JOHNS HOPKINS ALL CHILDREN'S HOSPITAL
MATERNAL, FETAL, AND NEONATAL INSTITUTE

NICU Home Nasogastric Tube Feeding Clinical Pathway

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All Children's Hospital

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Updated: February 23, 2026
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Rationale:

This clinical pathway was developed through a multidisciplinary group consensus to establish the management of home nasogastric (NG) tube feedings for infants currently admitted to the Johns Hopkins All Children's Hospital (JHACH) Neonatal Intensive Care Unit (NICU). It addresses the following:

1. Inclusion and exclusion criteria for home NG tube use
2. Mandatory education and training for the family prior to the infant being discharged on home NG tube feedings
3. Outpatient follow-up with the Feeding Enhancement and Development (FEED) Clinic
4. Duration of time the nasogastric tube can be maintained until a gastrostomy tube (GT) needs to be placed

Background:

Extremely premature infants can achieve full oral feeding around 36 weeks corrected gestational age (CGA) (Jadcherla, 2010). However, the NICU is replete of infants who are stable but have not achieved independent oral feeding. This delayed acquisition of oral feeding skills necessary for maintaining hydration and growth leads to increased length of stay and added stress for families. Up to 3.1% of infants ≤32 weeks gestational age (GA) at birth require either a nasogastric tube or a surgically placed GT at discharge due to inadequate oral feeding skills (Alshaikh, 2022). Extremely low birth weight infants are at even higher risk of oral feeding failure, with 7.3% requiring surgically placed GT (Warren, 2019). Maintaining a GT costs $46,000 per year and approximately $180,000 over five years (Gulati, 2020; Jadcherla, 2016) 2020). In addition to this financial and psychosocial burden, a GT is an independent risk factor for worse neurodevelopmental outcomes; infants with GTs have lower Cognitive Bailey III Scores than those without, even after controlling for comorbidities such as prematurity, neurological injury, and bronchopulmonary dysplasia (Jadcherla, 2017).

Safety:
While it is still common practice to place GTs in infants who have otherwise met discharge criteria but are unable to eat adequate volume by mouth, there is increasing data to support the safety and efficacy of using NG tubes for home in a select population of neonates as a bridge to home while they work on acquiring independent oral feeding skills (Lagatta, 2021; Williams, 2020). Both GT and NG tube placement have their own risk profiles. GT placement is a surgical procedure with risks associated with anesthesia, infection, leakage, wound healing problems, dislodgement, perforation, and death (Khalil, 2017; Williams, 2019). NG tubes are also at risk for dislodgement.

Repeated NG tube placement can lead to trauma and feeding aversion. In comparing the safety profile of a GT versus the NG tube, Khalil et al. (2017) reported that infants discharged with GTs had significantly higher tube-related emergency department (ED) visits (33.6%) than those discharged with NG tubes (9.5%; $p<0.01$). The reasons for those 115 ED visits are as follows:

Tube-Related Complications Evaluated in the Emergency Department		
Enteral Tube and Complication		Frequency
NG tube:		
	Concerns for aspiration	3
	BRUE*	2
	Inadvertent removal	1
	Tube misplacement	1
	Constant fussiness	1
GT:		
	inadvertent removal/misplacement	45
	Broken/malfunctioning tube	17
	GT site issues	
	Leakage of around GT	7
	Site bleeding	5
	Skin irritation	4
	Granulation	1
	Enlarge the stoma site	1
Infection:		
	Cellulitis	9
	Purulent discharge	2
	Peristomal abscess	1
BRUE*		6
Aspiration pneumonia		3
Constant fussiness		1
Vomiting		1
Gastroesophageal reflux		1
Gastric outlet obstruction		1
Visceral perforation		1
Enterocutaneous fistula		1

*BRUE, brief resolved unexpected event. Adapted from Khalili (2017).

Infants with concerns for aspiration in both groups did not require intubation. There were two deaths in the GT group, which resulted from duodenal perforation and gastric outlet obstruction.

- In examining emergency room (ER) visits between the two populations, Khalil et al. (2017) noted that 9.2% of infants with GTs had more than one ER visit related to their feeding tube. In contrast, none of the infants with NG tubes required more than one ER visit.
- Unscheduled gastrointestinal (GI), tube-related readmission, and ED encounters were higher in the GT group (34%) than in the NG tube group (11%), $p<0.01$ (Lagatta, 2021).
    - In addition, they also reported that infants who were discharged with an NG tube had similar rates of unplanned GI or tube-related readmission as those who were

discharged on full oral feeds (NG, 6%; oral feeding 1%, adjusted OR 0.39 [0.02-7.78]; p = 0.540).

- Infants discharged on nasogastric tube feeds had similar healthcare encounters after discharge as infants discharged on full oral feeds (Lagatta, 2021).

Growth:

In comparing the growth parameters of those who stayed in the NICU for nutritional support via NG tube versus those supported at home via NG tube, Kamden et al. (2019) found no significant difference in growth at 3 months corrected age. Williams et al. (2020) showed that growth was not significantly different between infants sent home with GT versus NG tubes at 44 weeks CGA, discharge, and 12 months corrected age. Embarth et al. (2020) showed that weight-for-length standardized scores (z-scores) within 6 months post-discharge from the NICU did not differ between those who were weaned off the NG tube versus those who could not be weaned (-0.06 [IQR -0.82, 0.88], p=0.08). It is important to note that eight out of the nine infants who required hospital admission from this cohort were admitted due to concerns for malnutrition and required <72 hours of inpatient care.

Parental Satisfaction:

Kamden et al. (2019) also reported that parents who went home with NG tube feeds felt it was safe and would do it again. In addition, when babies are discharged earlier from the NICU, Kamden reports reduced parental stress, leading to improved psychological well-being and bonding with their child.

Criteria:

The criteria for home NG tube feedings vary across institutions. Shared characteristics across different programs for infants who qualified for home NG tube feedings were deemed safe for oral feeding and:

- were clinically stable in unassisted room air
- did not have apnea or bradycardia events for five days
- off caffeine
- had no other need for inpatient NICU care

Infants were evaluated (GI, Neonatology, Feeding Team) prior to discharge to make sure they met the eligibility criteria (Khalil, 2017; Lagatta, 2021; Williams, 2020).

Table 1: Summary of NG Tube Programs:

Author	GA at discharge (wks)	Weight (kg)	Minimum % oral feeding volume	Outpatient follow-up	Full oral feeds achieved (days)	Conversion of the NG tube to GT after discharge)
Williams, 2019	----	----	50	----	60	1-2 months
Khalil, 2017	42.6 (40.5-45.7) NG, 45.8 (43.9 – 49.7) GT	----	≤ 25	1st 2-3 weeks	30 (IQR 15-61)	67 days (IQR 40-90)
Kampen, 2019	----	----	----	Weekly home visits by an RN	9	----
Lagatta, 2021	36 wks	2	≤ 25	----	29	3 months
Schuler, 2020	35.4 wks	----	> 50	Within 1 week	8	----
Embarth	>37	----	"Stable feeding method"	----	27 (IQR 8, 79)	123 days (IQR 84, 164)

Abbreviations: IQR = Interquartile Range; RN = Registered Nurse; wks = weeks

All the above groups required adequate resources for follow-up, family education, and training. The programs in the United States were all followed by an interdisciplinary team after discharge. Follow-up outpatient visits ranged from weekly home visits (Kampen, 2019) to 2-3 weeks (Khalil, 2017). For after-hours needs, some programs had parents contact the NICU (Kampen, 2019).

- Exclusion criteria for home NG tube feeding (Kampen, 2019; Khalil, 2017; Williams, 2019):
  - discharged to hospice/palliative care
  - total parenteral nutrition
  - gastro-jejunostomy tube feed
  - congenital anomalies interfering with oral feeding
  - tracheoesophageal fistula

Feeding Outcomes:

Full oral feeds have been achieved as early as 9 days to 30-60 days after NICU discharge, with NG tube feedings (Kampen, 2019; Khalil, 2017; Williams, 2019).

- Infants who were born at a younger GA required home NG tube feeds longer, with those born at 24-29 weeks GA requiring NG tube feeding for a median of 23 days after discharge, compared to only 7 days for those who were born at 34-36 weeks GA.
- When comparing the attainment of full oral feeds at 6 months after discharge, 71.4% of those who were discharged on NG tube feedings attained full oral feeds, while only

19.3% of infants discharged with GT feedings achieved full oral feeds (Khalil, 2017). The median time to full oral feeds was 30 days for those fed via NG tube, compared with 70 days for those who were fed via GT.
- When follow-up is extended to 12 months after discharge, Williams et al. (2020) noted that 65% of infants discharged on GT feeds still required tube feedings, whereas only 24% of infants discharged on NG tube feeds required tube feedings.

Gastrostomy tube placement was recommended if the infant had not reached full oral feeds between 1 and 3 months after home NG tube feeds (Khalil, 2017; Williams, 2019). The longest reported time interval for conversion from NG tube to GT is 123 days (Embarth, 2020).

Clinical Management:

The primary medical team and the FEED Team will determine suitable candidates for the home nasogastric tube feeding program. Of note, this clinical guideline is only applicable to infants working on oral skills, not to those who will be discharged home for palliative care.

Inclusion Criteria:
- ≥38 weeks corrected gestational age
- The only reason for the continued need for hospital admission is the attainment of full oral feeds
- in unassisted room air for a minimum of 7 days
- no changes to diuretic dosing for a minimum of 7 days
- no apnea, bradycardia, desaturation (A/B/D) events for at least 5 days
- ≥ 2 kilograms (kg) at discharge
- minimum 50% by mouth (PO) with Infant Driven Feeding (IDF) readiness scores of 1-2, 50% of the time, and no significant improvement in oral feeding intake in the last 7 days
- tolerating bolus feeds (maximum of 45 minutes for pump infusion time)
- appropriate growth trajectory (minimum 25 grams [g] to 35 g per day)
- if concern for aspiration, oropharyngeal motility study (OPMS) must be performed prior to discharge to determine a safe oral feeding strategy

Exclusion Criteria:
- craniofacial abnormalities not allowing nasogastric tube placement
- intestinal rehabilitation team (IRT) patients
- aspiration, preventing safe oral feeding
- palliative care patients
- inability of caregiver(s) to provide NG feeds safely in the outpatient setting. Examples may include, but are not limited to:
    - Cognitive, developmental, or health-related factors of the caregiver(s) that may affect the ability to safely manage NG feeds despite education and support
    - Ongoing difficulty demonstrating safe NG feeding skills during hospitalization despite education, coaching, and support
- receiving any respiratory support

- changes to diuretic therapy ≤ 7 days prior to discharge

Family Inclusion Criteria:

- family/caretaker has been involved with the infant's oral feeding while in the NICU
- complete education and demonstrate competency in placing and using the NG tube
- two independent successful NG tube placements on the baby by the family member/caregiver
- two family members/caregivers must be able to room-in for a minimum of 24 hours prior to discharge
- reliable transportation to attend every scheduled FEED Clinic appointment
- ability to obtain all medical and equipment supplies

Education, Training, and Home Planning:

- Once the patient has been identified as an eligible candidate, education, training, supply acquisition, and discharge preparation will be initiated.
- The primary team will discuss the inclusion and exclusion criteria for the home NG tube feeding program through the FEED Clinic with the family. The requirement for rigorous close outpatient follow-up will be discussed, as will the criteria for surgically placing a gastrostomy tube if the patient's oral feeding still does not improve within 3 months of discharge from the JHACH NICU. This information will be reinforced with the FEED Team consult.
- Two family members/caretakers will watch the following GetWell Network videos:
    - NG Tube: The Basics
    - NG Tube: Feeding and Giving Medicine
    - NG Tube: How to Place Safely
    - NG Tube: Troubleshooting
- Case Management will start the Durable Medical Equipment (DME) process as EARLY as possible. Home supplies include (as approved by the insurance company):

    - feeding pump
    - nasogastric tube x 2
    - 12 - 60 cc syringes per month
    - 10 Duoderm per month
    - 10 Hypafix per month
    - 5 Surgilube packets per month
    - securement tape
    - permanent marker

- The designated RN Champion will complete education with the family using the standardized Discharge Education Guide: JHACH NICU Home Nasogastric Tube Insertion**.** This teaching tool discusses how to insert the NG tube, verify its position, troubleshoot the NG tube, and the necessary steps if problems are encountered at home.

- After the identified family members/caregivers have completed the education, they will both need to successfully insert an NG tube on the mannequin for hands-on training.
- Both family members/caregivers must successfully insert the NG tube and confirm placement on their infant twice before discharge. One of these insertions must occur once before rooming-in.
- Rooming-in for a minimum of 24 hours will be required and will occur AFTER home equipment and supplies have been delivered, and all of the teaching has been completed.
- As part of the education and training, the family will be instructed to stop feeds, remove the NG tube, and call their health care provider if:

    - The skin around the tube site has redness, swelling, leaking fluid, pus, or sores.
    - They see blood around the tube, in the infant's stool, or in the contents of the stomach.
    - The infant coughs, chokes, or vomits while feeding.
    - The infant is vomiting between feedings.
    - The infant's abdomen looks bloated or feels hard when gently pressed/
    - The infant has diarrhea or constipation.
    - The infant has a fever 100.4°F (38°C) or higher, or as directed by the infant's healthcare provider
    - If the infant is unresponsive, turns blue, or has trouble breathing, parents should call 911 immediately.
- The primary NICU team will call the primary care provider (PCP) to give a sign-out about the home nasogastric tube before discharge.

Emergency Center Management:

- If the NG tube becomes dislodged, the family member/caregiver can reinsert it. If, after three attempts, the NG tube reinsertion is unsuccessful, the infant should be taken to the Johns Hopkins All Children's Emergency Center (EC), where the NG tube will be replaced.
- The last known NG tube size will be documented in the most recent FEED Clinic note.

Readmission Management:

- If the infant requires readmission for feeding-related issues within 7 days of NICU discharge, the infant may be readmitted to the NICU.
    - If additional comorbidities are present, discuss the appropriate admission location with the neonatologist on call.
- If the infant was discharged from the NICU more than 7 days prior, admission should occur to the pediatric floor or Pediatric Intensive Care Unit (PICU), depending on clinical presentation and the level of medical management required.
- If the infant is admitted to any unit other than the NICU, consult the Feeding Enhancement and Development (FEED) Team by placing an order for "Consult to Feeding Enhancement and Development Team."

Outpatient Follow-up via the Infant FEED Clinic:

- Infants being discharged from the NICU with an NG tube for nutritional and oral feeding support will receive interdisciplinary outpatient care through the Neonatal FEED Clinic, which includes a Neonatologist, Speech-Language Pathologist (SLP), Registered Dietitian**,** and Lactation consultant.
- The first outpatient clinic follow-up will occur within 1 week after NICU discharge.
    - The family/caretakers should come to all outpatient follow-up appointments with the Infant Feeding Log.
    - There will be weekly follow-up with the interdisciplinary team for the first 2 weeks after discharge to monitor oral feeding progress and growth.
        - During these visits, NG tube placement will be checked with the family.
        - SLP will provide appropriate oral feeding interventions during these visits.
        - Nutrition will assess their growth.
    - The Feeding Team will determine subsequent outpatient follow-up after the first 2 weeks, depending on the infant's progress. The interval between visits may increase or remain the same as needed.

Pathway to NG Tube Removal:

- The nasogastric tube will be removed once the infant is taking at least 90% of the feeding volume for three consecutive days.
    - After NG tube removal, the infant will be seen in the FEED Clinic for outpatient feeding follow-up to monitor growth following transition to full oral feeds (approximately 1 week).
    - SLP follow-up will continue outpatient through the SLP Clinic until the patient has been discharged from the SLP Clinic.
- If the infant has not met criteria for NG tube removal 3 months after NICU discharge, the infant will be referred to Pediatric Gastroenterology for percutaneous GT placement.
    - At this point, the patient will be discharged from the FEED Clinic.
    - SLP follow-up will continue via the SLP Clinic.

Summary:

The NICU is replete with stable infants who are only admitted to the NICU because they have not mastered the complex mechanism of successful oral feeding. According to the literature reviewed, a particular group of neonates who meet the criteria can successfully work on oral feeding at home. We have highlighted data showing that babies discharged from the NICU with an NG tube rather than a GT have fewer complications, leading to fewer ER visits and hospital readmissions. Their growth is also not inferior to that of those who have been discharged from the NICU on full oral feeds. As such, it is our consensus that babies who meet our established criteria above may be discharged from the NICU with an NG tube, with close follow-up by our interdisciplinary Neonatal FEED Team.

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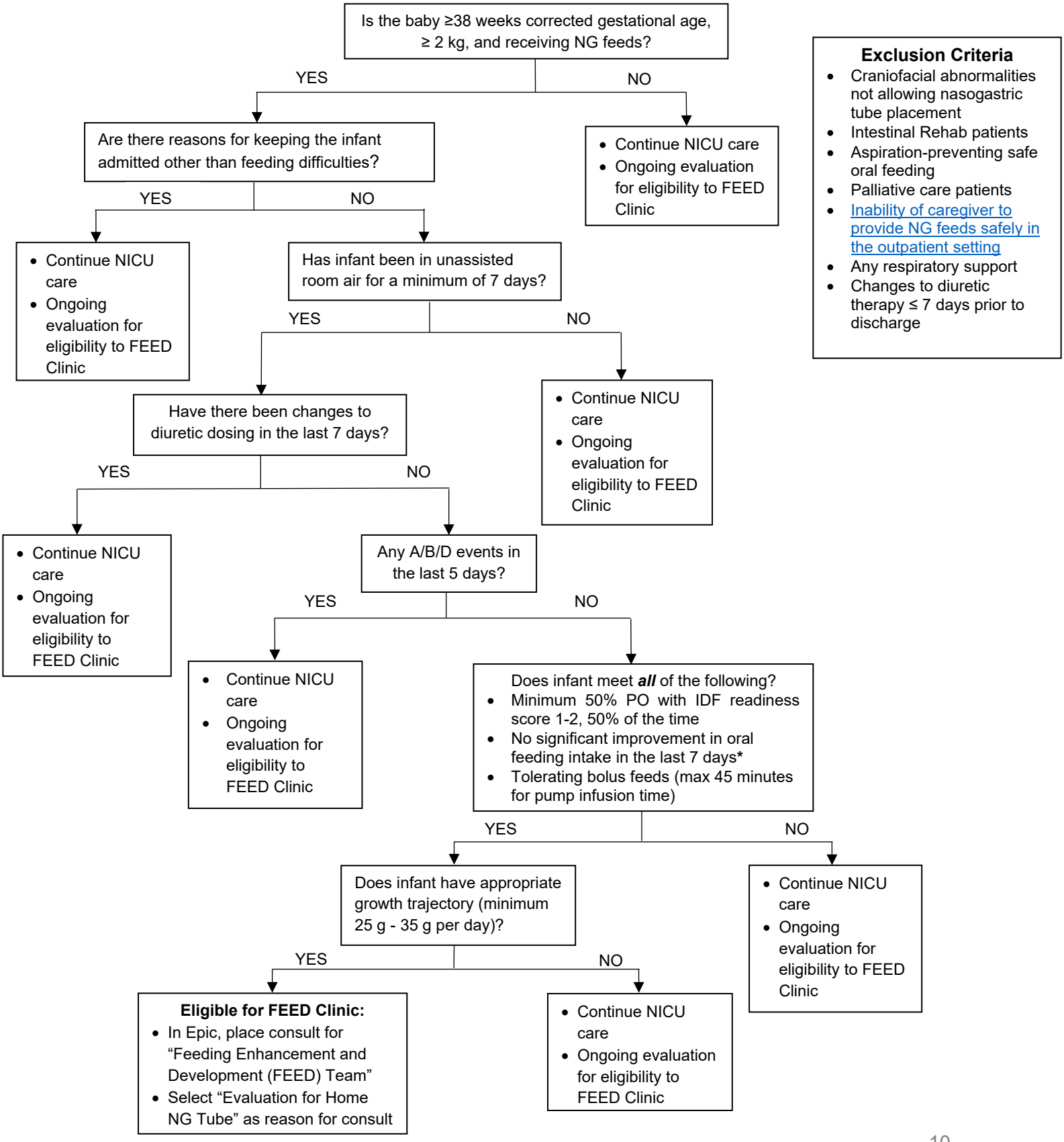
Maternal, Fetal, and Neonatal Institute

Inpatient NICU Home Nasogastric Tube Feeding Algorithm



Exclusion Criteria

- Craniofacial abnormalities not allowing nasogastric tube placement
- Intestinal Rehab patients
- Aspiration-preventing safe oral feeding
- Palliative care patients
- Inability of caregiver to provide NG feeds safely in the outpatient setting
- Any respiratory support
- Changes to diuretic therapy ≤ 7 days prior to discharge

*If concern for aspiration, OPMS must be performed prior to discharge to determine a safe oral feeding strategy.

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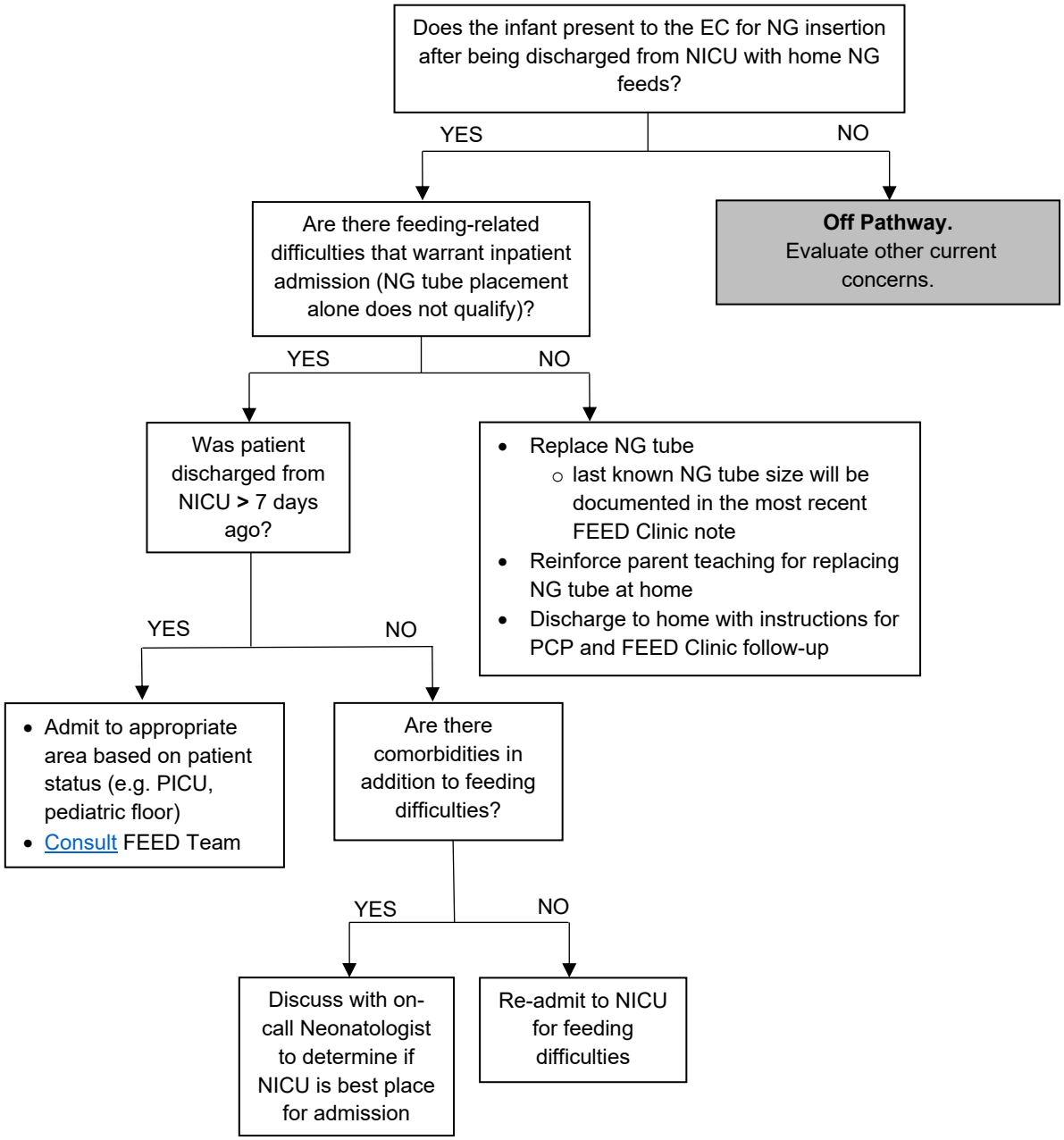
Emergency Center NICU Home Nasogastric Tube Feeding Algorithm



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Outcome Measures:

- number of outpatient visits
- growth
- number of NG tube replacements
- duration of NG tube feeding
- GT conversions
- adverse events
- number of ER or urgent care visits
- hospital readmissions
- family satisfaction with discharge education

Clinical Pathway Team

NICU Home Nasogastric Tube Feeding Clinical Pathway

Johns Hopkins All Children's Hospital
Maternal, Fetal, and Neonatal Institute

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Date Approved by MFNI Clinical Practice Council: December 2, 2025

Date Approved by MFNI Clinical Pathways: December 11, 2025

Date Approved by Clinical Pathway Development Committee (CPDC): February 3, 2026

Date Approved by JHACH Clinical Practice Council: February 18, 2026

Content Last Revised: February 11, 2026

Date Available on Webpage: February 23, 2026

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 diagnosing, managing, or preventing specific diseases or conditions. The physician must make the ultimate judgment regarding the care of a particular patient in light of the patient's individual circumstances.

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