The Influence of Birth and Feeding Methods on the Infant Gut Microbiome

Emily R. Rudis

Margaret H. Rollins School of Nursing

N201: Nursing Care of Special Populations

D. Blankenship, RN

November 6th, 2023

The Influence of Birth and Feeding Methods on the Infant Gut Microbiome

While every human has a microbiome, not much about it is widely understood and many may even be unaware of its existence. The microbiome is a network of over 3 trillion microbes, including bacteria, viruses, and yeast that exist within the human body (Young, 2024; Zhang et al., 2022). Most of these microbes live in the gut and have a mutually beneficial relationship with the host (Zhang et al., 2022). The microbiome can be thought of as an organ that helps the body to function properly. Included here is the role of the gut microbiome, how it is established, factors that impede healthy development, and how infant birth and feeding methods influence the composition.

The microbiome lives in symbiosis with the body, meaning that both the body and the microbes benefit from this relationship. It plays a pivotal role in developing an individual's immunity, regulating metabolism, and influencing psychosocial behavior (Young, 2024). Perhaps the most interesting thing about the microbiome is that it is dynamic in nature, continually changing in composition based on an individual's development, environmental exposure, diet, and use of medications (Enav et al., 2022). Because of this, no two microbiomes are the same. Due to its susceptibility to change, the balance between the microbiome and the immune system can be disrupted, also known as dysbiosis (Zhang et al., 2022). Dysbiosis has been associated with obesity, type 2 diabetes, hypertension, asthma, allergies, C. difficile infection, colon cancer, necrotizing enterocolitis (NEC), inflammatory bowel disease (IBD) and some neurological diseases like autism, depression, and multiple sclerosis (Young, 2024; Zhang et al., 2022). Effectiveness of the innate immune system, risk for disease development, and lifelong health are influenced by the condition of the microbiome (Zhang et al., 2022).

Establishment of the microbiome begins at birth. Immediately a newborn is exposed to an

extrauterine environment abundant with bacteria which supply the infant gut with its first microbe inhabitants (Zhang et al., 2022). Ideally, the very first microbes the infant is exposed to come from the maternal microbiome through contact with the birth canal (Enav et al., 2022). Within the first seven days of life the initial colonization rapidly multiplies, establishing the foundation which determines lifelong stability of the microbiome (Zhang et al., 2022). This is a pivotal time in the infant's life that will determine the ability to fight infection and later impacts health throughout adulthood (Zhang et al., 2022).

Factors impeding healthy development of the infant microbiome include those that influence the maternal microbes such as diet, BMI, and antibiotic exposure (Lundgren et al., 2023). Antibiotic use has been shown to cause dysbiosis by decreasing both harmful and beneficial bacteria in the gut (Zhang et al., 2022). When used in the perinatal period, antibiotics alter the maternal microbial composition leading to dysbiosis of the infant microbiome (Zhang et al., 2022). It is imperative that health care providers seriously consider the risks and benefits of antibiotic use and only prescribe perinatal antibiotics when it is necessary for the health of the mom or baby. However, factors other than maternal microbes also have an adverse effect on the developing infant microbiome. Among the most important concerns are birthing and feeding methods (Lundgren et al., 2023).

With vaginal birth, the infant's first exposure to microbes comes from the mother's intestines and vagina as it passes through the birth canal (Zhang et al., 2022). This exposure establishes a protective foundation for the newborn. However, infants born via cesarean section (c-section) do not encounter the birth canal and are first exposed to microbes within the hospital environment (Enav et al., 2022). This creates a potential for exposure to opportunistic pathogens existing in the hospital setting and among hospital staff prior to proper establishment of a

protective intestinal microbiome (Enav et al., 2022). Although differences in microbial composition, according to delivery method, have been shown to decrease over time, the gut microbiota of vaginally born infants is more stable spanning the first year of life (Enav et al., 2022).

Because the infant lacks exposure to the valuable microbes of the birth canal, c-section delivery method increases risk of diseases associated with dysbiosis (Zhang et al., 2022). Additionally, mothers undergoing surgical delivery are likely to receive antibiotic treatment, altering the maternal microbial load. However, evidence shows that when administered to the mother after cord clamping, antibiotic effect on the neonate was diminished (Enav et al., 2022). C-section delivery may also slow the onset of breastfeeding, a process crucial to passing immunity to the infant (Li et al., 2021).

Interventions to circumvent risks associated with c-section birth method exist. Health care providers can administer antibiotics to the mother after cord clamping rather than before surgery when appropriate. Nurses and other members of the maternal health care team should encourage the mother to begin pumping colostrum prior to arrival for planned c-sections so that there is supply available, providing passive immunity to the infant if surgery slows lactation or initiation of breastfeeding. Also, vaginal seeding can be performed in the operating room (Mueller et al., 2023). This procedure involves collecting a mother's vaginal secretions with gauze and then transferring it to the infant's mouth, eyes, and skin after delivery (Mueller et al., 2023). Seeding introduces the infant to microbes from the birth canal, creating a microbial exposure like that of a vaginally delivered infant. A controlled study examined the effects of vaginal seeding in 20 c-section deliveries, exposing half of the infants to vaginal secretions and half to a sterile saline placebo immediately after delivery, before skin-to-skin contact with the

mother was initiated (Mueller et al., 2023). Seeding was shown to increase maternal-infant microbial transmission, caused no adverse effects, and reduced potentially pathogenic bacterial species existing within the infant stool even after 30 days of life (Mueller et al., 2023).

The American Academy of Pediatrics recommends feeding exclusively breastmilk to all infants until 6 months of age because of the immediate and long-term advantages it provides to the mother and baby (Pados, 2023). Human milk contains biologically active components including prebiotics, microbes, immune cells, and micro-RNAs, transferred to the infant with the help of immunoglobulin A, all of which contribute to the newborn's immune system (Lundgren et al., 2023). Macrophages and leukocytes within the breast milk kill pathogenic bacteria, while milk sugars stimulate growth of desirable microbes within the infant's intestinal tract (Zhang et al., 2022). In addition to those that make up the milk composition, microorganisms existing on the skin around the mother's nipple are also transferred to the infant while breastfeeding (Lundgren et al., 2023). Time of breastfeeding initiation is an important factor, with earlier exposure especially in the first days of life, having the most optimal impact (Pados, 2023).

One study evaluated reports from research teams on the impact of breastmilk on multiple pathologies and found that 57% reported a reduced incidence, severity, or risk of death attributed to NEC (Pados, 2023). 56% found that breast milk positively affected sepsis and infection rates, showing decreased persistence of infection with treatment and less antibiotic resistance (Pados, 2023). 94% of the studies found that breastmilk reduced pain and stress (Pados, 2023). Overall, the data showed human milk to have an astounding impact on immunity, inflammation, and the microbiome with 93% positive outcomes and no negative impact reported (Pados, 2023).

According to the CDC, 83.1% of children born in 2020 in the United States were initially breastfed, but only 25.4% continued to be exclusively breastfed through the first six months of

life (National Center for Chronic Disease Prevention and Health Promotion, 2023). The main reasons for early cessation of breastfeeding are perceived low milk supply, difficulties with latching, other breastfeeding challenges, and barriers associated with returning to employment or school (Hornsby et al., 2019). The American Academy of Pediatrics recommends the following evidence-based interventions to enhance primary care support of breastfeeding: staff education, community resources, and incorporation of breastfeeding observation in routine care (Kawan et al., 2022).

Nursing practice must incorporate interventions to allow for achievement of the mother's breastfeeding goals. Lactation consultation should be encouraged to all patients as it is essential to identify issues with lactation early in the breastfeeding process. Nurses should observe the latch and positioning and intervene, providing demonstration when necessary. An individualized feeding plan should be created in collaboration with the mother to incorporate a schedule that accommodates personal preferences and obligations. Education on benefits of breastfeeding, maintaining lactation, and community resources should be provided to the mother and support system (Kawan et al., 2022). Workplaces should provide nurses and other multidisciplinary team members with lactation education as it has been shown to strengthen staff knowledge and attitudes about breastfeeding (Parker et al., 2021).

Regulation of the microbiome can be used as therapeutic treatment in healthcare practice by preventing and correcting dysbiosis (Young, 2024). Current methods include introduction of new microbes or modification of the existing microbial community (Young, 2024). Targeted antibiotic treatment is used to eliminate specific undesirable strains of bacteria, while prebiotic and probiotic supplementation enhances the presence of beneficial microbes within the gastrointestinal tract (Young, 2024). While the microbiome can be manipulated later in life, it is

important to ensure a good foundation is created at birth to establish the infant immune system.

Understanding the complexities of the microbiome is crucial for health care providers as it affects the health of every patient. Because of its dynamic nature, the microbiome can be manipulated to beneficially impact an individual's immune system, risk for disease, and lifelong overall health condition. As it is first established at birth, methods to initiate the most effective infant gut microbiome must be implemented in nursing and healthcare practice. It is most important to focus efforts on interventions that impact infant birth and feeding methods, providing the greatest benefit to the establishment of the individual microbiome.

References

Enav, H., Backhed, F., & Ley, R. E. (2022). The developing infant gut microbiome: A strain-level view. *Cell Host & Microbe, 30*(5), 627-638. https://doi.org/10.1016/j.chom.2022.04.009

Hornsby, P. P., Gurka, K. K., Conaway, M. R., & Kellams, A. L. (2019). Reasons for early cessation of breastfeeding among women with low income. *Breastfeed Med*, *14*(6), 375-381. https://doi.org/10.1089/bfm.2018.0206

Kawan, M., Gregory, E. F., & Spatz, D. L. (2022). Improving breastfeeding care & support in a large, urban, pediatric primary care practice. *Journal of Pediatric Nursing*, *70*, e3-e8. https://doi.org/10.1016/j.pedn.2022.10.007

Li, L., Wan, W., & Zhu, C. (2021). Breastfeeding after a cesarean section: A literature review. *Midwifery*, *103*, 103-117. https://doi.org/10.1016/j.midw.2021.103117

Lundgren, S. N., Madan, J. C., Karagas, M. R., Morrison, H. G., Christensen, B. C., & Hoen, A. G. (2023). Human milk-associated bacterial communities associate with the infant gut microbiome over the first year of life. *Frontiers in Microbiology*, *14*, Article 1164553. https://doi.org/10.3389/fmicb.2023.1164553

Mueller, N. T., Differding, M. K., Sun, H., Wang, J., Levy, S., Deopujari, V., Appel, L. J., Blaser, M. J., Kundu, T., Shah, A. A., Dominguez Bello, M. G., & Hourigan, S. K. (2023). Maternal bacterial engraftment in multiple body sites of cesarean section born neonates after vaginal seeding – A randomized controlled trial. *American Society for Microbiology*, *14*(3), 1-11. https://doi.org/10.1128/mbio.00491-23

National Center for Chronic Disease Prevention and Health Promotion. (2023, August 1). *Results: Breastfeeding rates*. Centers for Disease Control and Prevention. https://www.cdc.gov/breastfeeding/data/nis_data/results.html

Pados, B. F. (2023). State of the science on the benefits of human milk for hospitalized, vulnerable neonates. *Nursing for Women's Health*, *27*(2), 121-140. https://doi.org/10.1016/j.nwh.2023.01.008

Parker, M. G., Stellwagen, L. M., Noble, L., Kim, J. H., Poindexter, B. B., & Puopolo, K. M. (2021). Promoting human milk and breastfeeding for the very low birth weight infant. *American Academy of Pediatrics*, *148*(5), 1-15. https://doi.org/10.1542/peds.2021-054272

Young, V. B., (2024). The human microbiome. In L. Goldman & K. A. Cooney (Eds.), *Goldman-Cecil medicine* (27th ed., pp. 1836-1840). Elsevier.

Zhang, H., Zhang, Z., Liao, Y., Zhang, W., & Tang, D. (2022). The complex link and disease between the gut microbiome and the immune system in infants. *Frontiers in Cellular and Infection Microbiology*, *12*, Article 924119. https://doi.org/10.3389/fcimb.2022.924119