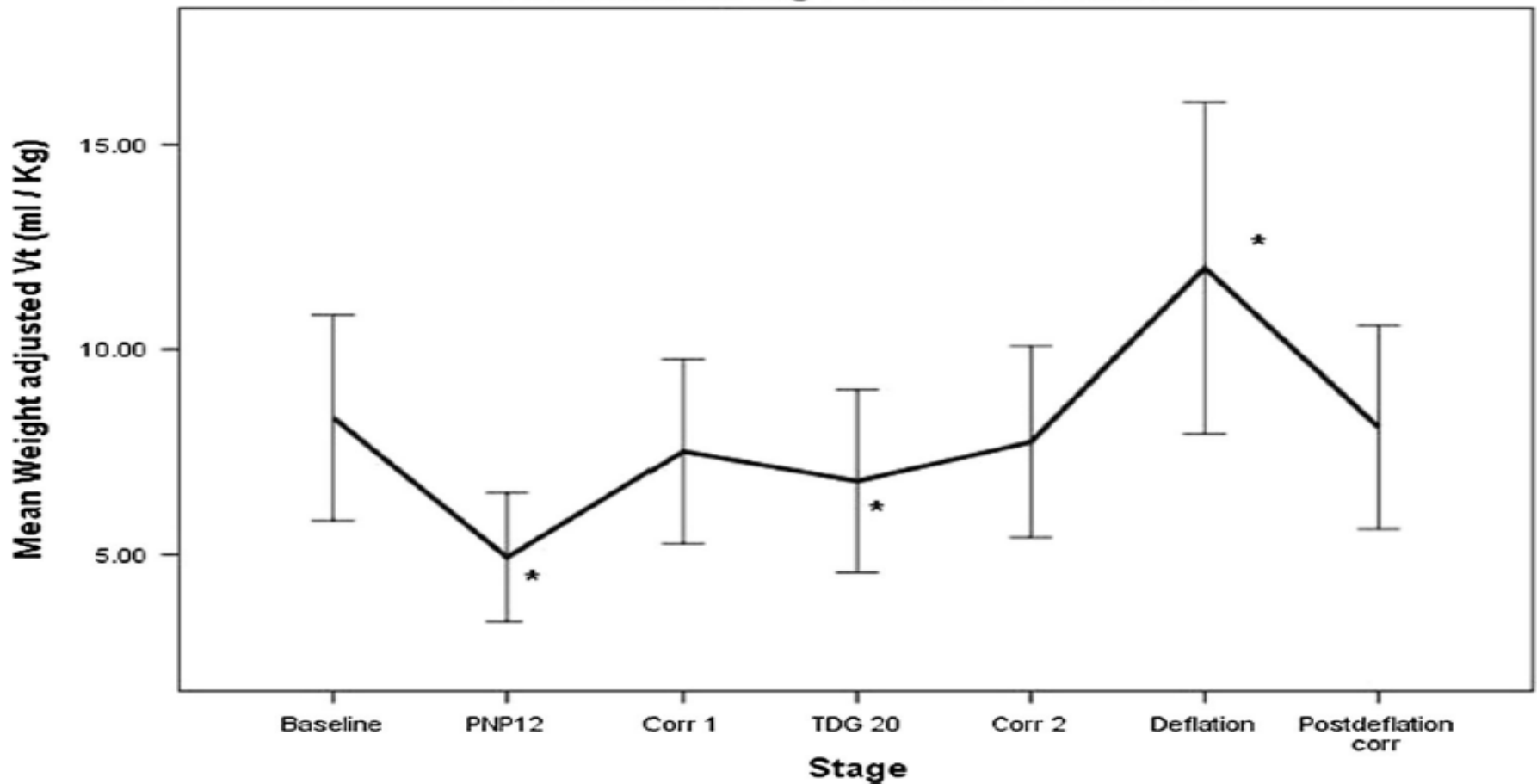
- ✓ Intraabdominal pressure
- ✓ Position
- ✓ Release of neurohumoral vasoactive substances

# Intraabdominal Pressure IAP and CV Performance



# Position

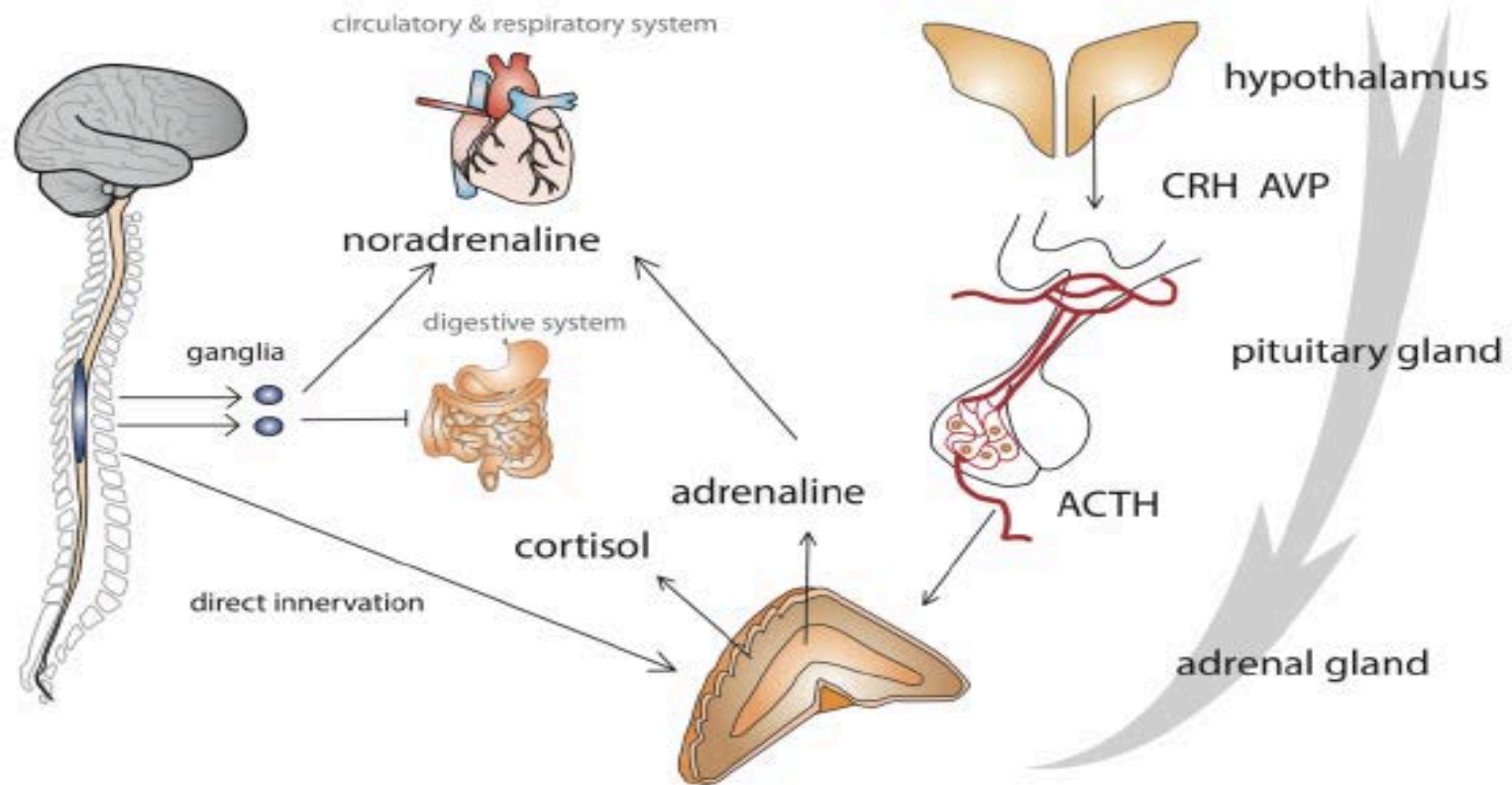
**Weight Adjusted Tidal Volume Changes During Laparoscopic Surgery and Trendelenburg Position in Children**



# Release of Neurohumoral Vasoactive Substances

## sympathetic nervous system

## endocrine HPA axis

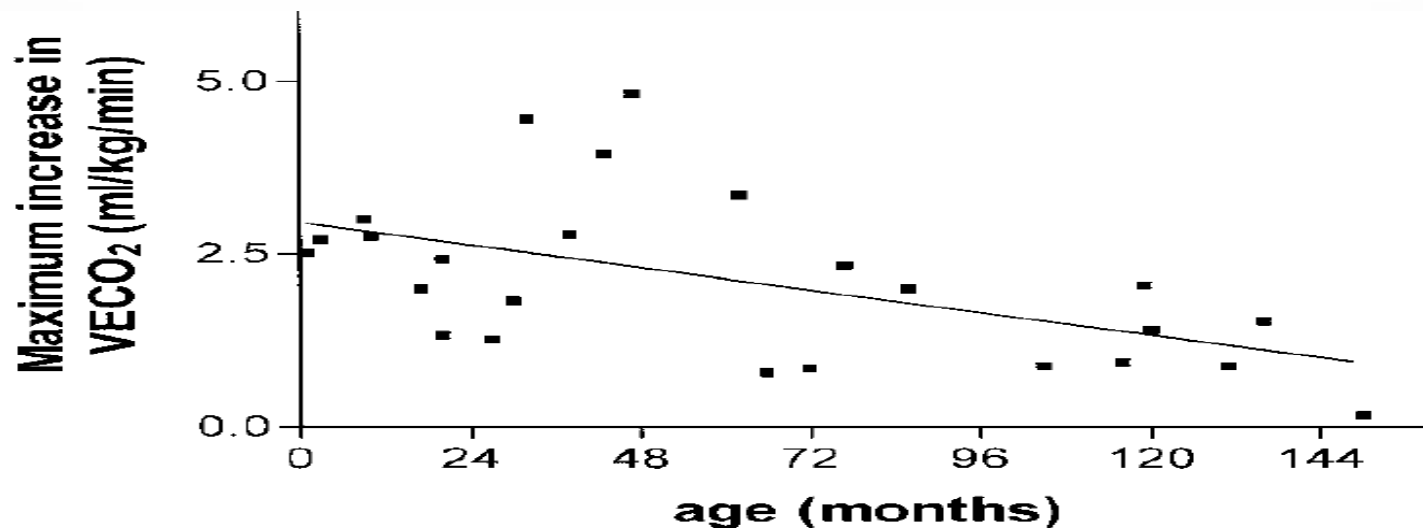


# Adverse Effects of Pneumoperitoneum

## Carbon Dioxide Absorption

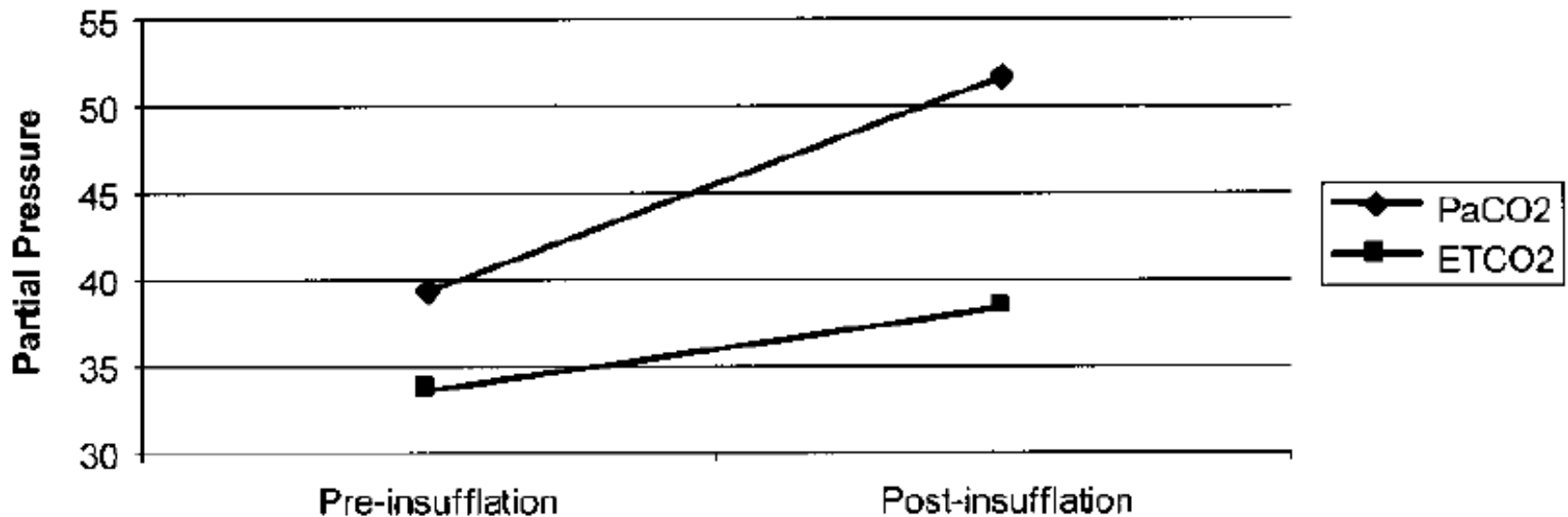
### Hypercarbia and Acidosis

The inverse relationship between age and the rate of CO<sub>2</sub>: Thinner peritoneum, reduced peritoneal fat deposits in the abdomen of infants compared with older children



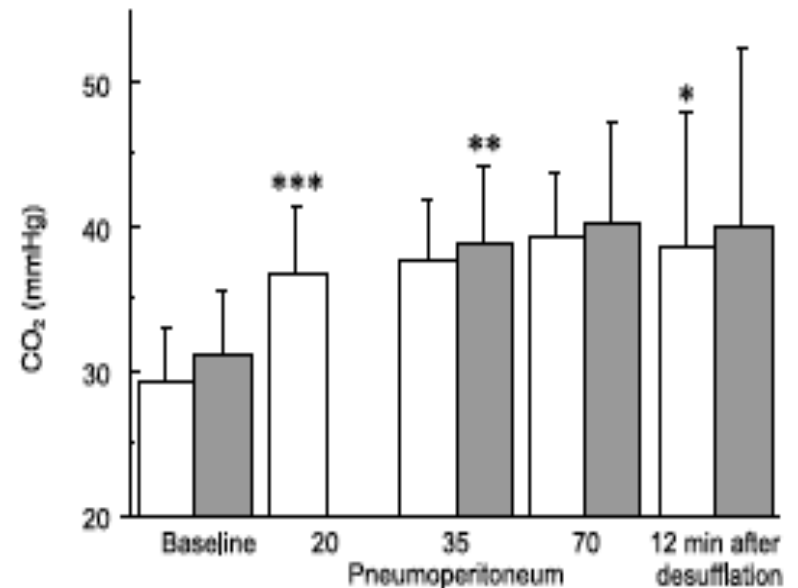
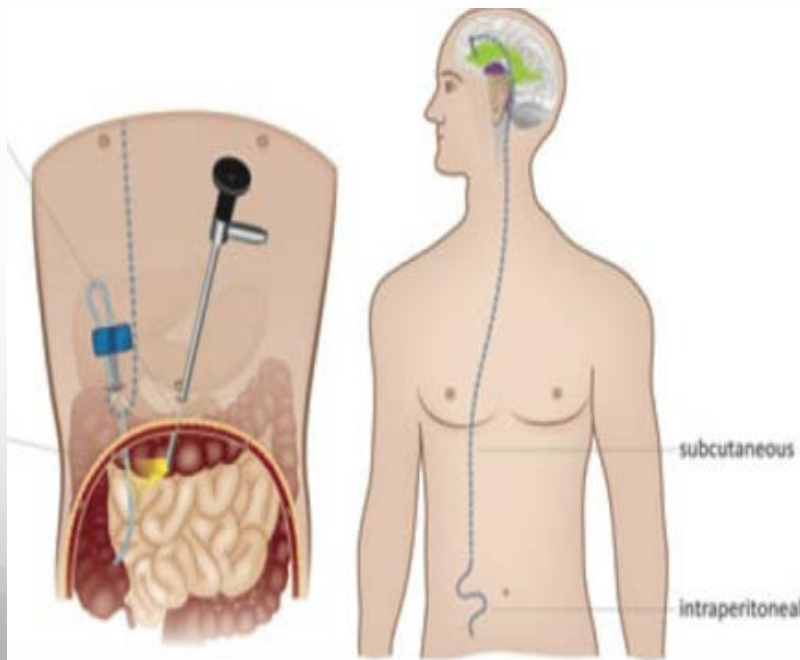
# Carbon Dioxide Hypercarbia and Acidosis

**PaCO<sub>2</sub> and ETCO<sub>2</sub>  
Pre- vs. Post-Insufflation**



# Central Nervous System Effects

MIS must be carefully evaluated in child with increased (ICP) or in the presence of a VP shunt



# Pediatric Adaptive Brain and Systemic Oxygenation and HD Changes

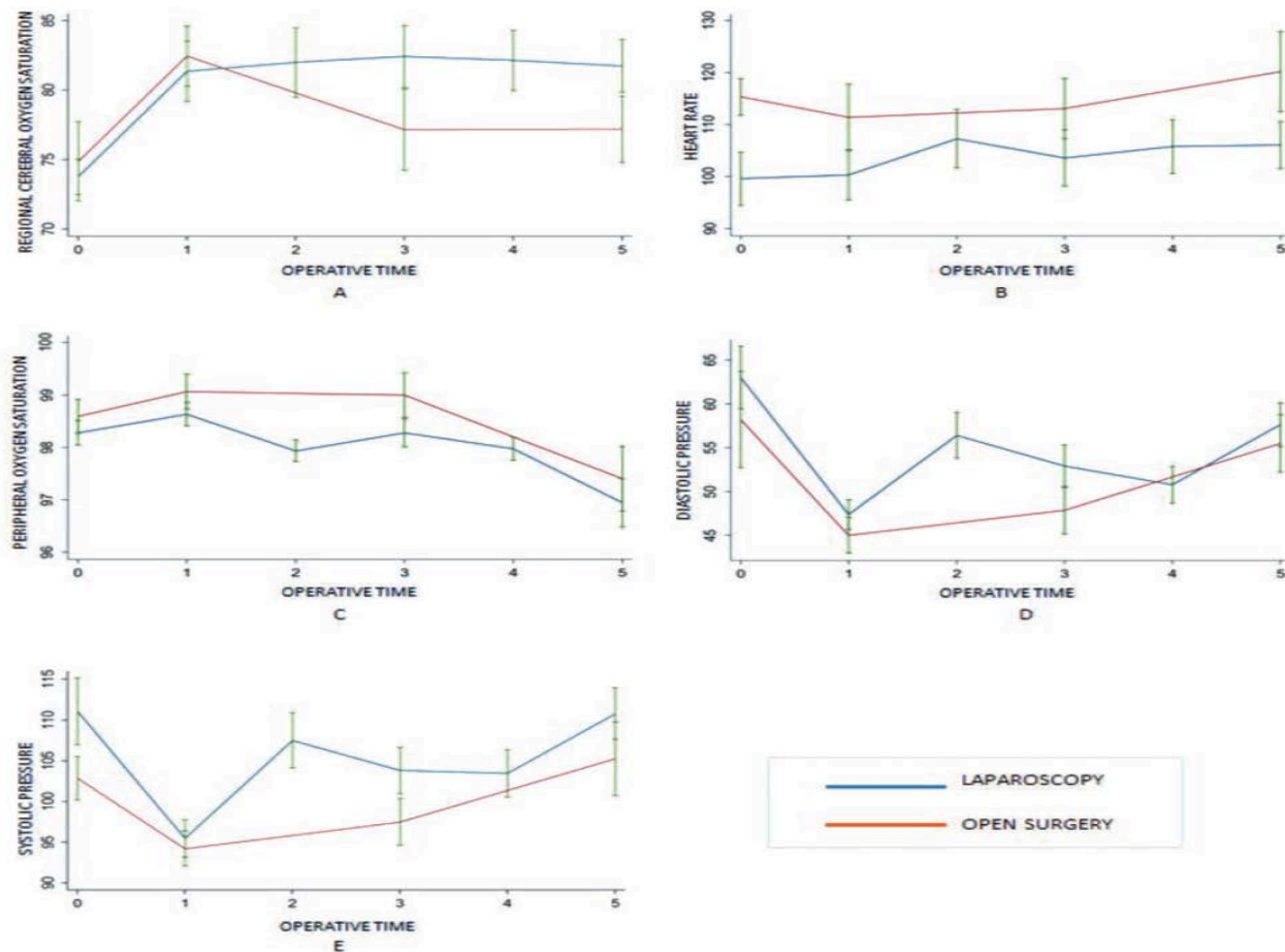


Figure 1. Profile of regional cerebral oxygen saturation (A), heart rate (B), peripheral oxygen saturation (C), diastolic pressure (D) and systolic pressure (E) in LAP and OPEN groups at the different surgical time points.

# Gas Emboli

APSF NEWSLETTER Summer 2010

PAGE 25

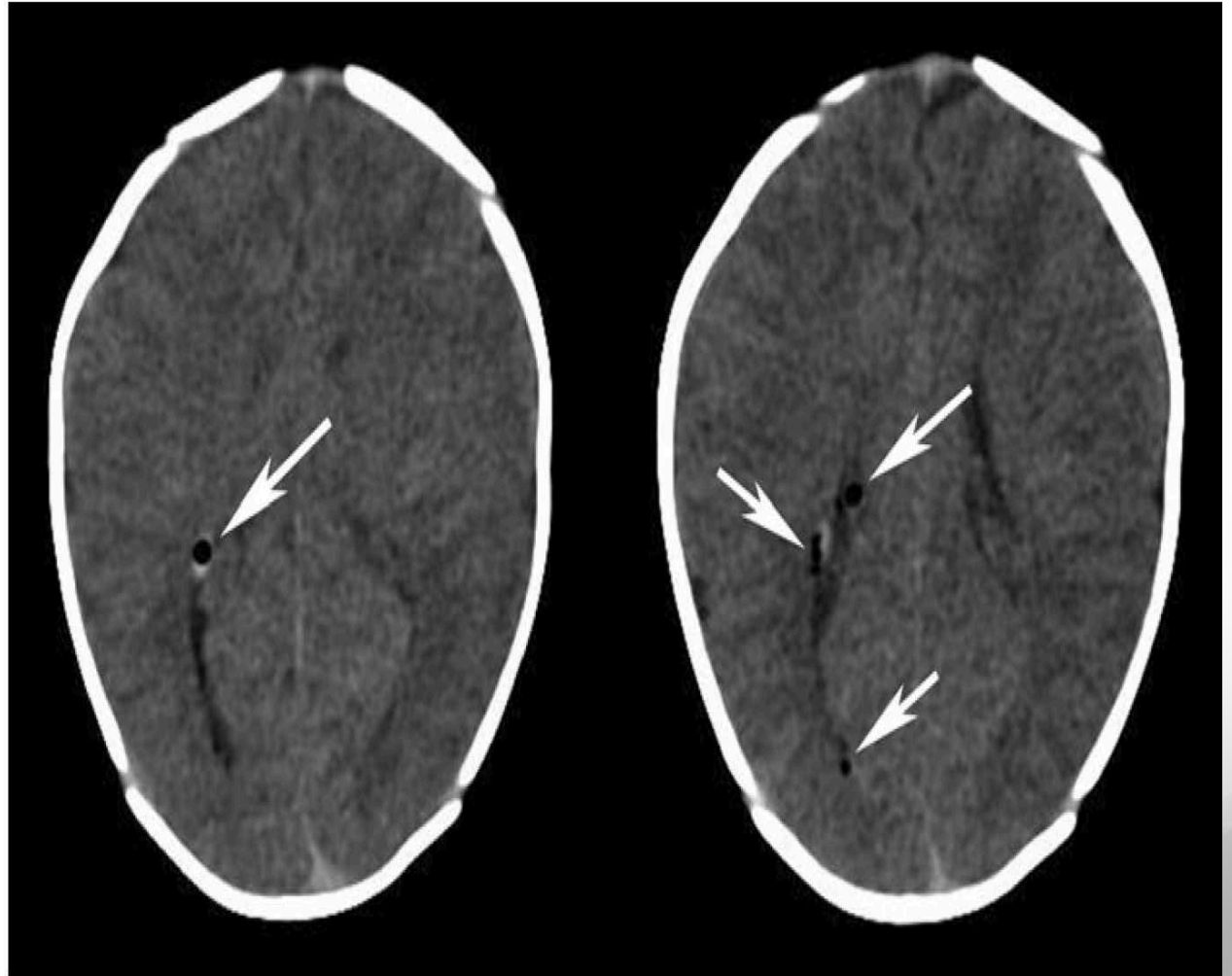


## **Adverse Events Associated with Neonatal Laparoscopy: Are They Truly Rare Events or the Tip of the Iceberg?**

Susan P. Taylor, MD  
Dr. Assistant Professor of Anesthesiology  
at the Children's Hospital of Wisconsin (Medical College of  
Wisconsin) in Milwaukee, WI.

# Gas Emboli

**Fig. 1** Cranial computed tomography (CT) scan. Axial cut at the level of the lateral ventricles demonstrates multiple small foci of gas



# Pneumoperitoneum and Tracheal Tube Tip

Anaesthesia, 2007, **62**, pages 131–134

doi:10.1111/j.1365-

## Tracheal tube tip displacement during laparoscopy in children★

S. Böttcher-Haberzeth,<sup>1</sup> A. Dullenkopf,<sup>2</sup> C. A. Gitzelmann<sup>3</sup> and M. Weiss<sup>4</sup>

*1 Resident, 3 Consultant, Department of Paediatric Surgery, 2 Consultant, 4 Head, Department of Anaesthesia, University Children's Hospital Zurich, Steinwiesstr. 75, 8032 Zurich, Switzerland*

### Summary

The risk of endobronchial intubation during laparoscopy because of displacement of the tip of the tracheal tube is a well known problem in adults. Laparoscopy in children is increasingly performed, but there are no data available regarding the above problem. We prospectively studied 46 children aged 2 months to 15.7 years (median 4.2 years) undergoing laparoscopy. After tracheal intubation with the Microcuff Pediatric Endotracheal Tube, with the 'intubation depth marking' of the tube at the vocal cords, the distance from the tracheal tube tip to the carina was endoscopically measured with the patient in the neutral position and with 20° head-down tilt, both with and without capnoperitoneum. Maximal displacement of the tip of the tracheal tube tip in cm was  $0.5 + (0.05 \times \text{age (years)})$  for 20° head-down tilt,  $0.6 + (0.09 \times \text{age (years)})$  for capnoperitoneum alone, and  $1.2 + (0.11 \times \text{age (years)})$  for 20° head-down tilt with capnoperitoneum. In no patients did endobronchial intubation occur with the tracheal tube placed according to the intubation depth marking.

# Pneumoperitoneum Complicated Pneumomediastinum

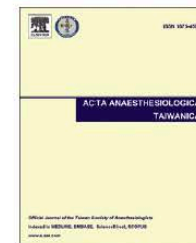
Acta Anaesthesiologica Taiwanica 51 (2013) 177–179



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journal homepage: [www.e-aat.com](http://www.e-aat.com)



## Case Report

# Pneumoperitoneum complicated pneumomediastinum causing cardiovascular deterioration in a low-body-weight premature infant during laparoscopic Nissen fundoplication



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Department of Anesthesiology, Mackay Memorial Hospital, Taipei, Taiwan

## ARTICLE INFO

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### Key words:

infant;  
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mediastinal emphysema;  
premature

## ABSTRACT

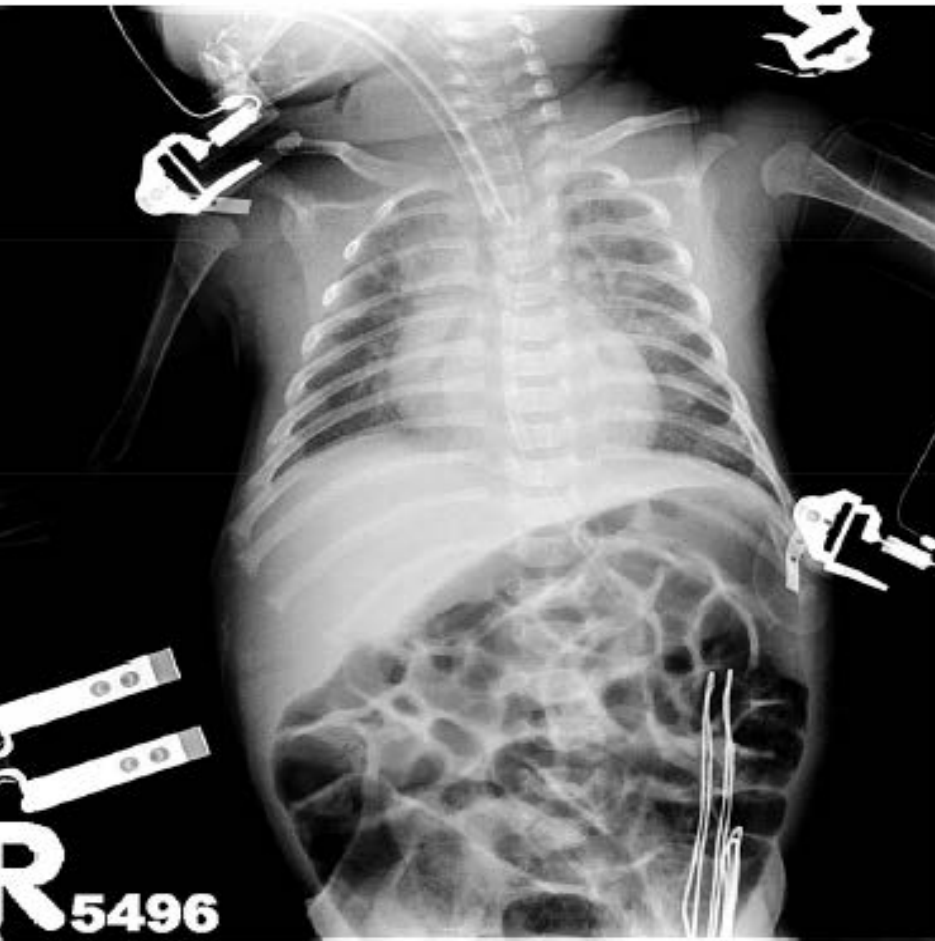
Due to smaller incisions, fewer wound injuries, and a shorter time of recovery, laparoscopic procedures are becoming increasingly popular in pediatric surgery, but the safety of their application in low-body-weight or premature infants should be a major concern. Here we present a case report of a 3-month-old premature infant, who developed a sudden change of hemodynamic instability while undergoing a laparoscopic Nissen's fundoplication for gastroesophageal reflux disease. This was thought to result from an accidental passage of massive insufflation of carbon dioxide gas across the diaphragm, leading to pneumomediastinum.

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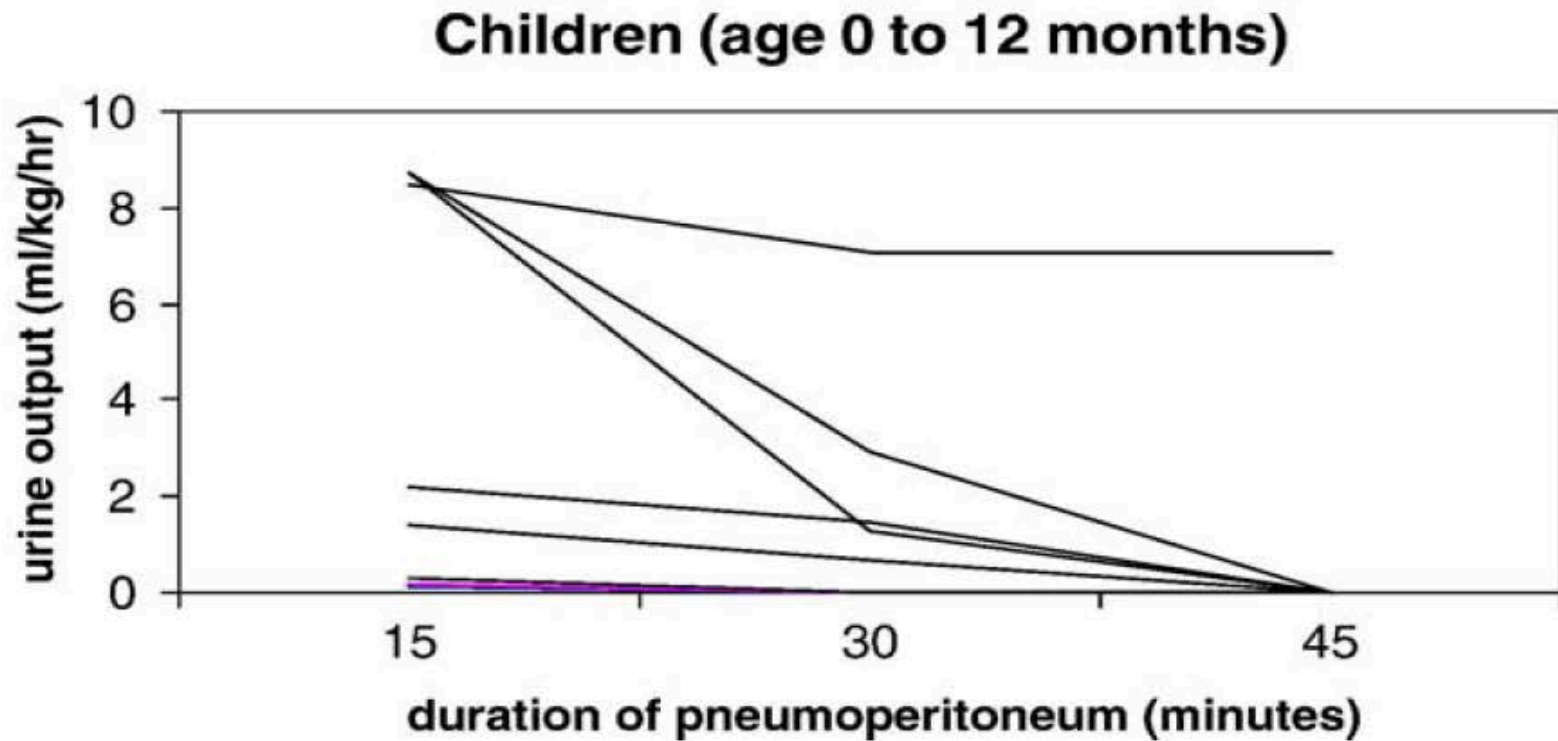
# Pneumoperitoneum Complicated Pneumomediastinum



**Fig. 1.** Intraoperative lead II electrocardiography (EKG) revealed widened QRS change, premature atrial contractions and severe ST segment elevation.



# Renal Effects and Fluid Requirements



**Fig. 1** Urine production during pneumoperitoneum (pressure, 8 mm Hg) in 8 infants aged 0 to 12 months. Each line represents urine production of 1 patient. Seven infants (88%) developed anuria within the first 45 minutes of pneumoperitoneum.

# How Survived to Perfect Storm? Specific Training for Pediatric Surgeons

Pediatr Surg Int (2011) 27:727–731

DOI 10.1007/s00383-011-2871-y

ORIGINAL ARTICLE

## **Skill qualifications in pediatric minimally invasive surgery**

**Tadashi Iwanaka · Yasuhide Morikawa · Atsuyuki Yamataka · Masaki Nio ·  
Osamu Segawa · Hiroshi Kawashima · Masahito Sato · Hirotsugu Terakura ·  
Hiroshi Take · Ryuichiro Hirose · Makoto Yagi**

How Survived to Perfect Storm?  
Do we need specific anesthesia Training ?

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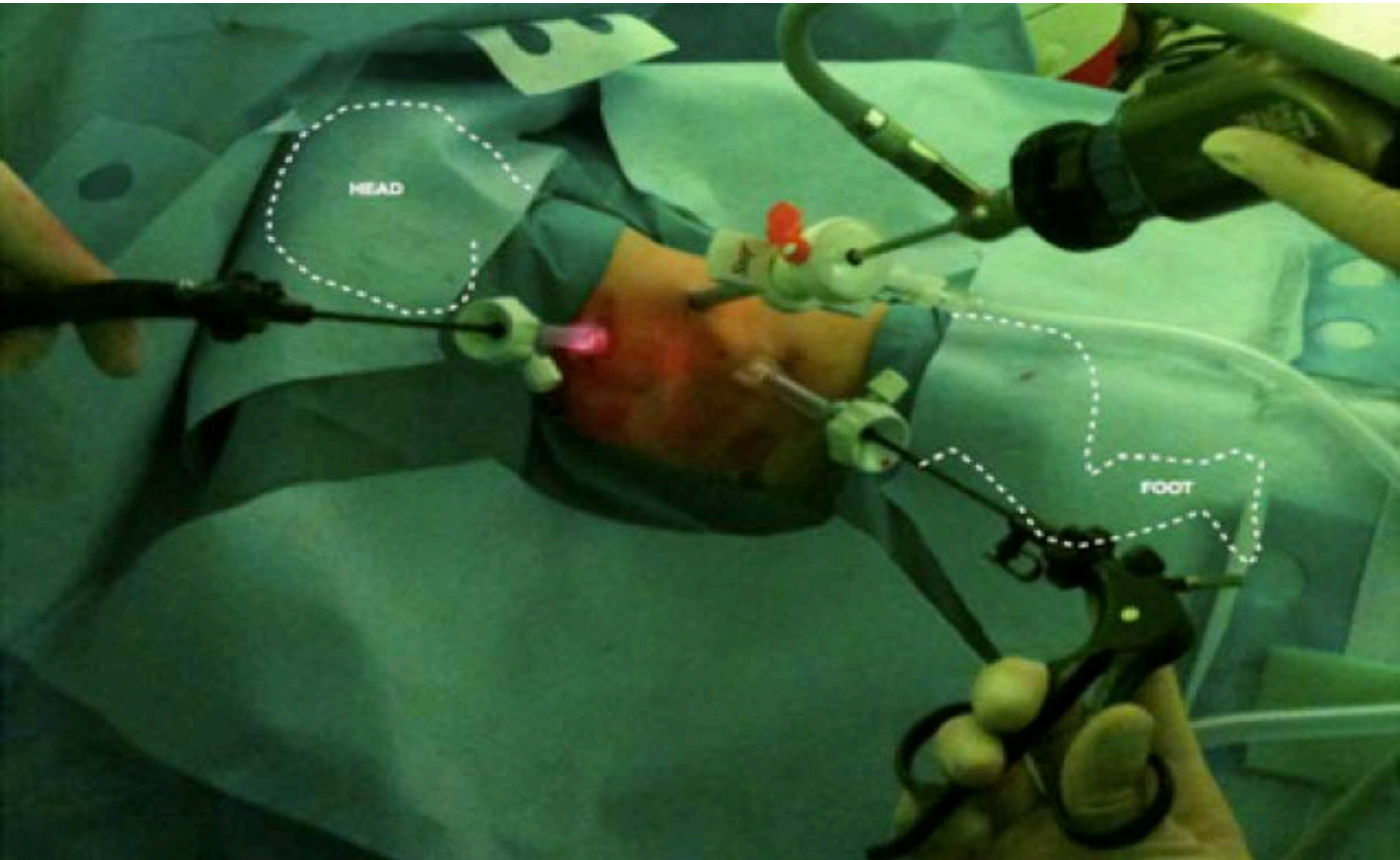
THE FEDERATION OF EUROPEAN ASSOCIATIONS  
OF PAEDIATRIC ANAESTHESIA

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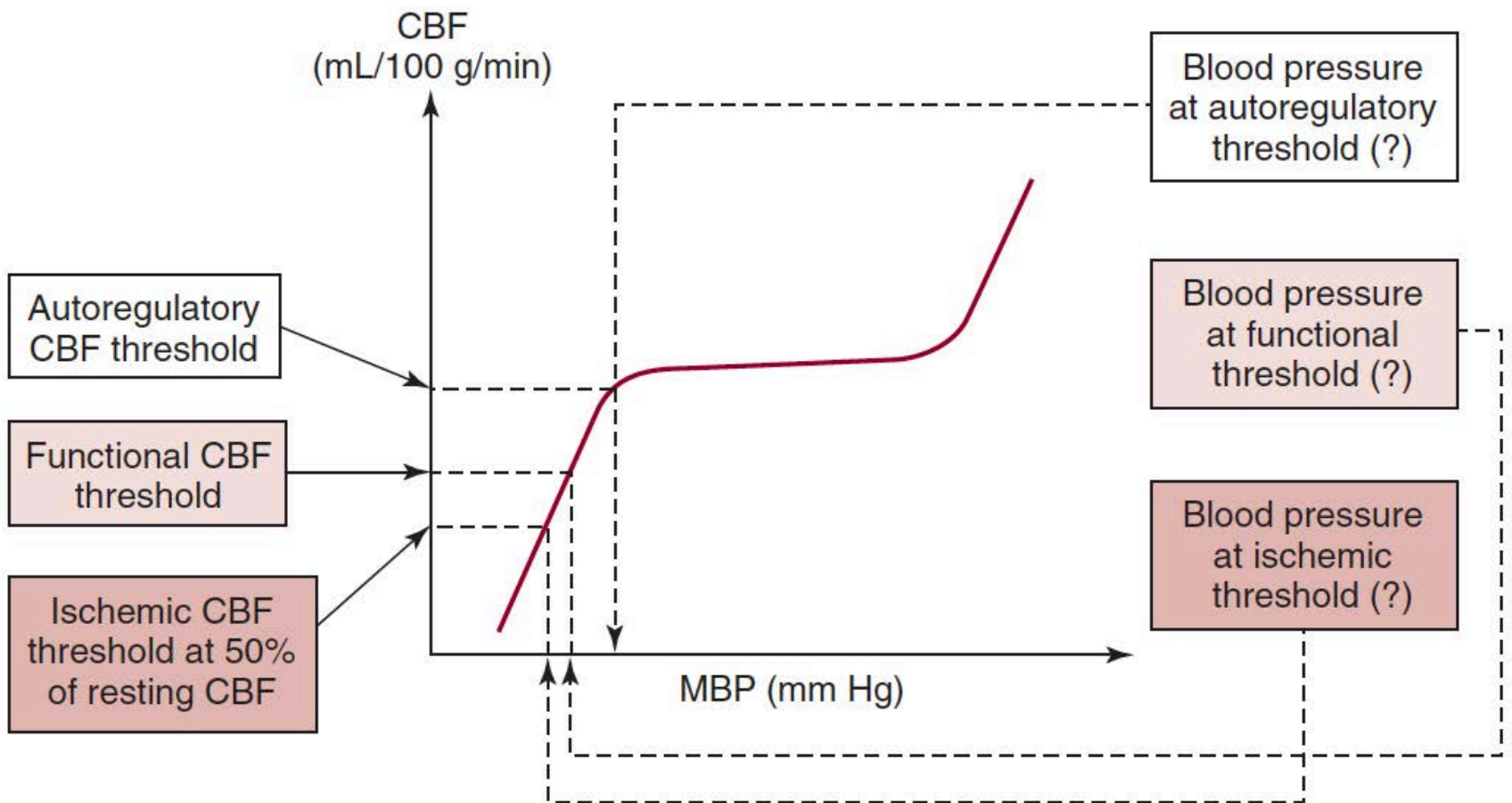
(Recommendations for Paediatric Anaesthesia Services,

ECOFFEY JC, France; ERBER A, Switzerland; HOLZKI J, Germany TURNER NM, The Netherlands,  
personal communications)

How should we address these patients?  
How to prepare to face The Perfect Storm?

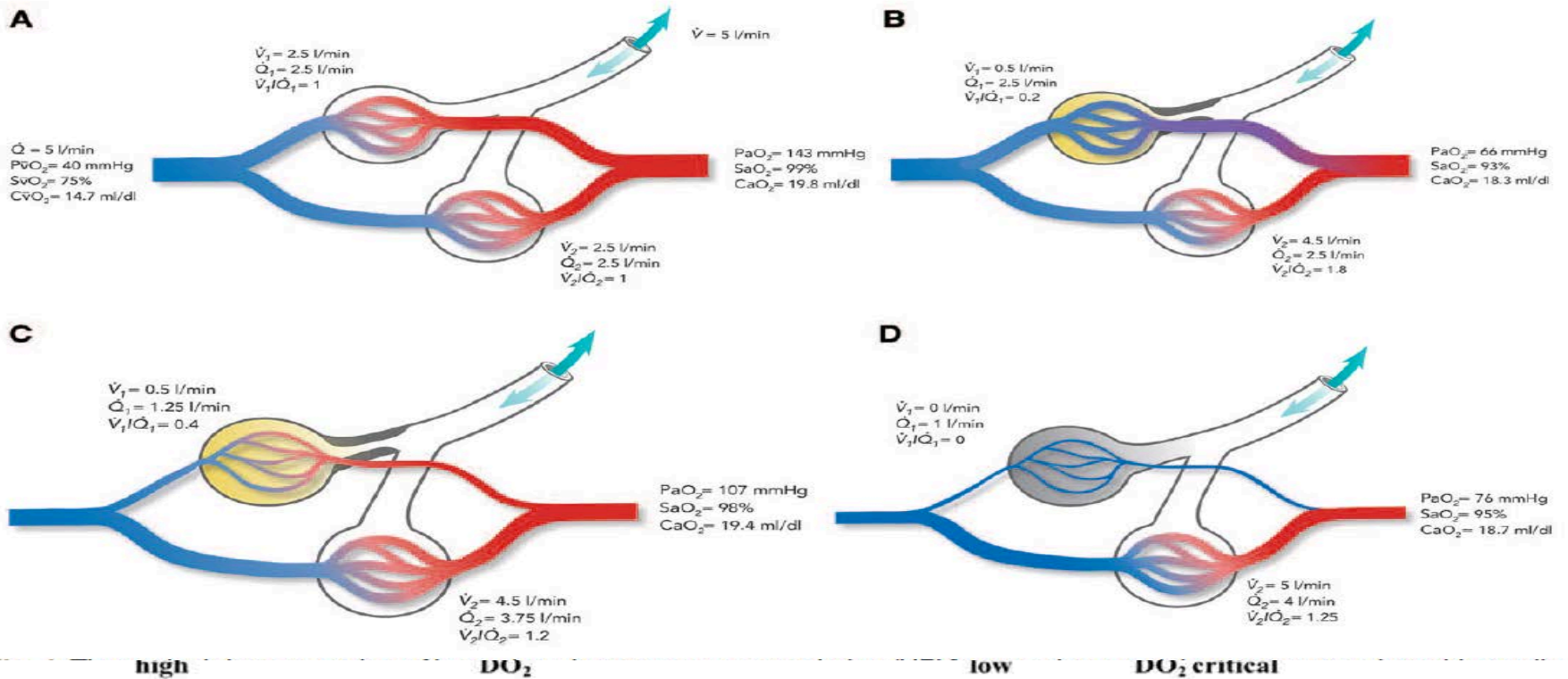


# Hemodynamic Perioperative Care



# Hemodynamic Management

$\dot{V}O_2$



# Pharmacology Approach

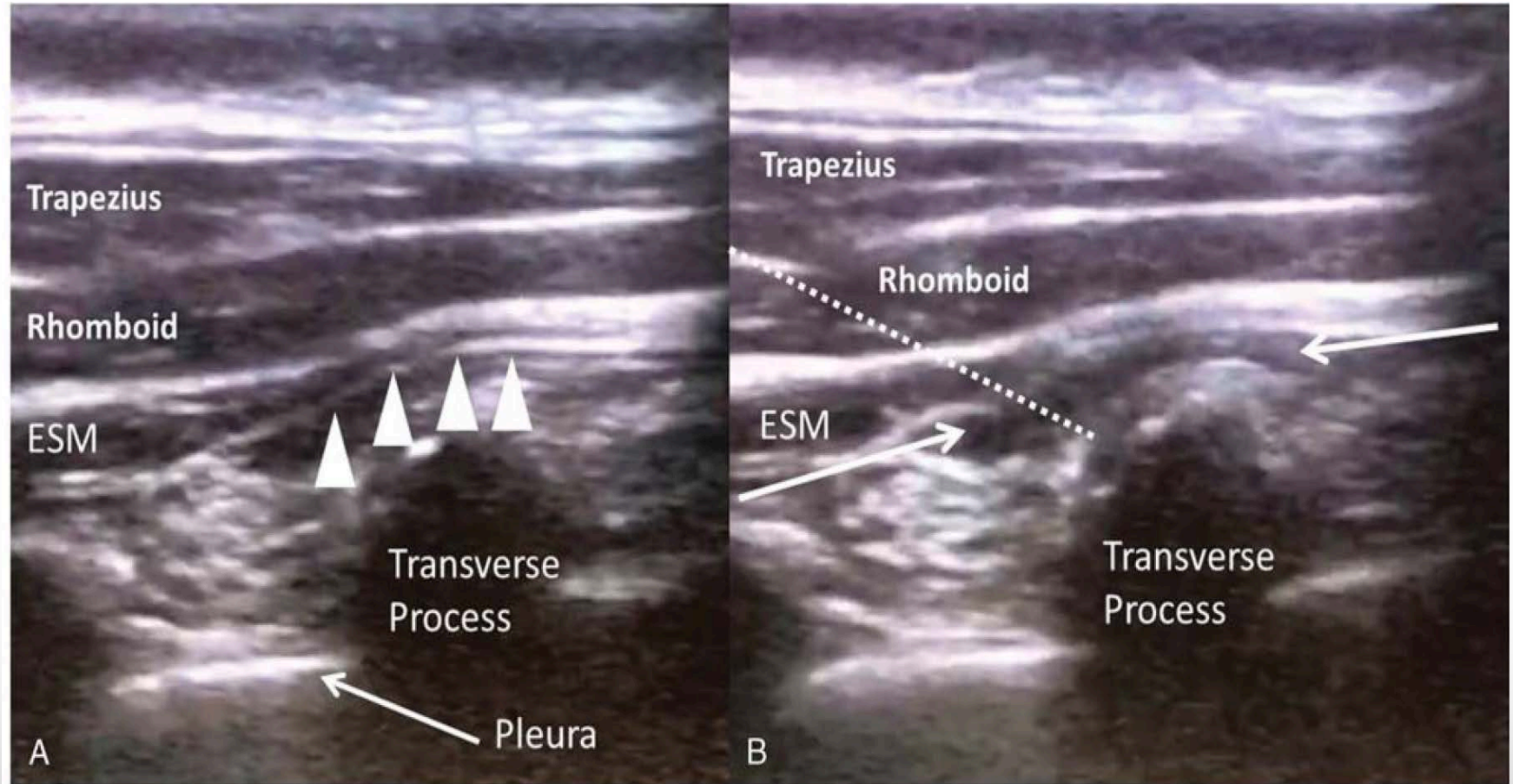
- Off-label drug use: only three anesthetic drugs remifentanyl, rocuronium, and sevoflurane had updated labeling for neonates.
- Pharmacokinetics and pharmacodynamics: Growth and maturation are major issues that influence drug action in pediatric patients.
- The absorption, distribution and clearance of drugs change abruptly during the infant period

# My Approach: Regional Anesthesia +



Caudal Block

# Regional Anesthesia +



ESP Block

# Regional Anesthesia +



# Minimally Invasive Pediatric Anesthesia?

Lancet. 1987 Jan 31;1(8527):243-8.

## **Randomised trial of fentanyl anaesthesia in preterm babies undergoing surgery: effects on the stress response.**

Anand KJ, Sippell WG, Aynsley-Green A.

Department of Paediatrics, John Radcliffe Hospital, Oxford.

### **Abstract**

In a randomised controlled trial, preterm babies undergoing ligation of a patent ductus arteriosus were given nitrous oxide and d-tubocurarine, with ( $n = 8$ ) or without ( $n = 8$ ) the addition of fentanyl (10 micrograms/kg intravenously) to the anaesthetic regimen. Major hormonal responses to surgery, as indicated by changes in plasma adrenaline, noradrenaline, glucagon, aldosterone, corticosterone, 11-deoxycorticosterone, and 11-deoxycortisol levels, in the insulin/glucagon, molar ratio, and in blood glucose, lactate, and pyruvate concentrations were significantly greater in the non-fentanyl than in the fentanyl group. The urinary 3-methylhistidine/creatinine ratios were significantly greater in the non-fentanyl group on the second and third postoperative days. Compared with the fentanyl group, the non-fentanyl group had circulatory and metabolic complications postoperatively. The findings indicate that preterm babies mount a substantial stress response to surgery under anaesthesia with nitrous oxide and curare and that prevention of this response by fentanyl anaesthesia may be associated with an improved postoperative outcome.



# TAKE HOME MESSAGE

- Pathophysiological hemodynamic alterations are influenced by both the procedure and the anesthesia during pediatric abdominal laparoscopic surgery
- Due to age-related homeostatic vulnerability, hemodynamic status should not be underestimated in pediatrics
- Knowledge of the pathophysiological changes, the standardization of intraoperative surgical assessment and anesthesia management are all mandatory to prevent adverse hemodynamic outcomes

# LUNG-PROTECTIVE VENTILATION (LPV)

- LPV: Using (PEEP) to prevent atelectasis
- LPV: Tidal volume is limited to avoid overdistension
- Caution: Extremely premature infants have lungs that are both structurally and biochemically immature

● THANKS

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