Children's of Alabama
Post-Operative Norwood Care: The benefits of protocol

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Acute Care PNP, CVICU
Hearts at Home Coordinator
Disclosure Statement

I DO NOT HAVE ANY RELEVANT FINANCIAL RELATIONSHIPS WITH ANY COMMERCIAL INTERESTS TO DISCLOSE.
Objectives

• To identify benefits of standardized post-op CV care of the critically ill infant
• To recognize safe boundaries set by protocolized care
• To be aware of other protocols and how they apply to HLHS patients
Why HLHS?
Why HLHS?

• Acuity of patients
  – If able to master most critical, should be able to apply principles to less acute

• Lots of variables
  – CPB
  – Surgical Technique
  – SVR/PVR
  – QP:QS
Audience Question #1

Do you routinely feed HLHS patients pre-operatively at your institution?

a. Yes, Advance to Full Feeds
b. Yes, Trophic Feeds Only
c. No, we never feed HLHS pre-op
## Daily Clinical Pathway
Starting Day of Surgery

### STAGE 1 NORWOOD OPERATION

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| **NURSING ASSESSMENT** | Q ½ hr vital signs x 4, then Q 1hr; strict I & O  
Record CT output Q 15 minutes until < 5 ml/kg/hr | | Initiate bleeding protocol while CT output > 10 ml/kg |
| **MONITORING** | Routine cardiorespiratory monitor with ETCO2  
Renal and Cerebral NIRS  
Rectal or Foley Temp  
All Chest Tubes at negative 20 suction  
Foley and PD to gravity  
Transduce CVP (distal port of CVL) with 1/2 NS @ 1ml/hr  
Transduce each arterial line with 1/2NS + Heparin 1 unit/ml @1ml/hr;  
Non-invasive BP Q 6 hrs  
Pacemaker on with settings and connection cables in room (cables connected to wires but not to pacemaker)  
Within 2 hours of admission clarify all patient specific vital sign goals and notification parameters with PNP/MD and record on daily rounding sheet and perform RAP rounds | Goal sat 70-80 %, HR < 170  
Goal: rNIRS > 60, cNIRS > 50  
Goal temp 36.5-37.5 Celsius  
Goal CVP 8-12 mm HG  
Goal MAP 45-55  
If >1 arterial line, ensure both lines have fluids infusing  
Remember 10-20 rule: Notify MD/PNP for change in SBP, NIRS, ETCO2, Sat by 10 and HR by 20  
Call for CXR upon admission | |
| **ADMIT DIAGNOSTIC TESTING** | Labs: ABG with lyses, lactate, VBG, RFP, PT/PTT, fibrinogen, platelet count, Hgb and Hct  
CXR upon admission  
EKG within 2 hrs | Goal Hgb > 15  
Mag > 1.5 or > 2 if H/O arrhythmia  
Transcribe results on Worksheet and calculate A-VO2 difference; notify MD if rising | |
| **SCHEDULED LABS** | ABG, VBG Q 2 hrs x 4 OR until lactate under 4; If lactate is under 4 - then Q 4 hrs x 4; then Q 6 until sternum closed  
Hgb/Hct, platelet count, fibrinogen, PT/PTT, Q 2 hrs while CT output > 5 ml/kg; then Q 12 hrs  
TEG x 1 if CTO > 5ml/kg/hr x 2 hrs | | |
Hypoxia Algorithm

Low Saturations (< 75%)
1. Move pulse oximeter probe to different location
2. Confirm reading with ABG saturation (should be 5-10% lower)
3. Confirm with NIRS monitor (follow pulse ox trend)

Evaluate for Pulmonary Venous Desaturation
1. Send ABG/chest x-ray
2. Adequate chest rise? Good return volumes?
   What is ETCO2 trend?
3. Suction patient (after pre-med)
4. Oxygen Challenge: If approx. 10% increase (or decrease) in saturation between FiO2 0.6 to 1.0 after 5 minutes, then lung disease is present – judicious increase in FiO2 or mean airway pressure to treat V/Q mismatch

Evaluate for Low SVO2
1. Low BP or evidence of compromised oxygen delivery, consumption or CO2 – see page 1
2. Hemoglobin < 15 g/dL – transfuse

Evaluate for Low Pulmonary Blood Flow
1. Minimal response to Oxygen Challenge
2. ± Hypoperfused chest x-ray/ETCO2
3. Usually normal BP

Evaluate for Elevated PVR
1. At risk: high sats pre-op; <38 wks; lung disease, restrictive ASD, pulmonary vein obstruction
2. Start iNO, alkalosis, sedation and paralysis, paco2 30-35, increase FiO2, increase milrinone

Small, Kinked or Thrombosed Shunt
1. Listen for murmur (different from admit?)
2. Echo
3. Fully heparinize patient if murmur different (see CVICU Heparinization Protocol)
4. Increase blood pressure to drive shunt flow (norepi, vasopressin, or neosynephrine)
5. Increase Hgb

No improvement
Safety Mechanisms

• Earlier identification of problem
  – Hypoxia
  – Hypotension

• Nurses have clear goals and guidelines
  – Help providers stay on task
  – Many New Nurses, Orientees

• Providers have clear goals and guidelines
  – Provider variability
  – Night-time coverage
What are other benefits?
Norwood Procedure Post Operative
Hemodynamic Goals Worksheet

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SEND VENOUS GAS FROM IN ORDER OF PREFERENCE: IV > UVC > FEMORAL. DRAW ABG AND SVO2 AND RECORD NON-INVASIVE MEASURES AT SAME TIME.

**Lactate** to be sent every 4 hours until normalized; goal: decreased in half at 12 hours – normal after 24 hours
SVO2 should reach its nadir at 6-12 hours post-op.
Inferior Vena Cava Oxygen Saturation Monitoring After the Norwood Procedure

Robert J. Dabal, MD, Leslie A. Rhodes, MD, Santiago Borasino, MD, MPH, Mark A. Law, MD, Stephen M. Robert, MD, and Jeffrey A. Alten, MD

Division of Cardiothoracic Surgery, Department of Surgery, Department of Pediatrics, and Section of Cardiac Critical Care, Division of Cardiology, University of Alabama at Birmingham, Birmingham, Alabama

**Background.** Superior vena cava oxygen saturation monitoring in the early postoperative period after the Norwood procedure (NP) has been associated with improved survival and decreased adverse events (AE). There is no data describing inferior vena cava saturation (Sivo₂) monitoring after NP. We sought to investigate the utility of intermittent Sivo₂ monitoring after NP and to assess the correlation of Sivo₂ with renal near-infrared spectroscopy (rNIRS). We hypothesized failure to achieve Sivo₂ greater than 45% within the first 4 hours after NP is predictive of AE, and that rNIRS correlates with Sivo₂.

**Methods.** A retrospective study of 26 consecutive NP patients who received postoperative management with Sivo₂ monitoring according to a strict protocol was conducted. Primary outcome was AE, defined as cardiopulmonary resuscitation, extracorporeal membrane oxygenation, death before discharge, or residual surgical defects.

**Results.** Ten (38%) patients had one or more AE; mortality was 23%. On admission to the cardiac intensive care unit, patients with AE had lower Sivo₂ (45% ± 9.4% versus 62% ± 12.0%; *p* < 0.001) and lower rNIRS (56 ± 6.5 versus 77 ± 7.2; *p* < 0.001). At 4 hours, 90% of AE patients had an Sivo₂ less than 45% versus 6% of non-AE patients. Both Sivo₂ and rNIRS were highly predictive of AE: the area under the receiver-operating characteristic curve was greater than 0.86 and 0.95, respectively. Two hours after admission, an Sivo₂ less than 45% predicted AE with a specificity of 93%, a sensitivity of 70%, and a positive predictive value of 82%. The Sivo₂ was strongly correlated with rNIRS (*r* = 0.81).

**Conclusions.** Intermittent Sivo₂ can be used to guide early postoperative NP management; rNIRS is an accurate continuous, noninvasive surrogate for Sivo₂. An Sivo₂ of less than 45% in the first 4 hours after the NP is predictive of AE.

Other Protocols that Apply

- Echocardiogram Frequency for HLHS
- Preoperative Feeding
- Postoperative Feeding
- Post-op PO Feeding Eval
- Hydrocortisone for Neonatal Bypass
- Peritoneal Dialysis for Neonatal Bypass
- Anti-Xa Monitoring for Heparin
- Chylothorax
- Ventilator Weaning Protocol
- RAP (Resuscitation Action Plan)
- And more. . .
Protocols Driven by Research and Results

• Preoperative trophic feeds in neonates with hypoplastic left heart syndrome.
  Toms R, Jackson KW, Dabal RJ, Reebals CH, Alten JA.
  Congenit Heart Dis. 2015 Jan-Feb;10(1):36-42.

• Prophylactic peritoneal dialysis following cardiopulmonary bypass in children is associated with decreased inflammation and improved clinical outcomes.
  Sasser WC, Dabal RJ, Askenazi DJ, Borasino S, Moellinger AB, Kirklin JK, Alten JA.
• **Anti-xa directed protocol for anticoagulation management in children supported with extracorporeal membrane oxygenation.**
  O'Meara LC, Alten JA, Goldberg KG, Timpa JG, Phillips J, Laney D, Borasino S.

• **Central venous lines are a risk factor for chylothorax in infants after cardiac surgery.**
  Borasino S, Diaz F, El Masri K, Dabal RJ, Alten JA.

• **Postoperative Hydrocortisone Infusion Reduces the Prevalence of Low Cardiac Output Syndrome After Neonatal Cardiopulmonary Bypass.**
  Robert SM, Borasino S, Dabal RJ, Cleveland DC, Hock KM, Alten JA.
  Pediatr Crit Care Med. 2015 Sep;16(7):629-36.
Audience Question #2

How do you currently monitor heparin drips at your institution?

a. PTT  
b. ACT  
c. Anti-xa  
d. Other
More Abstracts and Data

- Post-op Feeding after ASO
- Ventilator Weaning Protocol
- Post-op Feeding Eval
- RAP
- Several available on SPCS site
These guidelines represent the expected convalescence after the Norwood Operation. Patient Care should be revised to meet individual patient needs.
Thank you!