Feeding Issues and BPD (NG vs NJ, GT Timing)

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48th Annual AAP District VIII Section on Neonatal-Perinatal Medicine Conference

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@mjkielt

Disclosures

- None

Objectives

- Review epidemiology and pathogenesis of disordered feeding in infants with bronchopulmonary dysplasia (**BPD**).
- Compare the risks and benefits of nasogastric (**NG**) vs nasojejunal (**NJ**) feeds in infants with BPD.
- Identify knowledge gaps in determination of “optimal” feeding disposition at discharge for infants with BPD.

Normal Infant Feeding

- **Phase-Based**
  - Oral Phase
  - Pharyngo-Esophageal Phase
  - Gastric/Intestinal Phase
- **Requires multi-organ system coordination**
  - Gastrointestinal (GI)
  - Neurologic
  - Respiratory
  - Cardiac

Hasenstab and Jadcherla, Clin Perinatol 2022

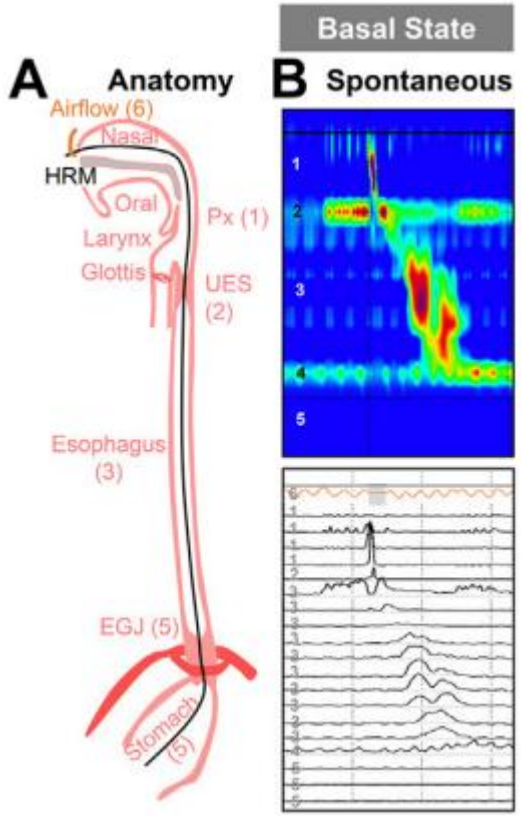
Oral Phase

- Sucking function
  - Muscles: orbicularis oris, buccinators, the medial and lateral pterygoid, masseter, temporalis, mentalis, and intrinsic muscles of the tongue
  - Nerves: CN V, VII, XII, IX, and X
- Sucking Process
  - Latch with cheeks
  - Tongue press to palate
  - Pulling of cheeks to generate rhythmic sucking
  - Lingual propulsion of bolus toward pharynx

The Virgin of the Green Cushion
Andrea Solario
Circa 1507 – 1510
Musée de Louvre

Pharyngo-Esophageal Phase

- Swallow patterns
  - Primary peristalsis (voluntary)
    - Bolus propulsion via pharyngeal peristalsis along with a brief (<2 second) deglutition apnea, upper esophageal sphincter relaxation, esophageal peristalsis, and gastroesophageal junction relaxation
  - Secondary peristalsis (involuntary)
    - UES contraction, esophageal peristalsis, and GEJ relaxation



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Gastric/Intestinal Phase

- Gastric
  - Receptive relaxation, contraction of LES, contraction of pyloric sphincter, mixing during gastric digestion, relaxation of pyloric sphincter followed by gastric contraction
- Intestinal
  - Persistent motility
  - Modified by nutritional content of feeds

Hasenstab and Jadcherla, Clin Perinatol 2022

Normal Feeding Milestones

Milestone	Definition	On-Time Target
Trophic	Minute volumes of enteral tube feeding for gut priming	10-20 ml/kg/d within 3d of admission
Full enteral	Sufficient gastrointestinal tract feeding volume via tube feeding as a primary source of nutrition	Enteral gavage feeding of at least 120 ml/kg/d by 2-4 weeks of life
First oral	First oral offering	~33-34 weeks' PMA based on infant cues
Full oral	Sustained oral intake of at least 120 ml/kg/d	~36-38 weeks PMA and/or hospital discharge at >150 ml/kg/d
Ad lib oral	Oral feeding whenever infant exhibits readiness cues	Full-term PMA and/or hospital discharge >150 ml/kg/d

Hasenstab and Jadcherla, Clin Perinatol 2022

What Are Feeding Issues?

- Troublesome symptoms or inadequate oral intake during infant feeding

- Infant feeding – any aspect of the feeding process between the parent/caregiver and infant
  - Parent/provider: preparation, administration
  - Infant: feeding skills

Hasenstab and Jadcherla, Clin Perinatol 2022

Signs of Feeding Issues in Preterm Infants

Phase	Symptoms
Oral	Drooling, pooling, poor bolus extraction, ineffective bolus transit, and potentially aspiration
Pharyngo-esophageal	Poor clearance or excessive secretions, achalasia, prolonged glottal closure (apnea and bradycardia)
Gastric/Intestinal	Reflux, residuals, feeding intolerance

Hasenstab and Jadcherla, Clin Perinatol 2022

Troublesome Feeding Symptoms May be Non-GI in Origin

- Tachypnea
- Apnea, bradycardia, and/or desaturation
- Excessive somnolence (“shut down”)
- Oral aversion

Hasenstab and Jadcherla, Clin Perinatol 2022

Pathologic Feeding Conditions

- Gastroesophageal reflux disease (GERD)
- Aspiration
- Dysphagia

Feeding Issues *Feel* Common in BPD

- Most (if not all) infants with BPD demonstrate “troublesome symptoms” during feeding
- All infants with BPD experience periods of “inadequate oral intake”

Anecdotal experience

Long-term Feeding Issues with Infants with BPD are Rare

- Only 7% of NRN cohort with GT (76% placed after discharge)
- Only 11% of infants with BPD in cohort with GT
- Severe BPD – 22% CHNC
- Grade 3 BPD – 45% BPD Collaborative

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Warren *et al.,* JPeds 2020
Grover *et al.,* Journal of Pediatric Surgery 2014
Cuevas Guaman *et al.,* JPerinatology 2021

Essential Question

- How do we manage “troublesome symptoms” while teaching infants with BPD how to feed?
  - Anticipatory feeding interventions
  - Feed delivery modifications
  - Diagnostic evaluations
  - Surgical interventions

Anticipatory Feeding Interventions

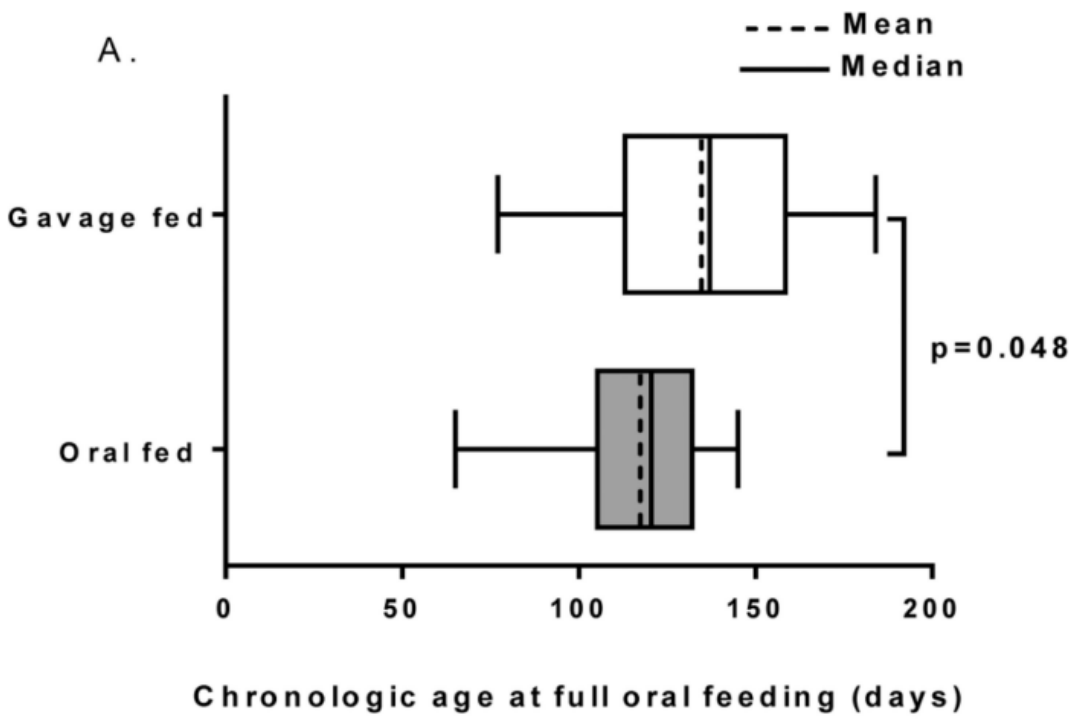
- Feeding on CPAP
- Cue-based feeds

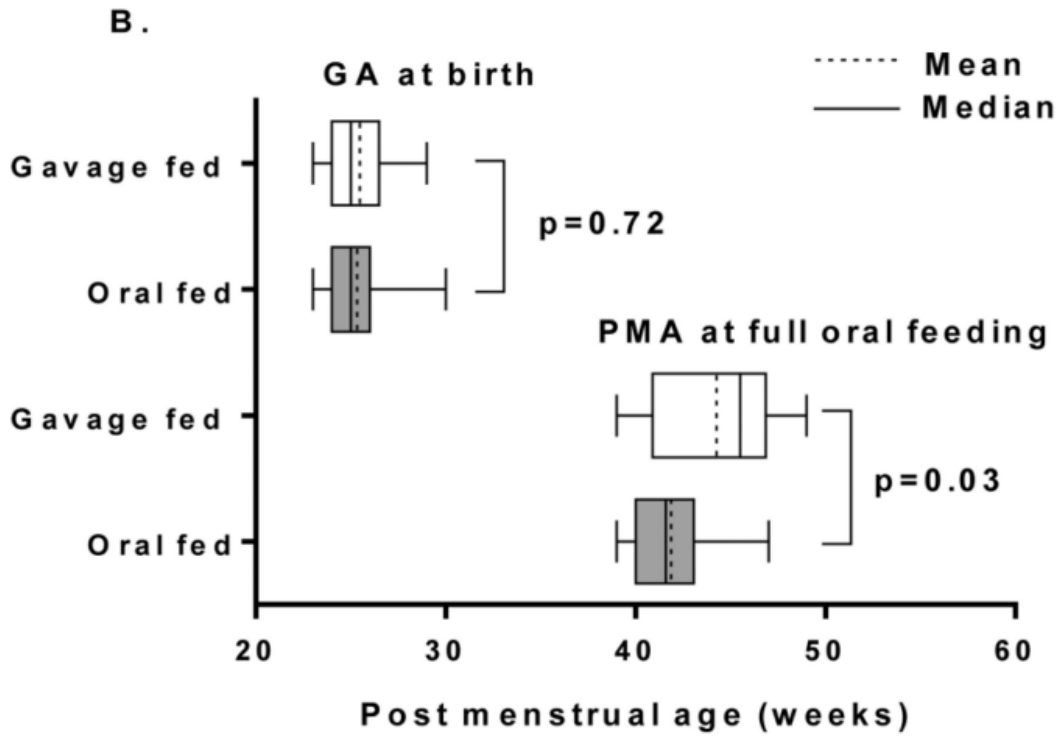
Feeding on CPAP is Likely Safe and Efficacious

- In N=26 infants orally fed on CPAP (n=218 feeding observations)
  - Apnea/bradycardia - 2.7%
  - Oxygen desaturation <90% - 11%
  - Tachypnea and/or retractions – 14%
- All subjects successfully weaned after 2 weeks of feeding

Hanin *et al.*, Dysphagia 2015

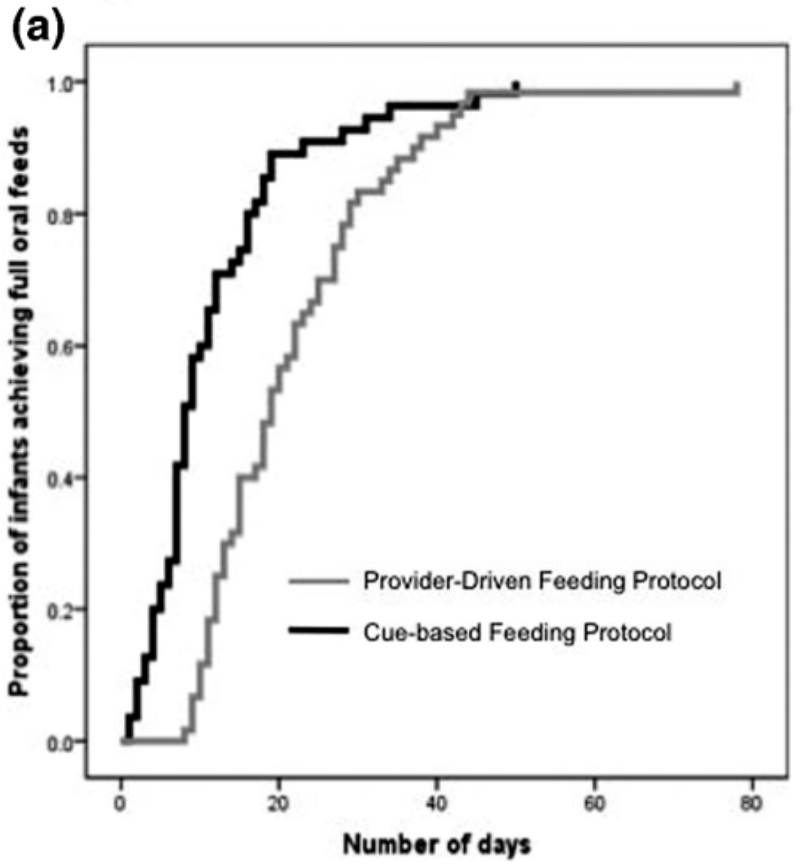
Feeding on CPAP is Likely Safe and Efficacious

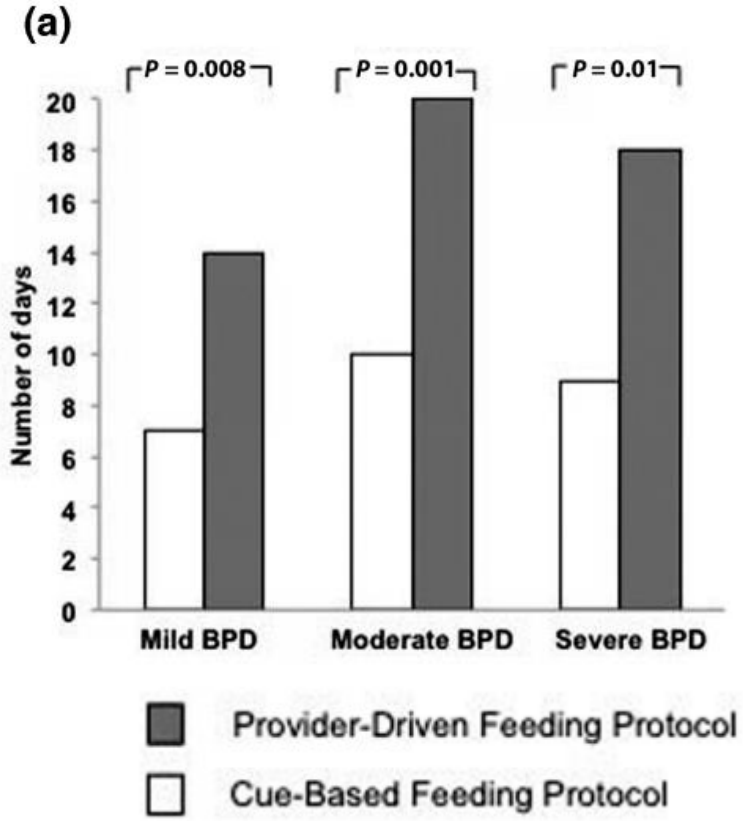




Hanin *et al.*, Dysphagia 2015

Infants with BPD Should Receive Cue-Based Feeds





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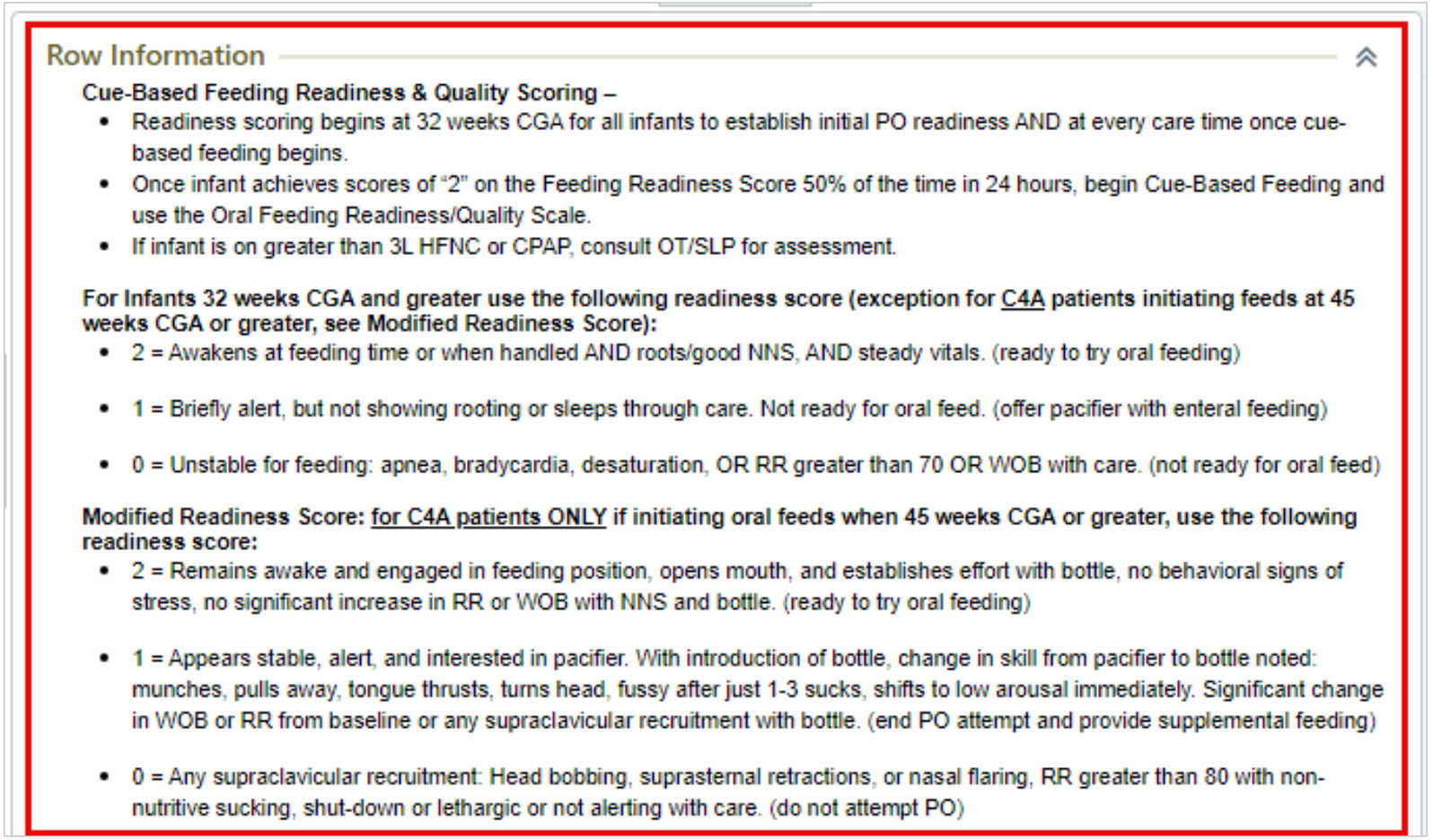
Davidson *et al.*, JOGNN 2013

NCH Feeding Readiness Scoring



Row Information

Cue-Based Feeding Readiness & Quality Scoring –

- Readiness scoring begins at 32 weeks CGA for all infants to establish initial PO readiness AND at every care time once cue-based feeding begins.
- Once infant achieves scores of "2" on the Feeding Readiness Score 50% of the time in 24 hours, begin Cue-Based Feeding and use the Oral Feeding Readiness/Quality Scale.
- If infant is on greater than 3L HFNC or CPAP, consult OT/SLP for assessment.

For Infants 32 weeks CGA and greater use the following readiness score (exception for C4A patients initiating feeds at 45 weeks CGA or greater, see Modified Readiness Score):

- 2 = Awakens at feeding time or when handled AND roots/good NNS, AND steady vitals. (ready to try oral feeding)
- 1 = Briefly alert, but not showing rooting or sleeps through care. Not ready for oral feed. (offer pacifier with enteral feeding)
- 0 = Unstable for feeding: apnea, bradycardia, desaturation, OR RR greater than 70 OR WOB with care. (not ready for oral feed)

Modified Readiness Score: for C4A patients ONLY if initiating oral feeds when 45 weeks CGA or greater, use the following readiness score:

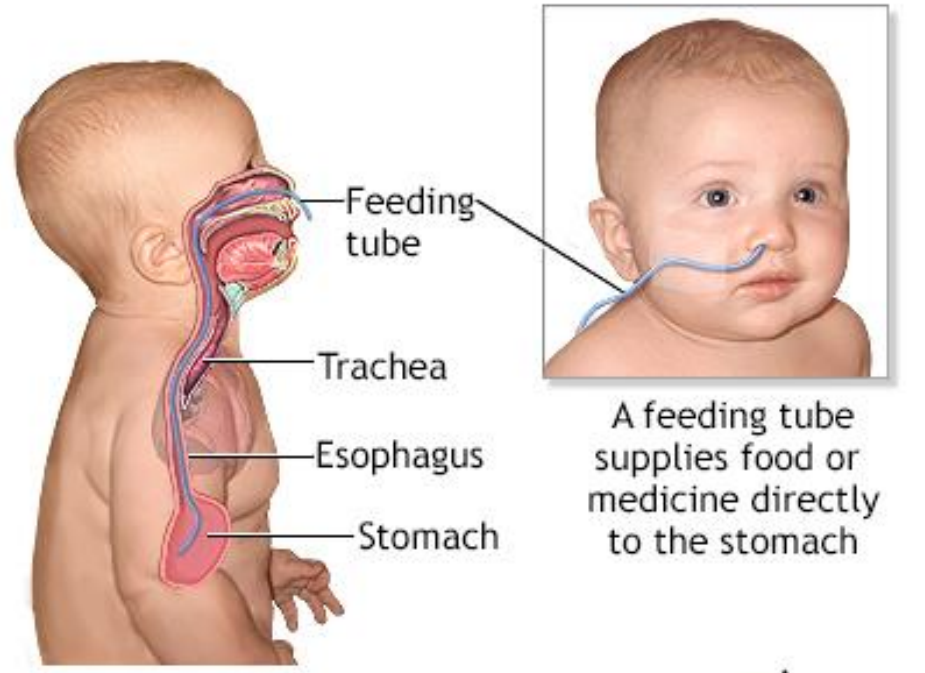
- 2 = Remains awake and engaged in feeding position, opens mouth, and establishes effort with bottle, no behavioral signs of stress, no significant increase in RR or WOB with NNS and bottle. (ready to try oral feeding)
- 1 = Appears stable, alert, and interested in pacifier. With introduction of bottle, change in skill from pacifier to bottle noted: munches, pulls away, tongue thrusts, turns head, fussy after just 1-3 sucks, shifts to low arousal immediately. Significant change in WOB or RR from baseline or any supraclavicular recruitment with bottle. (end PO attempt and provide supplemental feeding)
- 0 = Any supraclavicular recruitment: Head bobbing, suprasternal retractions, or nasal flaring, RR greater than 80 with non-nutritive sucking, shut-down or lethargic or not alerting with care. (do not attempt PO)

Feed Delivery Modifications

- Nasogastric (NG) feedings
- Nasojejunal (NJ) feeds
- Question: Does one mode more effectively reduce aerodigestive sequelae of gastoesophageal reflux disease (GERD)?

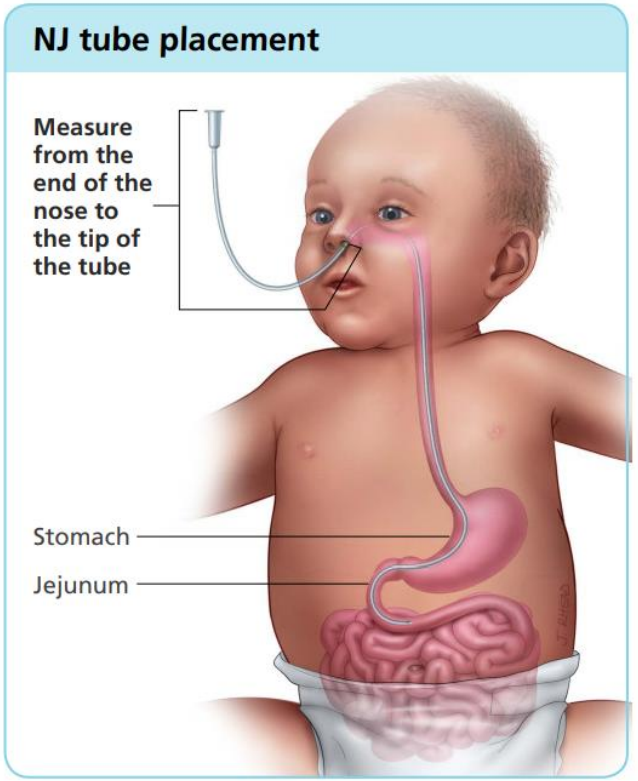
Rationale for NG Feedings

- Physiologic
- Provider ease
- Standard of care



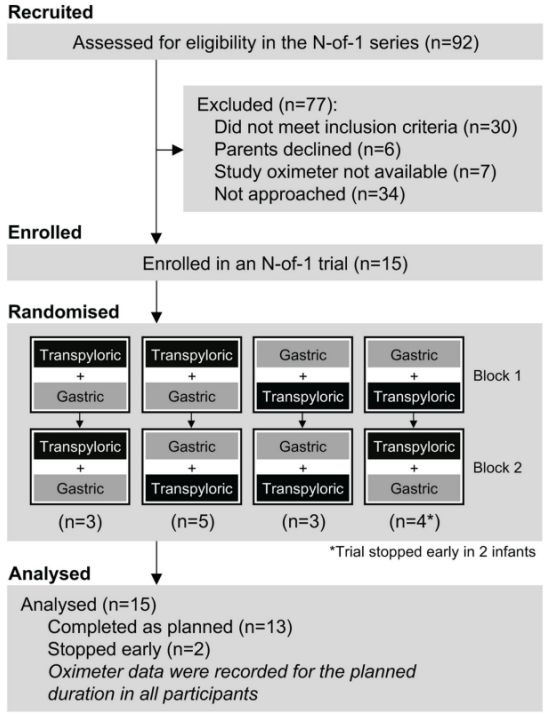
Rationale for NJ Feedings

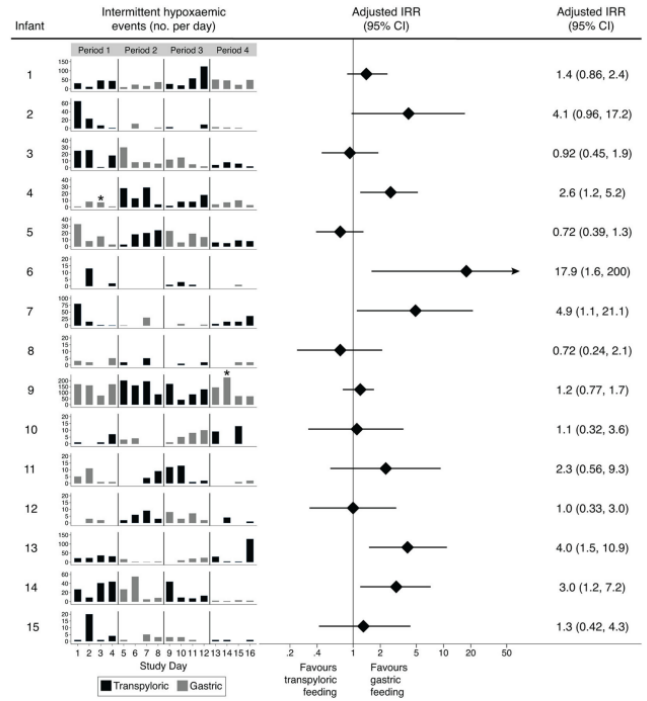
- Reduce risk of aspiration
- Avoid lung injury occurring secondary to acute-on-chronic aspiration

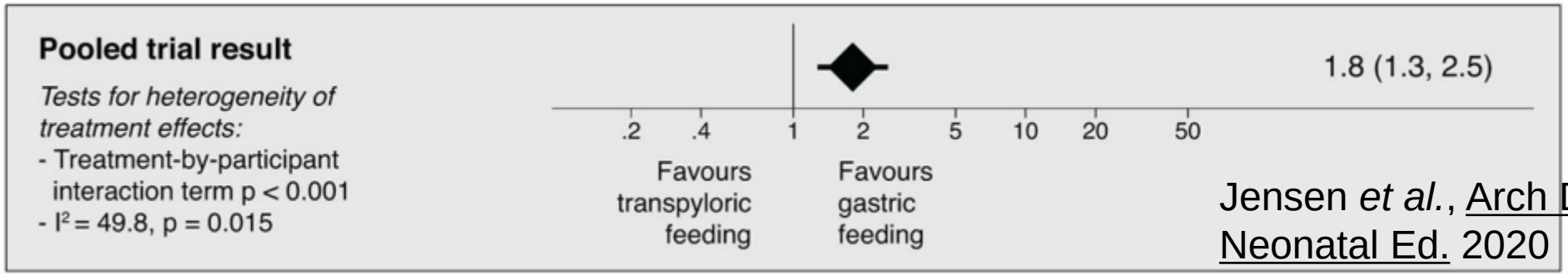


Intermountain Health/
Primary Children's Hospital

Hypoxemia Modestly Increases in NJ Feedings

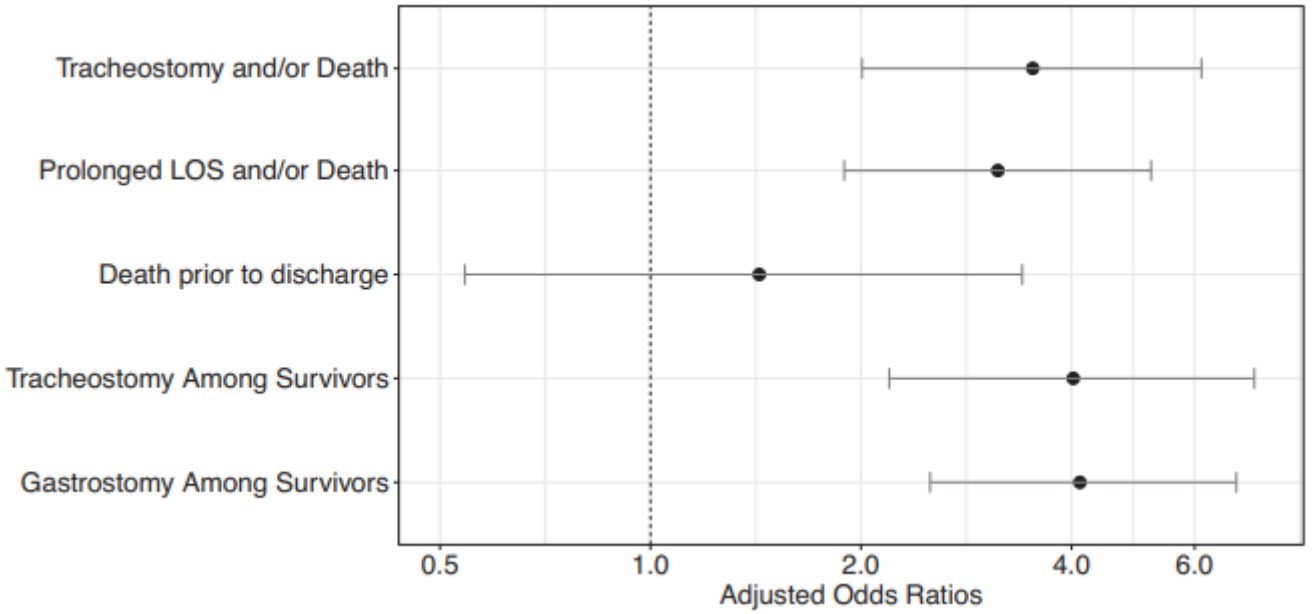






Jensen *et al.*, Arch Dis Child Fetal Neonatal Ed. 2020

NJ Feeds Associated with Unfavorable In-Hospital Outcomes



Levin *et al.*, JPerinatology 2024

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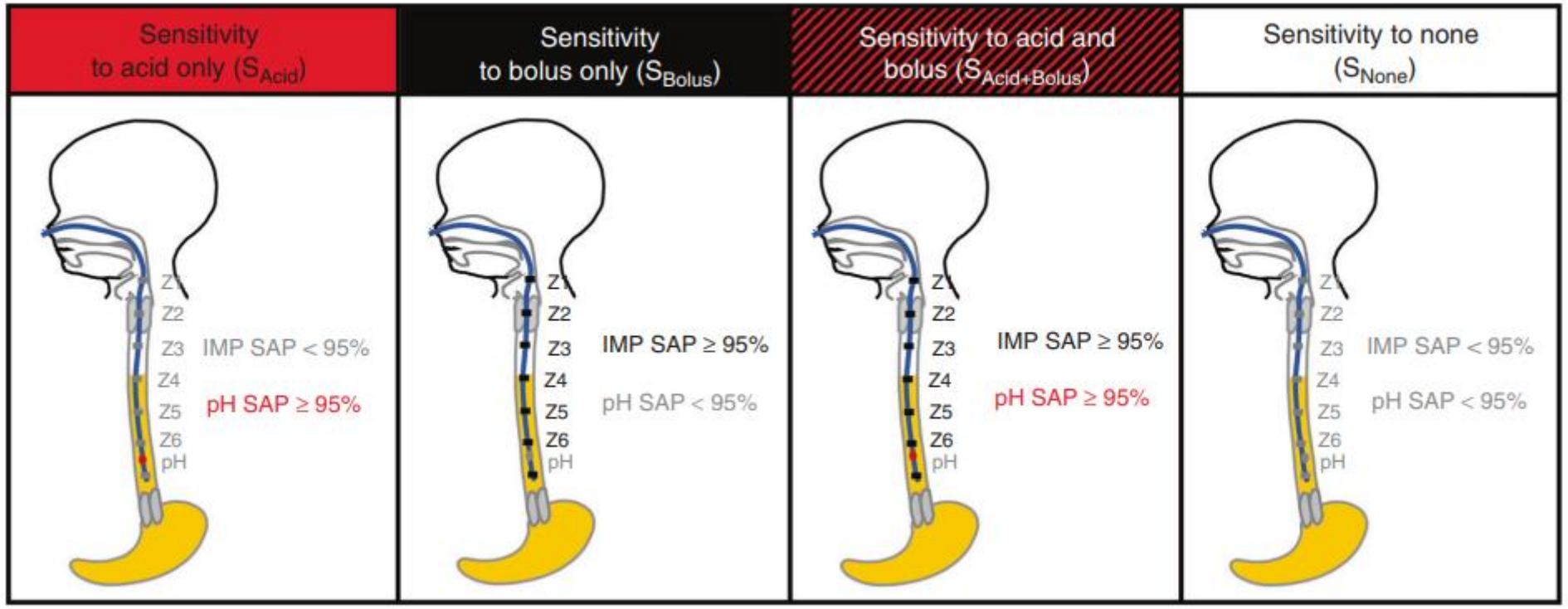
Diagnostic Evaluations

- pH Impedance
- Esophageal manometry
- Video swallow study

pH Impedance



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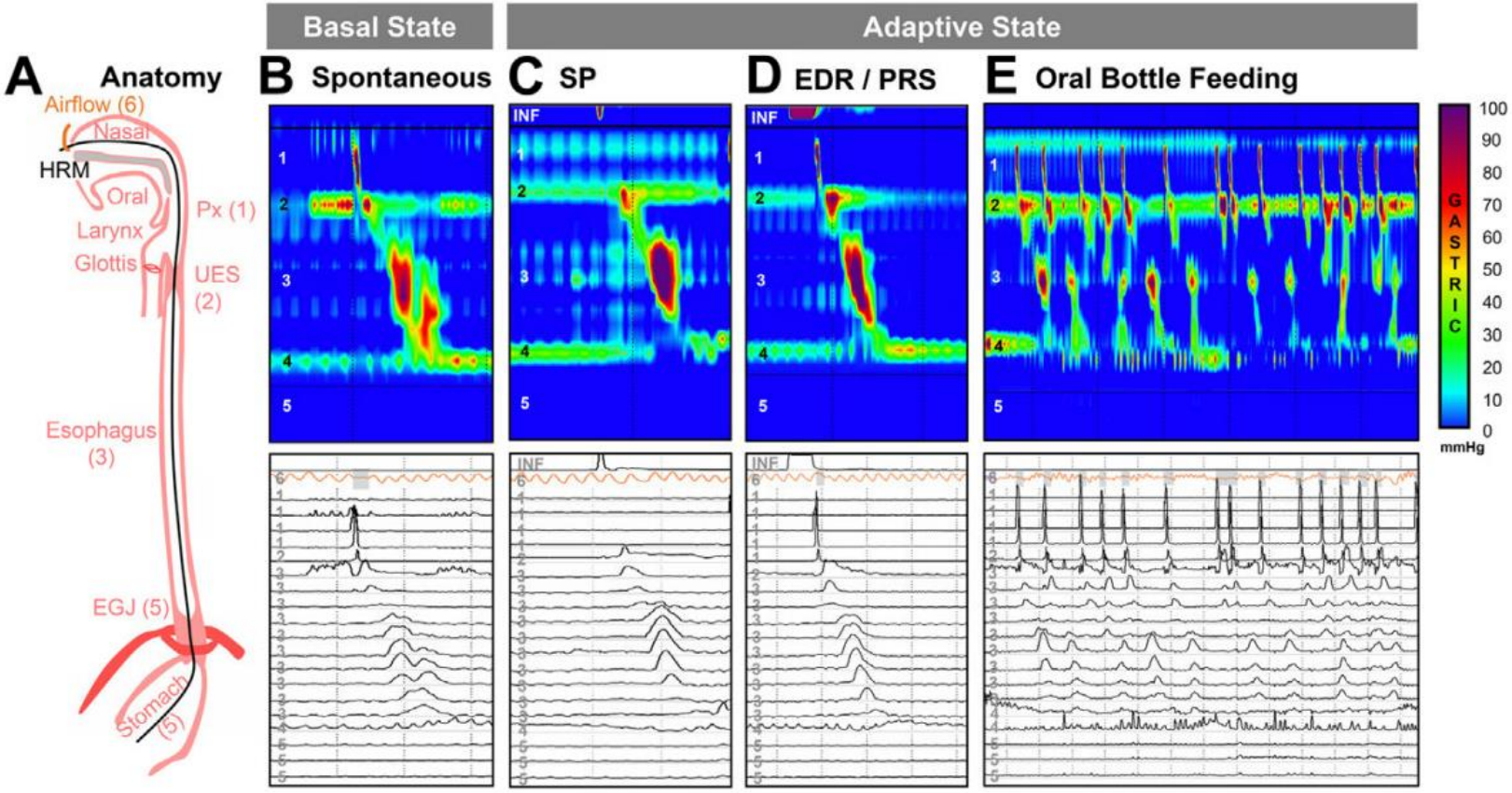
Jadcherla *et al.*, Peds Research 2020

Esophageal Manometry



Hasenstab and Jadcherla, Clin Perinatol 2022

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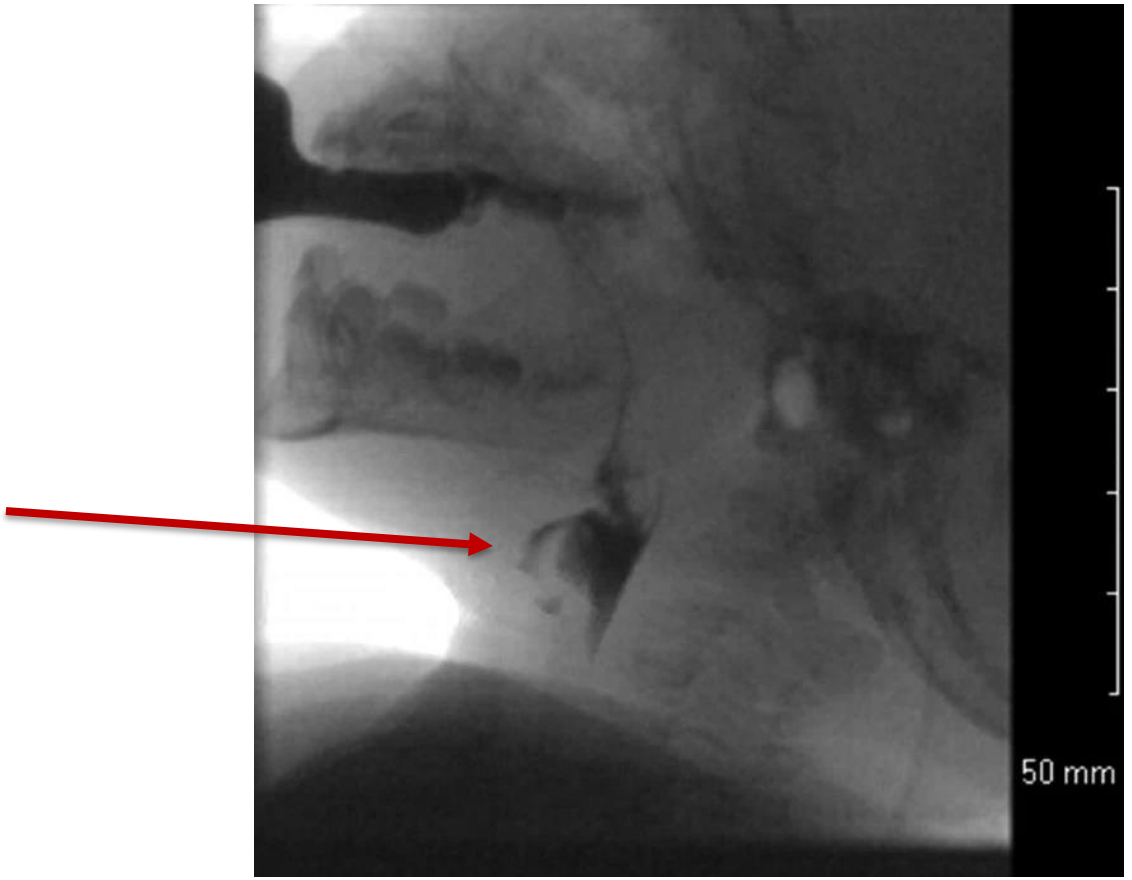
Video Swallow Study



Olson-Greb, B.K, Multidisciplinary Management of Pediatric Voice Swallowing Disorders, 2020.

Surgical Interventions

- Gastrostomy tube
- Gastrojejunostomy tube
- Nissen fundoplication

CHNC Surgical Burden in Infants with BPD

Table 3
Surgical interventions performed during NICU hospitalization.

	≤27 wk	28–33 wk	≥34 wk	All
Number of patients (N)	375	118	63	556
Number of surgical procedures (N)	888	252	158	1298
Infants with ≥1 surgery (N, %)	264 (70%)	82 (69%)	51 (81%)	397 (71%)
Mean procedures per patient (N ± SD)	3.3 ± 2.6	3.7 ± 3.2	2.5 ± 2.8	3.3 ± 2.7
Gastrostomy (N,% infants)	88 (23%)	21 (18%)	22 (35%)	131 (24%)
Fundoplication (N, %)	43 (11%)	10 (8%)	8 (13%)	61 (11%)
(% performed as open procedure)	(47)	(20)	(50)	(43)
Herniorrhaphy (N, %)	43 (11%)	10 (8%)	8 (13%)	70 (13%)
Tracheostomy (N, %)	46 (12%)	15 (13%)	7 (11%)	68 (12%)
Intraventricular drain (N, %)	62 (17%)	5 (4%)	5 (8%)	72 (13%)
Ductus arteriosus ligation (N, %)	78 (21%)	9 (8%)	2 (3%)	89 (16%)
Mean age at gastrostomy tube insertion (PMA, wk ± SD)	48 ± 10	43 ± 10	51 ± 10	48 ± 10
Mean age at tracheostomy placement (PMA, wk ± SD)	46 ± 6	48 ± 10	52 ± 7	47 ± 7
Central line utilization ratio (central line days/patient days)	0.45	0.55	0.63	0.49
Bronchoscopy (N, %)	82 (22%)	29 (25%)	12 (19%)	123 (22%)
Cardiac catheterization (N, %)	12 (3%)	7 (6%)	4 (6%)	23 (4%)

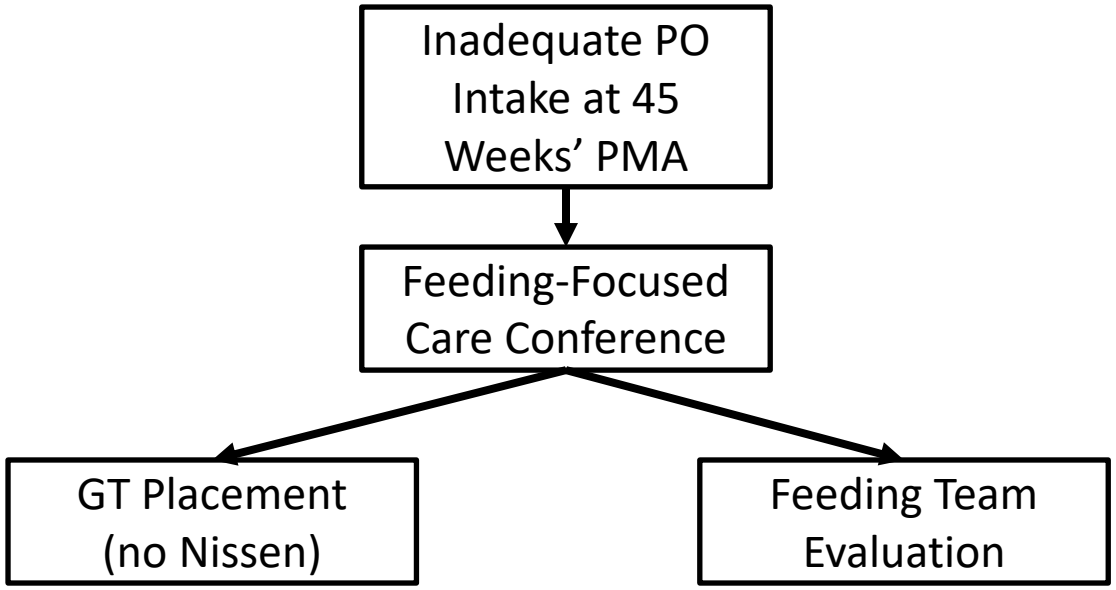
Grover *et al.*, JPeds Surgery, 2014

BPD Collaborative Surgical Burden in Infants with BPD

- Multicenter cohort (N=1039)
- GT/GJ rate – 37%
- Nissen rate – 5%

Grover *et al.*, JPeds Surgery, 2014

NCH Approach to GT Placement



- Upper GI
- Peds surgery or GI
- Advanced to full by 24 hours post-op
- Discharge within 1 week

- pH impedance
- Serial esophageal manometry
- Formula change rarely made
- ~4 week evaluation
- Often still require GT

Knowledge Gaps

- Is it safe to orally feed on CPAP?
- NJ vs NG
- GT Prediction and Timing

NG vs NJ

Pilot trial comparing transpyloric to gastric feeding in very preterm infants with bronchopulmonary dysplasia

Project Number	Former Number	Contact PI/Project Leader	Awardee Organization
1R21HD113897-01A1	1R21HD113897-01	JENSEN, ERIK ALLEN	STANFORD UNIVERSITY

NIH RePORT RePORTER

Description

Abstract Text

PROJECT SUMMARY/ABSTRACT Bronchopulmonary dysplasia (BPD), or infant chronic lung disease, is among the most devastating complications of preterm birth. BPD affects half of surviving extremely preterm infants, is associated with life- long deficits in health and cognition, and carries enormous societal burden and cost. Strikingly, there are no therapies shown to improve outcomes for infants with BPD. Our research seeks to resolve this care gap. Gastroesophageal reflux disease (GERD) is diagnosed in >40% of infants with BPD. Through aspiration and neurogenic mechanisms, GERD exacerbates lung disease in BPD by induction of bronchospasm, hypoxemia, airway injury, infection, and chronic lung inflammation. Unfortunately, there are no proven safe and effective ways to treat GERD in infants. Acid suppression and GI promotility drugs are ineffective and carry significant risks. Surgical fundoplication is invasive and often inappropriate for infants with unstable lung disease. Conversely, transpyloric tube feeding is easily initiated and has been shown to reduce aerodigestive sequelae of GER in older children and adults. Unfortunately, the safety and efficacy of transpyloric feeding in BPD is uncertain and the limited infant data are conflicting. Our preliminary data show variable contribution of GERD to lung disease in BPD and significant heterogeneity in response to transpyloric feeding. In a recent randomized trial of alternating 4d periods of transpyloric and gastric feeding in 15 infants with BPD, we showed that transpyloric feeding reduced hypoxemia and FiO2 need in some infants but worsened these in others. These findings demand identification of evidence-based means to individualize feeding route selection and GERD management in preterm infants with BPD. A key first step towards achieving this goal is to determine whether transpyloric feeding safely and effectively reduces GER in infants. To do so, we propose a randomized trial that will compare moderate duration (2wk) transpyloric vs. gastric tube feeding in very preterm infants (n=60) with grade 2-3 BPD. Serial gold-standard esophageal pH-impedance testing will be used to objectively define pre-trial GER and in-study treatment response. Motivated by our prior data suggesting heterogeneity of treatment effects, we will determine whether the tolerability and physiologic efficacy of transpyloric feeding varies by pre-trial GER severity. Common GER and lung aspiration biomarkers will be measured and compared to objective pH/MII and clinical outcome data. The results of this study will immediately inform evidence-based GER diagnosis and feeding practices in BPD and establish the foundation required to conduct a definitive, multicenter trial of prolonged transpyloric feeding in chronically tube fed preterm infants with grade 2-3 BPD who are at high risk for GER-induced lung injury.

GT Prediction and Timing

CHNC
Children's Hospitals Neonatal Consortium

Severe BPD Focus Group

THE BPD COLLABORATIVE

Nutrition ad Hoc Working Group

CHILDREN'S HOSPITAL ASSOCIATION

Pediatric Health Information System

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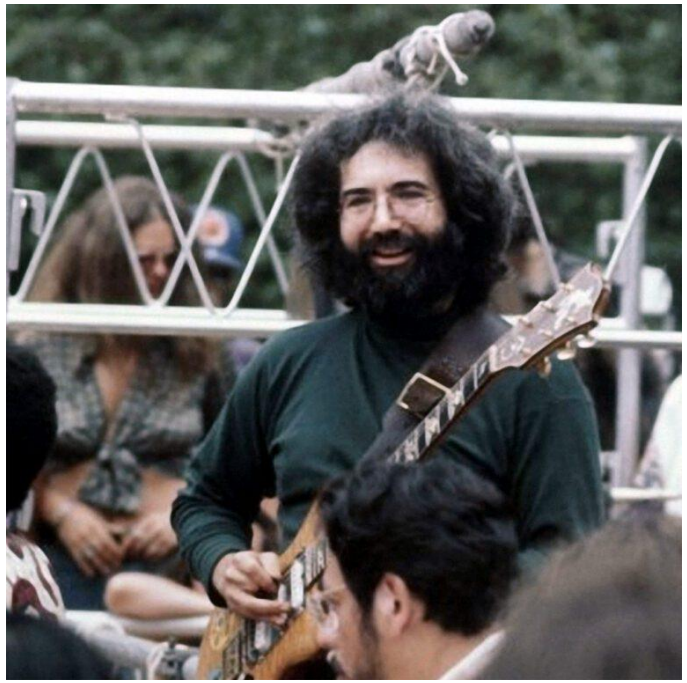
Take Home Points

- Feeding issues in infants with BPD are common but most patients experience favorable feeding outcomes.
- Limited data suggest NJ feeds may be harmful but future studies are needed.
- Ideal timing for GT placement remains unknown.

Questions



“We're like licorice. Not everybody likes licorice, but the people who like licorice really like licorice.” - Jerry Garcia