Anesthetic Considerations in the Child with Pulmonary Hypertensive Vascular Disease
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Disclosures
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Objectives
• Overview of anesthesia related cardiac arrests in children
• Pulmonary Hypertension and Non-Cardiac Surgery
• How do we assess risk?

Anesthesia Related Cardiac ARRESTS in Children
• Paucity of systematic studies in children with HD to assess risk of NCS.
• Overall children at higher risk of anesthesia related CA: 1/10,000 in adults; 1/1000 in neonates
• Outcomes following cardiac arrests depends on ASA physical status
Causes of Anesthesia Related Arrests

- Cardiomyopathy with low EF
- Left Sided Obstructive lesions
- Single Ventricle Physiology
- Pulmonary Hypertension: Moderate, Severe

ASA PHYSICAL STATUS

- ASA 1: No organic disturbance
- ASA 2: Mild to moderate systemic Dz
- ASA 3: Severe systemic Dz
- ASA 4: Life threatening systemic disorder
- ASA 5: Moribund patient
- E: Emergency procedure

Limitations of the ASA Physical Status

- Does not include risk associated with the procedure eg., cardiac catheterization vs Spinal fusion vs Laparotomy
- Does not account for experience of the operators

Anesthesia and heart DZ: High RISK

- Cardiomyopathy with low EF
- Left Sided Obstructive lesions
- Single Ventricle Physiology
- Pulmonary Hypertension: Moderate, Severe
You want to do what?

• 10 years old, ASD, Scoliosis
• On Sildenafil
• Spinal fusion: C7-L4
• Risk Assessment?
• PH+Surgery+Anesthesia

Additive or Exponential

Impact of Pulmonary Hypertension on the Outcomes of Noncardiac Surgery - Predictors of Perioperative M & M

Ramakrishna G et al; JACC, 2005; 45,1691

• Mayo Clinic: 1991-2003
• PH by cardiac catheterization
• 7% deaths - compare with 3.4% and 4.6%
• Functional class >2, complex surgery, duration of anesthesia >3 hours.

Length of Stay

Ramakrishna G et al; JACC, 2005; 45,1691

• Intraoperative use of Vasopressors
• Duration of anesthesia
• High risk surgery
• 6MWT: Not predictive

Non Cardio-Thoracic, Non-Obstetric Surgery in Adults with mild-moderate Pulmonary Hypertension


• 7 years; retrospective data review
• 28 patients; NYHA 1-2
• 29% had periop complications rel to DZ
• 7% perioperative death
• Risk Factors: Emergency surgery, major Surg, Long op Times (3hours or >er)
Outcome predictors for non-cardiac surgery in PHTN

- Cleveland Clinic: 5 year; 173, 95 PH
- Independent predictors: MPAP, ASA status, CRF
- PH pts: Unstable pressures, CHF, Resp failure, LOS, readmission within 30 days.
- Excluded: kids

Data in Children-1

- Cardiac cath, 5 year period
- 75 children- 70 records
- Cardiac Compression- 4 (6%)
- Mortality: 1 death (1.4%) - RHF in PACU
- Risk Assessment: Symptoms, ECHO indices; Idiopathic PHT

Perioperative Complications in Children with PH

- 5 year retrospective chart review
- n=156; 256 procedures; 50% CC
- Cardiac arrest 1.7%; mortality <1%
- Overall institutional CA = 0.024%
- Hence a 48% increased risk of CA
- Only Predictor: Baseline suprasystemic PAP

Outcomes in Children @ Stanford

- 6 year; Retrospective
- PAP>25 mmHg, PVRI>3WU
- n=68; 192 procedures
- Cardiac cath 128; major surgery=20
- major complications=9
Stanford Data-Complications

- CA: 18% for major surgery; 0.78% for CC
- Overall Cardiac Arrest: 0.8%; 0 mortality
- Risk Factors: Airway instrumentation, major surgery, opioid administration
- Pulmonary vasodilator therapy reduced risk of complications (OR: 0.31, CI: 0.1-0.7)
- Ketamine was used in 75% of procedures

Ketamine in PH

- In the presence of low dose volatile anesthetic no change in PVR noted
- Maintains SVR and PVR/SVR ratio
- Avoids airway instrumentation
- Normocapnia and Normoxia

Effects of Anesthetic Medications

- “The principle hemodynamic effect of propofol in children with congenital heart disease is a decrease in systemic vascular resistance”
- Williams GD, 1999 Anesth-Analg, 89
- Venodilation: In those with Vent. Dysfunction

Volatile Anesthetic Agents & the Heart

- Negative Inotrope but nonspecific Pulmonary Vasodilators
Dexmedetomidine

- Alpha-2 agonist
- Case reports of successful use in PH patients
- Dose dependant hemodynamic changes
- Useful adjunct to Propofol or Ketamine

Interim Summary

- PAH -increased risk for CA under anesthesia
- Severity of PAH may be a risk factor
- Pulmonary vasodilator therapy may be helpful
- Major surgery associated with major Complications

Anesthesia for Spinal Fusion

- 10 years old, ASD, Scoliosis, Restrictive Lung Dz
- Surgery: C7 to L5
- Cardiac Cath: PVRI>7 WU
- Flolan initiated , PA catheter, Prone position
- 4 hours later: PH crisis, V Fib arrest

Imaging Studies?

- 8 year old; cyanosed, clubbing, unable to lie flat, loud murmur
- ECHO: PDA; TR suggesting PHTN
Anesthetic Challenges

• Monitoring
  • ECG quality varies: loss of early ischemia detection
  • Pulse oximeter & BP: poor design for neonates and infants
  • CV effects of Anesthesia and Sedation
  • Breatholds: game changer
  • Resuscitation challenges in MRI suite

So how do we assess risk at Stanford?

• Close Collaboration with the PH team
• History: syncope, fainting, arrhythmia, meds
• Physical Exam: Cyanosis
• Investigation: Echo, functional assess, cath,
  • “complex care model” coordination
• Discuss the need for exposure to risk

Conveying the risk?

• CV mortality is a major burden during NCS
• Risk Stratification-Goldman index 1977
• Develop procedure specific risk score
• Predict cardiac M &M
• Modified again in 1986 to improve predictive accuracy; 1999; 2005
Conclusion

- Risk Assessment tools for anesthesia and procedures need to be refined
- Focus on team approach
- Monitor appropriately to diagnose
- Intervene early when trouble occurs

Oops I just fell in!!

Happy ending for the 10 year old

- Now 5 years later
- ASD closure under GA and CPB
- Extubated in the OR
- Discharged 10 days later

How did we resuscitate

- Goal: Raise SVR and maintain coronary Perfusion
- 1st drug of choice is Phenylephrine - its right there 1-2 µg/kg bolus and repeat
- Epinephrine 0.5-1µg/kg - avoid tachycardia
- Calcium Chloride 10-20 mg/kg : raise SVR