JOHNS HOPKINS ALL CHILDREN’S HOSPITAL
HEART INSTITUTE

Enteral Nutrition in Neonates
with Congenital Heart Disease Clinical Pathway
Johns Hopkins All Children’s Hospital

Enteral Nutrition in Neonates with Congenital Heart Disease Clinical Pathway

Table of Contents
1. Rationale
2. Background
3. Clinical Management
4. Inpatient
   a. Inpatient Management
   b. Pre-Operative Pathway
   c. Post-Operative Pathway
5. References
6. Outcome Measures
7. Clinical Pathways Team Information

This pathway is intended as a guide for physicians, physician assistants, nurse practitioners and other healthcare providers. It should be adapted to the care of specific patient based on the patient’s individualized circumstances and the practitioner’s professional judgment.

Updated: November 2021

Owners: Reema Patel, MD; Michelle Smith, MD; Amy Kiskaddon, PharmD
Rationale:
This clinical pathway was developed by a consensus group of JHACH physicians, advanced practice providers, nurses, speech therapist, dietitian, and pharmacist to standardize the management of children hospitalized for congenital heart disease. It addresses the following clinical questions or problems:
1. When to start enteral feeds in preoperative and postoperative neonates with congenital heart disease
2. How to advance enteral nutrition based on a risk category
3. What parameters to use to hold feeding advancements or hold feeds

Background:
Preoperative feeding in neonates who require early surgical intervention is a controversial issue and feeding practices vary across institutions worldwide. Typically, these congenital heart lesions are classified as ductal-dependent pulmonary circulation, ductal-dependent systemic circulation, and ductal-independent mixing lesions. By keeping the ductus arteriosus open, it may cause an imbalance of excess blood flow to the pulmonary circulation, causing steal from the splanchnic bed potentially causing ischemia and placing these neonates at higher risk for necrotizing enterocolitis. It is unclear if having congenital heart disease is an independent risk factor for NEC, but there are certain cardiac lesions that have been shown to have a higher incidence of NEC, such as hypoplastic left heart syndrome. Infants with congenital heart disease have an increased resting energy expenditure and feeding the gut would further increase metabolic demand leading to gut hypoxia and the potential for NEC. Given these risks, there is often a delay in initiation of enteral feedings in the pre-surgical period, a critical time when the milestone of oral feeding is typically achieved. There are very few published studies on the safety of preoperative feedings in this population to support or refute early initiation of enteral feedings. Similarly, in the post-operative setting these children often go several days before having enteral nutrition introduced depending on the complexity and severity of their surgery and post-surgical course. Surgical palliation can alter the physiologic blood flow through the splanchnic bed, which may impact their success with feeding. For many neonates, the main reason for prolonged post-surgical hospital stay is feeding intolerance, and many neonates often require feeding assistance at discharge. We reviewed feeding guidelines and practices in the pre-operative and post-operative period from different institutions and created a pathway to implement at our institution.

Inpatient Management:
This pathway is intended for any neonate with corrected gestational age ≥35 weeks and ≥2kg admitted to the CVICU in the pre-operative and/or post-operative period.

Goal is to start feeds once:
1. No evidence of end-organ ischemia (lactate <3, pH >7.30)
2. Epinephrine infusion ≤0.05 mcg/kg/min
3. No significant or anticipated hemodynamic instability
Allow PO/bolus NG, if all criteria met:
   1. Non-invasive respiratory support <2 L/kg
   2. Respiratory rate <80 bpm
   3. No clinical concern for aspiration
   4. Speech consult in all patients with arch repair/reconstruction

Hold feeds if:
   1. Multiple large volume emesis
   2. Concerning abdominal distension on exam
   3. Bloody stools

If feeds need to be held:
   1. Re-evaluate in 1 hour and return to prior step that the patient was tolerating
   2. If having worsening abdominal distension or bloody stools:
      a. Hold feeds and obtain a KUB to evaluate for NEC

High risk patients:
   1. Single ventricle
   2. Shunts (surgical or ductal stent)
   3. ECMO
   4. Prior history of NEC
   5. Prior history of end-organ ischemia
   6. Any other patient that provider deems high risk based on surgical intervention or clinical status

**Clinical Management**
   1. Use maternal breastmilk or standard infant formula
   2. Use standard infant formula powder to fortify maternal breastmilk
   3. If feeding intolerance is present; consider a hydrolyzed formula (e.g., Alimentum)
   4. If feeding intolerance continues; consider an elemental formula (e.g., Elecare)
   5. If concern for chylothorax, refer to Heart Institute Chylothorax Clinical Pathway
   6. For additional considerations, please refer to the [JHACH Parenteral Nutrition Guidelines](#) or consult with unit dietician
**Enteral Nutrition in Neonates with Congenital Heart Disease:**

**Pre-operative Optimized Nutrition Clinical Pathway**

**Parameters for enteral feeds:**
- Start enteral feeds once:
  - No evidence of end organ ischemia
  - Lactate <3, pH >7.3
  - Epinephrine infusion ≤0.05 mcg/kg/min
  - No anticipated hemodynamic instability
- Allow PO/bolus NG feeds:
  - Non-invasive respiratory support <2 L/kg
  - RR <80 bpm
- Hold feeds if:
  - >2 large volume emesis in 12 hr
  - Worsening abdominal distension/exam
  - Bloody stools
- If feeds held:
  - Re-evaluate in 1 hour; return to prior step when tolerating
  - If worsening abdominal distention/blood stools, obtain KUB to evaluate for NEC

Patients ≥35 weeks corrected GA, ≥2 kg
with Biventricle or Single Ventricle physiology:

**Does patient require surgery immediately?**

**PO ad lib**
- Insert NG for enteral feeds* if poor PO intake

**Ductal Dependent?**

- **Yes**
  - Is ductal dependency for systemic or pulmonary blood flow?
  - Pulmonary blood flow
  - Systemic blood flow

**PO ad lib until repair**
- Insert NG for enteral feeds* if poor PO intake

**Day 0:**
- **Start PO feeds 20 mL/kg/day divided q3h + full TPN**

**Day 1:**
- **Advance PO by 20-40 mL/kg/day with each feed to max 100 mL/kg/day; adjust TPN until repair**
- **Insert NG for enteral feeds* if poor PO intake**
Johns Hopkins All Children's Hospital

Enteral Nutrition in Neonates with Congenital Heart Disease:
Post-operative Optimized Nutrition Clinical Pathway

Additional Guidance:
- Goal volume/kcal:
  - 140 mL/kg/day or 120 mL/kg/day if intubated
  - Minimum 120 kcal/kg/day
- Hold feeds if:
  - >2 large volume emesis in <12 hr
  - Worsening abdominal distension/exam
  - Bloody stools
- If feeds held:
  - Re-evaluate in 1 hour and return to prior step that was being tolerated
  - If worsening abdominal distension/bloody stools, obtain KUB to evaluate for NEC

Patients ≥35 weeks corrected GA, ≥2 kg with Biventricle or Single Ventricle physiology and post-operative repair

Does patient meet criteria for enteral feeds?
- No evidence of end-organ ischemia
- Lactate <3, pH >7.3
- Epinephrine infusion ≤0.05 mcg/kg/min
- No anticipated hemodynamic instability

Does patient meet criteria for PO bolus/NG feed?
- Non-invasive respiratory support <2 L/kg flow
- RR <80 bpm
- No clinical concern for aspiration
- Speech consult in patient with arch repair/reconstruction

Low-risk

Day 0
Start 20 mL/kg/day div q3h PO or bolus NG feeds, advance by 1 mL/kg/hr (3 mL/kg if bolus feeds q3h) every 6 hrs + TPN with weans to keep TF at goal (round to nearest whole number)

Day 1
Increase by 1 mL/kg/hr every 6 hrs towards goal; fortification to 24 kcal/oz once at 80 mL/kg/day if needed

ADVANCEMENT PLAN:
- Day 2
  - Increase by 1 mL/kg/hr (3 mL/kg if bolus feeds q3h) every 6 hr toward goal; begin fortification to 24 kcal/oz once at 80 mL/kg/day; wean TPN to keep TF at goal (Continuous reassess if patient meets PO bolus/NG feed criteria)
  - Day 3
    - Continue to advance every 6 hr to goal; can fortify further if needed (Continuously reassess if patient meets PO bolus/NG feed criteria)

High-risk

Day 0
Start 20 mL/kg/day continuous feeds, advance by 1 mL/kg/hr every 6 hrs via NG/ND tube + TPN with weans to keep TF at goal (round to nearest whole number)

Day 1
Start 20 mL/kg/day div q3hrs via PO or bolus NG for 24 hrs + full TPN (round to nearest whole number)

ADVANCEMENT PLAN:
- Day 2
  - Start 20 mL/kg/day continuous feeds for 24 hrs via NG/ND tube + full TPN (round to nearest whole number)
  - Daily reassess: does patient meet PO bolus/NG feed criteria?

References


### Outcome Measures:

- **Outcome measure:** Time to full enteral nutrition, time to fortification
- **Process measure:** Adherence to feeding guidelines
- **Balancing measure:** Incidence of NEC

### Clinical Pathway Team

**Heart Center: Enteral Nutrition in Neonates with Congenital Heart Disease Clinical Pathway**

*Johns Hopkins All Children’s Hospital*

**Owner(s):** Reema Patel MD; Michelle Smith, MD

**Also Reviewed by:** Heart Institute Clinical Practice Council
- **Specialists:** Courtney Hogan, MD (Cardiology)
- **Pharmacist:** Amy Kiskaddon, PharmD
- **Johns Hopkins Children’s Center Team:**
- **Others:** Kadie Swaney, RD; Nicole Adams, PA, LouAnn Smith, ARNP

**Clinical Pathway Management Team:** Joseph Perno, MD; Courtney Titus, PA-C

**Date Approved by JHACH Heart Institute Clinical Practice Council:** September 20, 2021

**Date Available on Webpage:** 11/11/2021

**Last Revised:** November 9, 2021

---

### Disclaimer

*Clinical Pathways are intended to assist physicians, physician assistants, nurse practitioners and other health care providers in clinical decision-making by describing a range of generally acceptable approaches for the diagnosis, management, or prevention of specific diseases or conditions. The ultimate judgment regarding care of a particular patient must be made by the physician in light of the individual circumstances presented by the patient.*

*The information and guidelines are provided “AS IS” without warranty, express or implied, and Johns Hopkins All Children’s Hospital, Inc. hereby excludes all implied warranties of merchantability and fitness for a particular use or purpose with respect to the information. Johns Hopkins All Children’s Hospital, Inc. shall not be liable for direct, indirect, special, incidental or consequential damages related to the user's decision to use the information contained herein.*