1.0 PURPOSE and INTENT:

1.1 Optimize care of infants with hemodynamic compromise of non-cardiac etiology, to prevent progression into late irreversible stages of shock. Decrease overall PDA related complications. Decrease the incidence of Intraventricular Hemorrhage resulting in neonates in the Neonatal Intensive Care Units (NICU) within the WRHA.

Note: All recommendations are approximate guidelines only and practitioners must take into account individual patient characteristics and situation. Concerns regarding appropriate treatment must be discussed with the attending neonatologist.

2.0 DEFINITIONS:

2.1 Integrated evaluation of neonatal hemodynamics (IENH): The integration of information obtained from clinical evaluation, echocardiography (echo), biochemical markers, in addition to the clinical information obtained from non-invasive and invasive monitoring of blood pressure, arterial and tissue oxygenation, leading to the formulation of a medical recommendation. See Appendix A.

2.2 Targeted neonatal echocardiography (TNE): A component of integrated evaluation of neonatal hemodynamics (IENH). It is the bedside use of ultrasound to longitudinally assess myocardial function, systemic and pulmonary blood flow, intra and extracardiac shunts. It can provide detailed real-time information concerning physiology and hemodynamics leading to rapid identification of the mechanism of circulatory failure in critically ill neonates, resulting in appropriate targeting of therapy.

2.3 TNE Physician: Neonatologist who has completed an educational component approved by the IENH Program Committee.

3.0 TNE PROGRAM:

3.1 The Department Head of Pediatrics and Child Health in consultation with the Chair of the Point of Care Ultrasound Committee, Neonatology Section Head and Pediatric Cardiology Section Head are responsible for evaluating the training and credentials of physicians performing TNE.

3.2 TNE physician will perform, interpret and sign-off TNE studies that do not require Pediatric Cardiologist supervision.

3.3 The Section of Neonatology takes responsibility for the ultrasound equipment, diagnostic reporting system and image storage.

3.4 The Section Head of Neonatology together with IENH Program Committee members are responsible for supervising the therapeutic component of the NICU hemodynamic program.

3.5 The IENH Program Committee sets and maintains standards of practice, cultivates education and research initiatives, and supports the training in TNE as per guidelines set by the American Society of Echocardiography (ASE), European Association of Echocardiography (EAC) and the Association for European Pediatric Cardiologists (AEPC). See Appendix A for composition of the committee.

3.6 TNE physicians perform and sign-off TNE studies with focused imaging (Focused TNE) and follow-up TNE standard studies after the patient has been shown to be free of congenital heart disease or cardiomyopathy.
4.0 CLINICAL PRACTICE GUIDELINES:

4.1 Assess infant and identify potential need for echocardiogram or IENH based on the three categories listed below: (See Triage algorithm in Appendix B)

4.1.1 Category 1- Infants who require a consult to Pediatric Cardiology for one of the following indications:
   - Suspected ductus dependant pulmonary circulation:
     - Cyanosis (SpO2 < 85%) and failed hyperoxia test (PaO2 < 150 mmHg) despite oxygen administration.
     - PaO2<25 mmHg require an urgent consult.
   - Signs of inadequate systemic perfusion or cardiogenic shock (metabolic acidosis, hypotension, tachycardia, elevated lactate).
   - Supraventricular/ventricular tachyarrhythmia or heart block. An urgent consult is required when there are clinical signs of hemodynamic compromise or if pacing is required.
   - Fetal diagnosis of congenital heart disease.
   - Blood pressure differential between upper and lower limbs.
   - “Pathologic” heart murmur.
   - Surgical disorder commonly associated with a cardiac defect
   - Genetic disorder or syndrome commonly associated with a cardiac defect.
   - Suspected infective endocarditis or intracardiac thrombus.

4.1.2 Category 2 – Infants who have had a previous cardiology consult with echocardiogram and present with a new indication for IENH including:
   - PPHN non-responsive or poorly responsive to INO therapy.
   - Clinically suspected pericardial effusion.
   - Hypotension and signs of inadequate systemic perfusion (lactic acidosis, tachycardia, oliguria)
   - Hypoxic ischemic encephalopathy and signs of inadequate systemic perfusion within the first 72 hours of life
   - Low urine output not responding to 20 ml/kg of volume expander.
   - Chronic lung disease with suspicion of right heart failure or pulmonary hypertension
   - Suspected hemodynamically significant ductus arteriosus (HSDA).
   - Patent Ductus Arteriosus- post-surgical ligation
   - Congenital diaphragmatic hernia with deteriorating oxygenation and /or signs of inadequate systemic perfusion.
   - Confirmation of central venous line or umbilical catheter tip position - comprehensive echocardiogram not mandatory.

4.1.3 Category 3 – Infants who present with one of the indications listed above for category 2, but who have not had a Pediatric Cardiology consult or echocardiogram.

4.2 For Category 1 infants TNE is not a replacement for a complete comprehensive pediatric cardiology assessment, if heart disease is clinically suspected in the infant/neonate (including suspicion of congenital heart disease, cardiomyopathy or cardiac arrhythmia), consult the Pediatric Cardiologist on call. Indicate “pre-TNE echo” on the consult request. Where IENH is indicated, the first echocardiography study must still be performed and interpreted by the Pediatric Cardiologist to exclude primary cardiac disease.

4.3 For Category 2 infants, notify the TNE Physician by page or phone call. To determine TNE physician availability call the Neonatology Office at 204-787-1853.

4.4 For Category 3 infants, before notifying the TNE Physician, notify the Pediatric Cardiologist on call to arrange the anatomic screening echocardiogram and fax the completed “Request for Integrated Evaluation of Neonatal Hemodynamics (IENH) and Targeted Neonatal Echocardiography (TNE)” form from Appendix C to them at fax# 204-787-2004.

4.5 Process for ordering IENH study
   4.5.1 Complete the IENH and TNE request form (Appendix C) and notify a TNE physician (by phone or paging).
4.5.2 Ensure that there are sufficient resources to complete the request in a timely manner before proceeding with the IENH consultation (responsibility of the attending Neonatologist and TNE Physician).

4.6 The IENH consultation which will include therapeutic decision-making is provided as a consultation service and documented on the current approved consultation form.

4.7 Follow up and changes made based on any repeated follow up IENH is documented in the patient’s Health Record.

4.8 TNE images are saved to the ECHO-PACS system. The images with the reports are then transferred to the hospital diagnostic imaging storage system (IMPACS). All TNE studies are recorded and the images stored in a manner allowing for immediate availability for review and easy retrieval.

5.0 REFERENCES:


5.5 Mertens L, Seri I, Marek J, Arlettaz R, Barker P, McNamara PJ et al. Targeted Neonatal Echocardiography in the Neonatal Intensive Care Unit: Practice Guidelines and Recommendations for Training. Writing group of the American Society of Echocardiography (ASE) in collaboration with the European Association of Echocardiography (EAE) and the Association for European Pediatric Cardiologists (AEPC)


6.0 PRIMARY AUTHORS:

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6.2 Dr. Michael Narvey, Section Head, Neonatology
6.3 Dr. Reni Soni, Section Head, Pediatric Cardiology
6.4 Dr. John Baier, Assistant Medical Director, NICU HSC
6.5 Dr. Ruben Alvaro, Medical Director, NICU, SBH
Appendix A

IENH Program Committee Members:

- Neonatologist Director (TNE Physician)
- Section Head of Neonatology
- Section Head of Pediatric Cardiology
- 2 Additional Neonatologists
- Assistant Medical Director NICU HSC
- Medical Director NICU SBGH
- Chair, Point of Care Ultrasound Committee

**COMPONENTS OF THE INTEGRATED EVALUATION OF NEONATAL HEMODYNAMICS**

![Diagram of Integrated Evaluation of Neonatal Hemodynamics (IENH)](image-url)
Appendix B

Echocardiogram Triage Algorithm

Neonatology Team Assess Infant

- Suspected congenital heart disease
- Suspected duct dependent systemic circulation
- Supraventricular/ventricular tachycardia or heart block
- Blood pressure difference between upper and lower limbs.
- "Pathologic" heart murmur
- Surgical disorder associated with a cardiac defect
- Genetic disorder or syndrome associated with a cardiac defect
- Suspected infective endocarditis or intracardiac thrombus

Category 1: Consult Pediatric Cardiology

- PPHN non-responsive or poorly responsive to INO therapy
- Clinically suspected pericardial effusion
- Hypotension and signs of inadequate systemic perfusion (lactic acidosis, tachycardia, oliguria)
- Hypoxic ischemic encephalopathy and signs of inadequate systemic perfusion within the first 72 hours of life
- Low urine output not responding to 20 cc/kg of volume expander.
- Chronic lung disease with suspicion of right heart failure or pulmonary hypertension
- Suspected hemodynamically significant ductus arteriosus (HSDA)
- Patent Ductus Arteriosus post-surgical ligation
- Congenital diaphragmatic hernia with oxygenation failure and/or signs of inadequate systemic perfusion
- Confirmation of central venous line or umbilical catheter tip position - comprehensive echocardiogram not mandatory

Previous Echo?

NO

Category 3: Complete Request Form and Contact Pediatric Cardiologist on call

YES

Followed by

Category 2: Complete Request Form and Contact TNE Physician

If delay in obtaining Echo anticipated and IENH is urgent contact both services to arrange parallel studies within 72 hours
Request for Integrated Evaluation of Neonatal Hemodynamics (IENH) and Targeted Neonatal Echocardiography (TNE)

Gestational Age of Infant at Birth __________ wks Current Corrected Gestational Age _______ wks

Infant’s Current weight: ________ gms

Requesting Physician (print name): ________________________ Signature: _____________________

**Indication:** check one from the following list:

- PPHN non-responsive or poorly responsive to INO therapy.
- Clinically suspected pericardial effusion.
- Hypotension and signs of inadequate systemic perfusion (lactic acidosis, tachycardia, oliguria)
- Hypoxic ischemic encephalopathy and signs of inadequate systemic perfusion within the first 72 hours of life
- Low urine output not responding to 20 cc/kg of volume expander.
- Chronic lung disease with suspicion of right heart failure or pulmonary hypertension
- Suspected hemodynamically significant ductus arteriosus (HSDA).
- Patent Ductus Arteriosus post-surgical ligation
- Congenital diaphragmatic hernia with oxygenation failure and/or signs of inadequate systemic perfusion.
- Confirmation of central venous line or umbilical catheter tip position - comprehensive echocardiogram not mandatory.

**TNE priority**

- As soon as possible (ASAP)
- Today.
- Within 48 hours
- Within one week.

**First comprehensive echocardiogram done by cardiology?**

- Yes: Has it been discussed and accepted by the neonatology staff performing TNE? □ Yes  □ No
- No: Is it priority No 1 (ASAP)?
  - Yes: Has it been discussed and accepted by neonatology attending to do TNE first? □ Yes □ No
  - No: Request comprehensive echo by Pediatric Cardiology (category III) first.

**Decision:**

- Pre TNE structural echocardiogram needed+ TNE: –
  Notify pediatric cardiology by phone (204-787-2412) or through paging, fax this form to cardiology
  fax# 204-787-2004
- TNE only needed- Page a TNE Physician.
  To find out who is available call Neonatology Office 204-787-1853