POSTOPERATIVE PULMONARY HYPERTENSION PROTOCOL

I Patient identified in High Risk Category (Pre-op) and the presence of any one of the factors below:
   a) Mean pulmonary artery pressure is greater than 25 mm Hg intraoperatively.
   b) Estimated RV pressure greater that 50-60% systemic.
   c) Intra-op TE Echo findings of significant tricuspid regurgitation with some RV dysfunction
   d) Intraoperative issues with: ventilation/oxygenation, long CPB run, arrhythmias etc.
   e) Clinical indicators of Low Cardiac Output (Decrease in SVO2/Cerebral Oximeter, elevated RAP, Decrease urine output, elevated lactate, metabolic acidosis)

II Institute Pulmonary Hypertension Protocol:

1) Premedicate with fentanyl/morphine +/- muscle relaxant prior to endotracheal suctioning or any painful procedure.
2) Continuous Morphine infusion
3) Continuous neuromuscular blockade in the first 24-48 hours post-op.(Use of BIZ monitor vs Train of Fours?)
4) Consider early institution of Nitric Oxide at 10-20 ppm
5) Avoid Hypoxia relative to underlying defect. Maintain baseline level of supplemental oxygen.
6) Avoid Metabolic/ Respiratory Acidosis: Maintain ph 7.4-7.5 and paCO2 30-40.
7) Avoid Hyperinflation/atelectasis
8) Avoid polycythemia ( Keep Hct range 36-45)
9) Maintain normal body temperature (36.5-37.5)
10) Follow Open Chest guidelines.

III Nursing Considerations:

1) Strategies to minimize overstimulation by surrounding environment.
2) Have extra dose of sedation and neuromuscular blockade readily available.(Morphine and vecuronium/ pancuronium).
3) Avoid hypothermia/hyperthermia
4) Preoxygenate prior to suctioning( non-shunt dependent patients with 100% FiO2; Shunt patients with O2 required to achieve 75-85% saturations)
5) Administer extra dose of sedative and neuromuscular blockade prior to suctioning/or any procedure that might cause agitation/pain.
6) Notify MD for any ABG with ph < 7.35 or > 7.5 ; PaCO2 > 40 or<30

NOTIFY MD IMMEDIATELY FOR ANY OF THE CLINICAL SIGNS OF A PULMONARY HYPERTENSIVE CRISIS. A SUDDEN INCREASE IN CVP OR DECREASE IN SATURATIONS BY MORE THAN 10% REQUIRES IMMEDIATE INTERVENTION.
<table>
<thead>
<tr>
<th>Early Signs</th>
<th>Late Signs</th>
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<tbody>
<tr>
<td>Labile saturations</td>
<td>Increase in CVP/RAP</td>
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<tr>
<td>Tachycardia</td>
<td>Tachycardia/hypotension</td>
</tr>
<tr>
<td>Decreased pulses/perfusion</td>
<td>Hypoxemia</td>
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<tr>
<td>Stable blood pressure</td>
<td>Oliguria</td>
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<tr>
<td>Decreased SV02/MVO2</td>
<td>Lactic acidosis</td>
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</tbody>
</table>

**ACUTE MANAGEMENT**

1) **Hyperventilation and oxygenation: 100% for Non-Shunt dependent lesions.**
   
   *For Shunt patients give supplemental O2 to get saturations to baseline.*

2) **Urgent administration of supplemental sedation and neuromuscular agent**

3) **Start Nitric Oxide if not already being administered**

4) **Start inotropic support if hemodynamic instability.**

5) **Obtain ABG, lactate and comprehensive metabolic panel and correct abnormalities.**

6) **Echocardiogram to assess cardiac function, tricuspid regurgitant velocity.**

**References:**


2) Lindberg L, Olsson A.K., Jogi P, Jonmarker C. How Common is severe pulmonary hypertension after cardiac surgery? *JTCVS 2001; Volume 123 Number 6*


8) Gothberg S, Edberg KE. Inhaled nitric oxide to newborns and infants after congenital heart surgery on cardiopulmonary bypass. *Scand Cardiovasc J 34; 2000; 154-158*


11) Beitzke A et al. Inhaled Nitric Oxide in patients with Critical pulmonary perfusion after fontan-type procedures and bidirectional glenn anastamosis. *JTCVS*; March 1997 Volume 113; Number 3