Human Milk as a Biological System: Implications for Infant Feeding

Daniel J. Raiten, Ph.D.
Program Director - Nutrition
Overview of B-24 Report and P/B-24 for 2020
Results of systematic reviews conducted by NESR to address some of these questions have been published:

“P/B-24 Project” Supplement, published April 15th, AJCN:
Nutritional Ecology of Infant Feeding

Factors Affecting Biology and Choice
An Approach to Addressing the Role of Nutrition in MCH

**Research Track**
- Fund research grants using established NIH mechanisms, procedures, and policies

**Translational Track**
- Work with domestic and international authoritative agencies to translate evidence into practice and policy

**GOAL**
- Improve the health of women/mothers and children
The Nutritional Ecology: “External” Factors affecting infant feeding practices

Physical/Economic/Social/Behavioral Environments

Diet/Nutrition
- nutrient exposure/status
- food/ag systems

Health Outcomes
- clinical/population assessment/care
- program M&E

Nutritional Ecology
The Nutritional Ecology: “Internal” Understanding the biology of HM

Physical
Extra- intra-cellular environment

Diet/Nutrition
nutrient exposure/status
nutrient: nutrient interactions

Health Context
processes of nutrition; genetics/epigenetics
Xenobiotics (drugs/toxins)

Nutritional Ecology
Environmental and Biological Context: Factors influencing choice

Environment

• Social/economic: systems for support
  ➢ Home (who’s the caregiver and who else is involved?)
  ➢ Workplace (is there support for breastfeeding?)
  ➢ Outside home (childcare situation: who else is feeding our babies?)

• Cultural practices

• Behavioral
  ➢ Attitudes
  ➢ Beliefs

• Biology…
Human Milk: Composition and practice

• Mode of feeding: is it the bottle or what’s in it? Pump vs breast vs donor/banked human milk.
  ➢ Role of the microbiomes (mother, milk, baby)

• Compositional changes over time:
  ➢ Within feeding
  ➢ Over the course of the day
  ➢ Over the course of lactation
  ➢ Implications for complementary feeding:
    o Nutrition
    o Bioactives: how long do babies need to be exposed to bioactive components (human milk oligosaccharides [HMOs], etc.)
    o Can maternal diet/nutritional status affect HMO/bioactive biosynthesis, patterns, composition of human milk?
    o How do we feed the answers to these questions into current/future dietary guidance for lactating women?

• Duration of exclusive and continuous BF: both in terms of nutrition and bioactives
Human Milk
A Model System
Human Milk: A poorly understood biological system

Components of Human Milk

Maternal Factors:
- Mammary gland biology/maternal health/diet/genetics

Infant Factors:
- Sucking/reflux/health oral microbiome

How do we understand this complex system?
- Is there cross-talk?
- How does the infant interact with this system and mom?
- What factors influence mom’s contribution?

TIME: GA/of day/over lactation
“Only a few decades ago, most experts considered HMO (HMOS) to be an incidental consequence of high concentrations of glycosyltransferases (for glycoprotein and glycolipid synthesis) in proximity to high concentrations of lactose in the mammary epithelium.”


Now..
Breastfed infants have a lower risk of developing otitis media than formula-fed infants.
Common pathogens of otitis media are inhibited by HMOS and/or HMGs.

Breastfed infants have a lower risk of developing enteric infections and autoimmunity than formula-fed infants.
HMOS and HMGs inhibit binding of enteropathogens to mucosal receptors.
HMOS suppress mucosal inflammation.

Breastfed infants have a lower risk of developing severe enteric infections and autoimmune disease than formula-fed infants.
The microbiota of breastfed infants contains abundant, beneficial bifidobacteria.
HMOS support the growth of bifidobacteria and their production of organic acids.
HMOS and HMGs inhibit the binding of enteropathogens to mucosal receptors.
HMOS suppress mucosal inflammation.
A Research Agenda—Bioactive components of HM

- Literally **thousands of “non-nutritives”** in human milk
- Likely ALL important
- Many are likely inter-related

**Immune cells and immune factors**
- Abundant and complex
- Critical for infant and mammary health
- Context-sensitive: personalized to the individual and variable across the globe and influenced by:
  - environment
  - maternal health
  - infant health
  - diet

**Human milk oligosaccharides**
- Abundant and complex
- Multiple roles, related to specific structures of specific HMO types
- Personalized to a woman and variable around the globe

**Milk microbiome**
- Complex
- Personalized to a woman and variable around the globe
- Related to maternal nutrition
- Likely important for breast health and colonization of infant GI tract
Human milk for low birth weight/preterm infants

• Composition of preterm milk:
  • Fortification? If so,
  • with what?
  • Nutrients only?
  • Bioactives? HMO? Peptides?

• Developmental issues re: nutritional and non-nutritional components; infant’s capacity for:
  ➢ Exposure: parenteral/enteral/oral
  ➢ Digestion
  ➢ Absorption
  ➢ Utilization (e.g., LCPUFA, vit B6)

• Donor milk: banked: what’s in it?

(Raiten et al., Pre-B Report. AJCN, 2016)
Take-home messages...

- Factors influencing the biology and choice are a complex interplay of external and internal “ecologies.”
- Understanding the biology of lactation and human milk composition requires a ‘systems’ approach that incorporates consideration of the myriad maternal and infant factors involved.
- Determining the nutritional needs of both mothers and infants requires a deeper appreciation of nutrition as a biological variable that affects and is affected by health and developmental stage.
- We need to translate our knowledge about both biological and environmental factors affecting internal and external nutrition ecologies into:
  - Palatable and accessible messages for consumers to inform decisions about infant feeding.
  - Avoid unintended consequences.
Thank you!