

Probiotics for Hospital Use: Choosing the Right Strain, Right Food and Right Form

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The Origins of the Infant Gut Microbiome

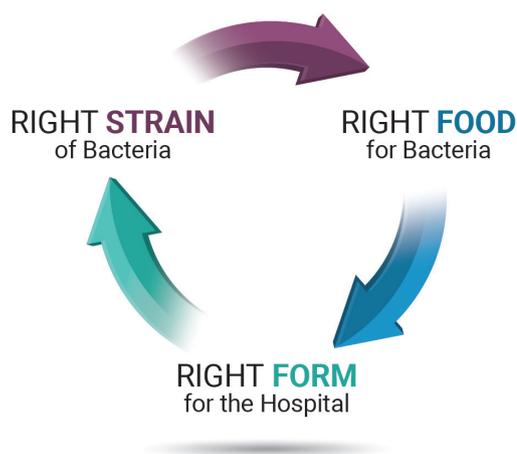
Considerable attention and research funding have recently been put toward understanding the role of the gut microbiome in human health, and its therapeutic potential for both infectious and chronic disease. Despite this increased effort, we are only beginning to understand how the infant gut microbiome is first established, how the microbial community is shaped, and the effect this critical period has on infant health.^{1,2} The organisms that comprise the gut microbiome are initially acquired at birth, and are largely dependent on delivery mode: vaginal vs C-section.³ Shortly following delivery, an infant's community of gut microbes is strongly shaped by diet, with human milk fostering the growth of a distinctly unique gut microbiome compared to formula fed infants. Finally, gut physiology and environmental exposure, such as the use of antibiotics, can further impact each individual gut microbiome. It is now increasingly recognized that this early composition of the newborn gut microbiome plays a major role in lifelong disease risk, as well as the acute risk of infection by opportunistic or overt pathogens.^{1,2} For health care providers, this becomes a unique opportunity to influence acute drivers of dysbiosis as well as the trajectory of an infant's lifelong health through careful consideration of each of these factors.

Historically, it has been observed that the gut of breast-fed infants was uniformly colonized by *Bifidobacterium*, the keystone gut symbiont of infants.⁴ Early *Bifidobacterium* colonization has potentially profound and beneficial effects for the infant, including a role in important immunological and metabolic programming events in the first few months of life.² *Bifidobacterium longum* subsp. *infantis* (*B. infantis*) is a particular type of bifidobacteria that is well adapted to the infant gut, in part due to its ability to consume complex carbohydrates found in human milk.⁵ This diverse set of carbohydrates, called human milk oligosaccharides (HMO), naturally make up about 15% of nutrients in human breast milk. Remarkably, these complex carbohydrates are not digestible by the newborn. Instead, HMOs are consumed by bacteria in the infant large intestine, or otherwise excreted in the infant stool.

Dysbiosis – an Emerging Issue in Healthcare

Recent research in the area of the infant gut microbiome has shown that HMOs are preferentially consumed by certain strains of bacteria, such as *B. infantis*, which can convert these

carbohydrates to short chain fatty acids in the infant intestine. In the scientific literature, intestinal short chain fatty acids have been shown to lower intestinal pH, improve gut barrier function and serve as energy signaling molecules during growth and development.



An infant gut microbiome colonized by *B. infantis* and fed by human breast milk will flourish and minimize the growth of pathogenic bacteria.⁶ However, if beneficial bacteria such as *B. infantis* are not present, other potentially harmful bacteria can partially utilize these milk oligosaccharides for growth, such as *Streptococcaceae*, *Staphylococcaceae*, *Clostridiaceae*, and *Enterobacteriaceae* often found in the dysbiotic infant gut. High populations of *Enterobacteriaceae* are increasingly recognized as having a negative impact on long term health and represent gut community dysbiosis.^{2,7} Recent work has indicated that blooms of gut microbial populations associated with gut dysbiosis play a role in everything from colic to Type 1 Diabetes. Although probiotics are hypothesized to alleviate this dysbiosis, the reported results are not consistent across probiotic organisms. Notably, a recent publication reported for the first time that significant modification of the infant gut microbiome, and complete resolution of dysbiosis, is possible through probiotic feeding of *B. infantis* in breastfed infants.⁸

Safely Building a Healthy Infant Microbiome in a Hospital Environment

With new data emerging that supports the use and efficacy of probiotics in infants, special consideration must be used for use in a hospital setting. First, as discussed above, the selection of an infant-adapted bacterium along with the appropriate fuel source

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to promote growth of these beneficial bacteria is key to seeding and feeding a protective gut microbiome. Human milk has many well-known benefits for the newborn infant, and it now appears that human milk has an equally important role in shaping the infant gut microbiome. Additionally, the method of delivery is particularly important in a hospital setting, where quality, ease of use and adaptability to existing feeding protocols (ie. enteral feeding tubes) will play a role in both safety and efficacy of probiotic administration. As powdered formulations of dietary products are often not allowed in hospitals nurseries, a single use, liquid formulation probiotic would be not only preferred but required.

While considerable work is yet to be done to validate the efficacy of probiotics in reducing risk of disease, there must be a thoughtful rationale to choosing the appropriate beneficial bacteria, paired with the appropriate food source, and administered in the right form for maximum benefit.

References

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Reference: 1. Frese SA et al. *mSphere*. 2017;2(6):e00501-17.
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