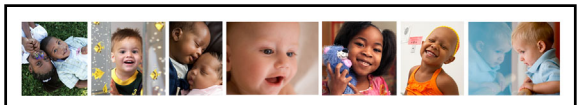

# Successful Nutritional Management of Premature Infants with Short Bowel Syndrome Using an Exclusive Human Milk Diet

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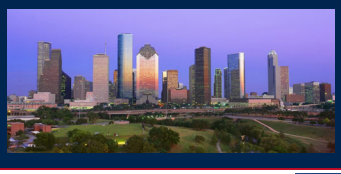
## Disclosures

- I receive research support from:

-Prolacta Bioscience® for the Human Milk Cream Length of Stay Multicenter Study (Study PI) and Cardiac Study; Fresenius for SMOF Randomized Trial





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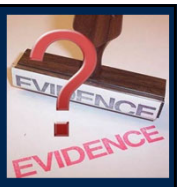
## Disclaimer




- There is limited evidence in the literature to guide how to feed premature infants with short bowel syndrome.
- The protocols I share today are from our "NICU Intestinal Rehabilitation Guidelines" at Texas Children's Hospital which have been approved by our NICU Intestinal Rehabilitation Team and Neonatology Section and are based on evidence when possible.
- Our goal is to practice in a similar manner and then research the outcomes of the protocols implemented.



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## NICU Intestinal Rehabilitation Program




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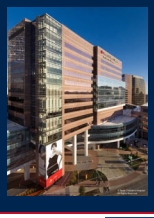
## Multi-disciplinary NICU IR team

•Management by specialized multi-disciplinary intestinal rehabilitation (IR) teams has improved outcomes for these high-risk infants

- -Neonatologists
- -Pediatric Surgeons/Surgical PAs
- -Pediatric Gastroenterologists
- -Neonatal and GI Dietitians
- -Research Dietitian
- -Care Coordinator



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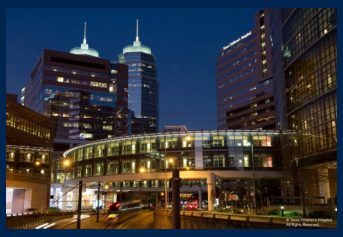
## Texas Children's Hospital Neonatal Intensive Care Unit



- 175 Total Beds
- 55 Level II
- 76 Level IV
- 44 Pavilion for Women

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## Intestinal Failure

•Reduction of functional gut mass below that needed for digestion and absorption of fluid and nutrients for maintenance of growth, hydration & electrolyte balance

•Anatomic:
-Reduced absorptive area (Short Bowel Syndrome)

•Mucosal:
-Inefficient Mucosal surface

•Neuromuscular:
-Motility disorders

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## Other definitions of Intestinal Failure

•Duration of Parenteral Nutrition
• > 42 days

-Length of residual bowel
• < 75 cm

•Very Short Gut
• 25 - 48 cm

•Ultrashort gut
• < 20 - 25 cm
• < 10 cm

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## Incidence of Intestinal Failure

•22/1000 NICU admissions

•0.25/1000 live births (24.5/100,000)
-0.03/1000 term births (3.5/100,000)
-3.5 /1000 preterm births
(Canadian Collaborative Study Group, Wales PW. 2010)

•7/1000 VLBW infants

•11/1000 ELBW infants
(NICHD Cole CR 2008)

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## Surgical causes (Short Bowel/Short Gut)

| Prenatal | Postnatal |
|---|---|
| Gastroschisis<br>Intestinal atresia<br>Apple peel syndrome<br>Midgut volvulus<br>Extensive Hirschsprung disease | Necrotizing enterocolitis<br>Midgut volvulus<br>Vascular thrombosis<br>Spontaneous intestinal perforation<br>Intussusception<br>Lymphangioma<br>Inflammatory bowel disease |

## Non-Surgical causes

| Inefficient mucosal surface | Motility dysfunctions |
|---|---|
| Congenital enterocyte disorders<br>Microvillus inclusion disease<br>Intestinal epithelial dysplasia<br>Post infectious diarrhea | Chronic intestinal pseudo-obstructions |



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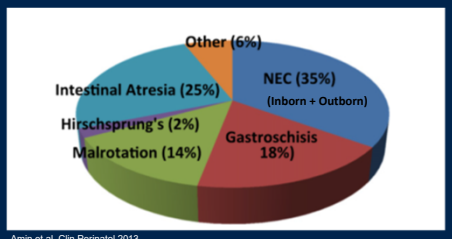
## Etiology of Short Bowel Syndrome




Amin et al, Clin Perinatol 2013



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## Do you take care of infants with Short Bowel Syndrome or Intestinal Failure?

- Yes
- No



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**Do you take care of premature infants < 1250g with GI injury leading to SB syndrome/IF?**

- Yes
- No

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## Stages of Intestinal Failure

| Acute Phase (1-3 weeks) | Recovery Phase (weeks-several months) | Maintenance Phase (Several months- several years) |
|---|---|---|
| Intestinal Adaptation | | |
| Post-op ileus<br>Fluid & electrolyte losses | Improvement in output<br>Stabilization of PN<br>Initiate enteral nutrition<br>Intestinal Adaptation | Intestinal adaptation<br>Advance enteral nutrition<br>Wean PN<br>Oral Feeds |

Batra A. Early Hum Dev 2013

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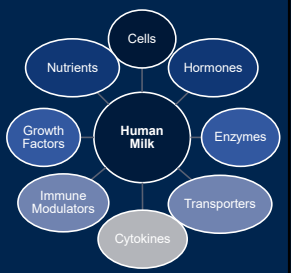
## Intestinal Adaptation

- Recovery of intestinal function
- Compensatory changes
  - -Mucosal architecture & Function
- Increase in absorptive surface area
  - -Lengthening of villi
  - -Deepening of crypts
- Increased enterocyte proliferation
- Enhanced enterocyte function

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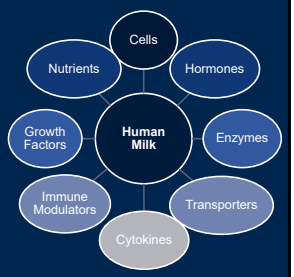
## Intestinal Adaptation

- What is the role of pasteurized donor human milk?
- What is the role of donor human milk-derived fortifier in this population?

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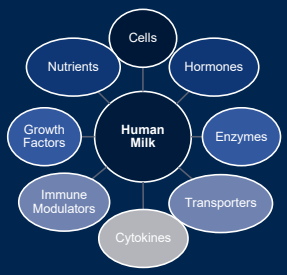
## Have you used pasteurized donor human milk in premature infants with short bowel syndrome?

- Yes
- No

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## Goals of Therapy

- Promote intestinal adaptation and intestinal growth
- Improve nutrition and promote growth
  - -Meet nutritional needs to promote growth with PN/EN
  - -Prevent nutrient deficiencies and growth failure
- Avoid Complications
  - -Minimize PN related cholestasis, blood stream infections
- Transition from parenteral nutrition to all enteral feeds
- Transition to all oral feeds

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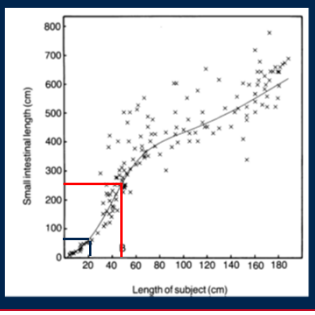
## Longitudinal Intestinal Growth




Weaver LT, Gut 1991

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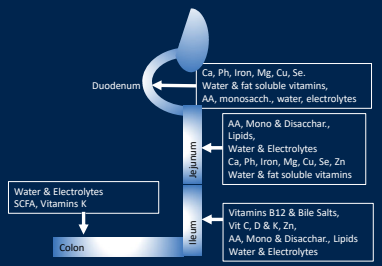
## Intestinal Sites of Nutrient Absorption

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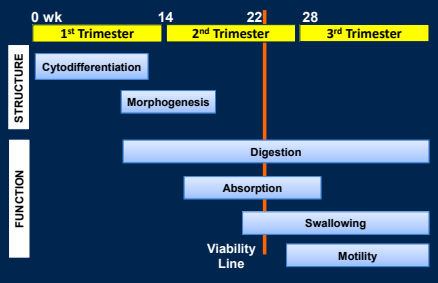
## The Developing Gut




Adapted from Commare and Tappenden, 2007 Nut Clin Pract

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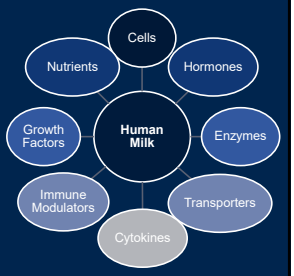
## Short Bowel Syndrome in Premature Infants

- What is the role of pasteurized donor human milk?
- What is the role of donor human milk-derived fortifier in this population?
  - -Wide spectrum of HMOs from milk donors

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## Breast milk-derived compounds with the potential to contribute to the development of the intestinal immune system

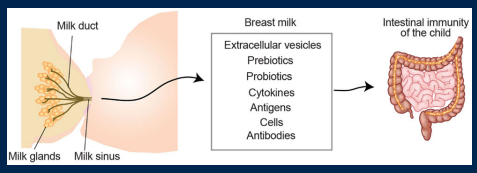


Image adapted from Eduardo J. Villablanca' s Breast milk and solid food shaping intestinal immunity.

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## Oral Care with Colostrum- Use in Premature Infants with Short Bowel Syndrome?

- Oropharyngeal administration involves placing small amounts of a liquid directly onto the oral mucosa
- Produced when the tight junctions in the mammary epithelium are open
  - Paracellular transport of immunologically derived protective components from mother's circulation into milk
- Contain various immunomodulatory agents
  - Secretory immunoglobulin A [sIgA]
  - Growth Factors
  - Lactoferrin
  - Anti-inflammatory cytokines
- More highly concentrated in preterm milk



Rodriguez, N.A., et al., Oropharyngeal administration of colostrum to extremely low birth weight infants: theoretical perspectives. J Perinatol, 2009. 29(1): p. 1-7.

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## Do premature infants in your NICU receive oral care with colostrum?

- Yes
- No



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## Role of MOM and Donor Human Milk?

- For former preterm infants < 1500 grams, should we give pasteurized donor human milk to infants with intestinal failure to promote intestinal adaptation and a more favorable microbiome?
  - Is this better than giving formula in the absence of mother's own milk?
- Should we give oral care with pasteurized donor human milk if mom's milk is unavailable?
  - If infant is a premature infant?
- How do we safely give enteral nutrition to premature infants with short bowel syndrome?



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## Advancement of Enteral Nutrition

| High Risk | Medium Risk | Low Risk |
|---|---|---|
| • **Ultra-short bowel infants (< 30 cm of remaining intestine):**<br>  • If gastrointestinal output is stable and approx. 20 mL/kg/day or less, initiate continuous feedings at approx. 10 ml/kg/day or 0.5 ml/hr<br>  • Advancement interval will be individualized | • **Infants with previous intolerance to bolus/oral feedings or anticipated need for partial long-term PN support:**<br>  • If gastrointestinal output is stable and approx. 20 mL/kg/day or less, advance by 10 mL/kg every 2-3 days as tolerated. Twice weekly volume advancements on Monday/Thurs | • **Infants without history of short-term feeding intolerance that are expected to reach full EN:**<br>  • Maintain trophic feeds for 3 days for infants <1250 g at birth<br>  • May consider providing trophic feedings to larger infants<br>  • Advance feeds as tolerated by 10-20 mL/kg/day |



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## Advancement of Enteral Nutrition

- Enteral Nutrition should provide 100-130 kcal/kg/day and 3.5-4.5 g protein/kg/day for preterm infants
- Monitor growth and adjust estimated needs accordingly

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## Fortification Strategies

- Individualized and dependent on:
  - gestational age, weight, gastrointestinal history, previous feeding history, and presence of cholestasis
- Strategies utilized may include:
  - Donor human milk-based fortifier, Bovine HMF, Elemental Formula, Transitional or Term Formulas when appropriate
- If fortification is indicated, this typically occurs when enteral nutrition volume is approximately 60-80 ml/kg/day to continue

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## Weaning of Parenteral Nutrition

- If infants are advancing well on EN, central lines may be removed when infant is receiving approx. 100-120 mL/kg/day of EN
- Exceptions:
  - Infants with high or medium risk conditions
  - Infants with history of feeding intolerance followed by NICU Intestinal Rehabilitation Team
- These at risk infants should demonstrate adequate growth and tolerance to enteral nutrition and fortification prior to removing central lines as they can exhibit inadequate growth and might require PN in conjunction with EN for additional caloric intake for a period of time.

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## Premature Infants < 1250 g Birth Weight

- Congenital or Acquired Intestinal Failure
  - -Atresias
  - -Necrotizing Enterocolitis
  - -Spontaneous Intestinal Perforation
    - Ostomy with bowel in discontinuity for prolonged period
  - -Mid-gut volvulus
  - -Segmental volvulus
  - -Prolonged "dysmotility of prematurity"



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## Premature Infants < 1250 g Birth Weight with IF

- When feeds are started:
  - -Start with trophic feeds at 20 mL/kg/day usually bolus
  - -Fortify at 60 mL/kg/day with +6 donor human milk-derived fortifier
  - -Once feeds at 100 mL/kg/day with +6 donor human milk-derived fortifier, start to wean off parenteral nutrition
    - If infant advances to full volume feeds and demonstrates adequate growth (15-20 g/kg/day) then PN is discontinued
  - -Continue until 34 weeks PMA or until full feeds are reached for 2 weeks post-operatively



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## Premature Infants < 1250g Birth Weight

- An exclusive human milk diet is well tolerated by premature infants pre- and post- operatively
  - -Early fortification
  - -No concerns about increased osmolarity with increased fortification
  - -Can give increased enteral calories with donor human milk-derived fortifiers
  - -Theoretical benefits of exposure to many HMOs in exclusive human milk diet
  - -Can minimize exposure to lipid emulsions and parenteral nutrition by advancing feeds quickly



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Questions?
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